EDUCATIONAL RESOURCES

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- Herbal Garden
- Resource Center
- Theme Park

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PREFACE

“Experience is the Best Teacher”

From the constructivist paradigm of teaching science, authentic experience is greatly emphasised as experiential learning, which enables students to appreciate science and is a sure way of getting students interested as per their choice. But how to get this message across to the pre-service trainee teachers in a teacher preparation programme such that it can be translated into a reality in their classroom practices with confidence when they are in schools in the later years? The best effective way is by showing the student-teachers the hands on doing approach by means of experiencing the indigeneous best practice paradigm that encompasses authentic experiences by them.

The true potential of any learning beyond and outside the classroom is the opportunity to model the concepts taught in a real-world context. The phrase “bring subjects to life” can be overused by all attractions, but behind this lies the undeniable truth that students engage with learning in multiple ways and that visiting **Educational Theme Parks** can motivate all levels of learners in their career. Positive impacts of outdoor education, recognised worldwide, include greater awareness of conservation issues, positive attitudes towards the environment, enhanced environmental knowledge, positive social experiences, and identity building. Indian teachers are also known in “story-telling” and activity-based teaching outside the set-up of a typical classroom. When learners are empowered to be aware of and in control of effective learning, they become better learners. Such places as theme parks provide a novel opportunity for students to experience phenomena and solve related problems through metacognitive engagement. This institute has developed a theme park with several models related to concepts of natural science, physical science and social sciences to improve education quality and to inculcate creativity and innovativeness among students.

According to NEP 2020, teacher education is the pillar that brings not only the teacher to the classroom but also the classroom to the students as the teaching-learning flows in a joyful experiential process that enhances the development of new human resources at one hand and creates new learners on the other. Integrating Science, Mathematics, Language and appropriate social science with pedagogy is vital in pre-service teacher preparation and in-service teacher development.

"I hear - and forget. I see - and remember. I do - and understand." This Confucian utterance is often considered the foundational basis of educational resource centres. With this vision in mind, the Regional Institute of Education, Bhubaneswar, has indigenously developed an unique resource centre to address various pedagogical challenges and foster critical thinking and decision-making skills in pre-service and in-service teacher education programmes. **Educational Resource Centre** helps to reinforce and extend the learning of concepts, skills and learning outcomes introduced in the classroom. It is not that every student will understand a concept right away, so they must have a place where they can go for further help and unleash the power of critical thinking. The resource centre is envisioned to enrich a sense of community, foster intellectual collaboration, preserve specimens and indigenous samples and ultimately improve the quality of teaching and learning within the institute. The resource centre of the institute is well-equipped with models, charts and materials for hands-on activities. Developing a resource centre aims to facilitate the experiential learning process for children at upper primary, secondary and senior secondary stages, which can make absorbing complex concepts fun for students. Visits to resource centres can thus broaden the horizons of both teachers and students. Here the teacher is introduced to new subject-matter developments and presentation techniques. At the same time, the student enters doors of self-discovery, independent study, and new experiences outside the classroom. This book showcases the various activities and game-based activities through which the play-way mode of teaching-learning can not only be activated but is expected to convert situation-based aroused motivation into intrinsic motivation and deep-understanding strategy for long-term impacts in learning among our students.

India is a treasure house of **Medicinal Plants**. Out of 18,000 species of higher plants reported in India, about 7000 plant species are known to have medicinal values. No other country has this much proportion of medicinal plants against the existing flora. Since time immemorial, various medicinal plants for curing different diseases/ailments of humans and animals have been used by Indians. The Indian Systems of Medicine (ISM) is one of the famous medical systems, which includes Ayurveda, Siddha, Unani, Homeopathy and other indigenous practices. The World Health Organisation (WHO) shows that 80% of the population in developed and developing countries depends on traditional plant-based medicines for their health requirements.

Due to increasing export demand, the local people's dependence on the herbal flora-fona and their implicit traditional faith on Ayurvedic medicines would go a long way in exploiting the wild plants for commercial return and expanding research activities to gain productive results. Hence, overharvesting, loss of habitat, increasing urbanisation and shrinking forest resource base have been causing irreversible loss of medicinal plant population in the wild habitat, resulting in a decline in the volume of raw materials.

A significant part of knowledge and tradition is being eroded due to modernisation, acculturation and the availability of alternatives. The herbal garden at R.I.E. Bhubaneswar has been developed and maintained so that young minds can inculcate the fascinating knowledge and tradition associated with these resources and help them to realise the immense potentials the medicinal plants possess for the future. “Promoting Herbal Gardens” in educational institutes can be a fun□filled learning activity for the students where they will get the opportunity to learn about the medicinal plants by planting them and by exploring information about them from various sources.

The most critical challenges today are climate change, pollution, human population growth, overexploitation of natural resources and habitat loss. Together, these challenges threaten the existence and sustainable use of natural resources for present and future generations. According to the United Nations, education for sustainable development (ESD) empowers learners to make informed decisions and take responsible actions for sustainable development. Biodiversity is included in the cognitive, socio-emotional, and behavioural learning domains and competencies for sustainable development goals. Education in biodiversity conservation is essential in shaping children’s knowledge of and attitudes towards preserving biodiversity. Regional Institute of Education has a rich photo-diversity and faunal diversity. Institute’s nature-based education programmes for children foster positive values and attitudes towards wildlife that contribute to conserving biological heritage for the future.

This book integrates innovative pedagogical strategies with multiple growths, opportunity, and collaboration avenues. The developers of this book have proficiently designed this content to be a torch-bearer of transformative educational hands-on programmes that serve as platforms for continuous cycles of discussion, innovation, evaluation and renewal, which may be emulated in future times. Together, the resource centre, theme park and herbal garden might serve as a valuable base for such school-based “in-service training” — a place where teachers can rethink what they are about in the best possible way — by uniting theory and practice in questioning assumptions, methods, and even goals.

Prof. P. C. Agarwal
Principal

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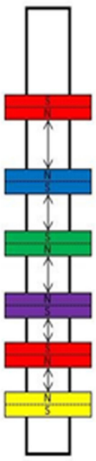
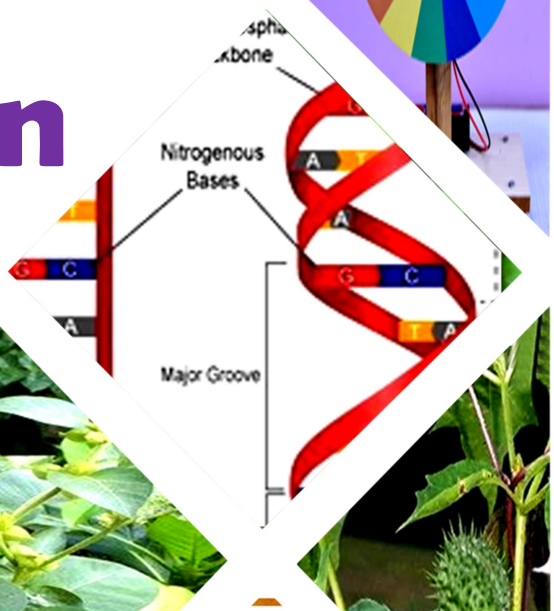
We are confident that this book on Educational Resources of RIE, Bhubaneswar would be extremely helpful for all the stakeholders which include school students, in-service and pre-service teachers for holistic development of School Education as per the recommendation of the NEP-2020.

Prof. P. C. Agarwal
Prof. S. K. Dash

CONTENT

Introduction





विद्या प्रशस्यते लोकैः विद्या सर्वत्र गौरवा।
विद्यया लभते सर्वं विद्वान सर्वत्र पूज्यते।।

(Everyone extolls knowledge, knowledge is considered significant everywhere, and one can attain everything with the help of knowledge. A knowledgeable person is respected everywhere.)

There are many paths of learning for self-realisation:
Śravaṇa (listening), *Manana* (reflection/contemplation/clearing of doubts),
and *Nididhyasana* (meditation on the truth/integration/experience):
three basic sequential techniques for mastering a subject matter.
(Vedic Education)

Education is the manifestation of the perfection already present in man.
(Swami Vivekananda)

Education is bringing out and nurturing the latent potentialities, integrating oneself with self, the harmonious living of an individual with society, country and humanity to make oneself a complete being or integral human being.
(Sri Aurobindo)

Education means enabling the mind to find out that ultimate truth which emancipates us from the bondage of dust and gives us wealth not of things but of inner light, not of power but of love.
It is a process of enlightenment. It is divine wealth. It helps in the realisation of truth.
(Rabindranath Tagore)

The primary focus of the students should be to excel in their studies. This is their first contribution to the development of the nation. The education system should instill in the minds of students capacities of inquiry, creativity, technology, and entrepreneurial and moral leadership.
(Dr. APJ Abdul Kalam)

Introduction

Education in India has witnessed a paradigm shift in recent times. There was once a time when the guru's knowledge and experience were considered infallible and total. Today, education is witnessing unprecedented scrutiny from all segments of society. The world is changing at an incredible pace. We must now understand that we are preparing our children for the unknown, unseen and unpredictable. Education is not just teaching the prescribed syllabus but opening the mind to multiple possibilities, imbibing life skills and preparing for entrepreneurship in every walk of life. The ideas will be beyond the textbook and more aligned to knowledge application rather than retention assessment.

Cognitive abilities are often enhanced in cooperative child-centric learning environments where the focus is on the joy of experiencing what is taught beyond the realms of a classroom. In the words of Swami Vivekananda, a renowned philosopher and educational reformer, "Give the students something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning results naturally." It has been seen that routine teaching practices often result in passive learning and emphasis on rote memory. Suppose we want to provide every student with a 21st-century education; we must foster deeper learning through the purposeful integration of rigorous academic content with experiences that intentionally cultivate the skills, mindsets, and literacies needed for students to become lifelong learners and contributors in our ever-changing world.

Inside the R.I.E, Bhubaneswar campus, in the Institute's main building, the Educational Resource Center was developed and inaugurated on 5th August 2019. It has three main components: Educational Resource Room, Herbal Garden and Theme Park. More than 250 activities from different disciplines have been developed and kept for demonstration in Educational Resource Room. The main objective of the Resource Center is to enhance creativity among the students and in-service and pre-service teachers.

According to NEP 2020, its mission is to promote experiential learning for innovation in teaching-learning process by providing a flexible interface where all the stakeholders can inculcate demonstration, model-building and activity design skills to appeal to students of multiple learning competencies and aptitudes. This is in tandem with the role psycho-pedagogical integration model, where learners can select, engage, analyse, and reflect on the learning resources. It showcases a diverse collection of indigenous teaching-learning charts, models, specimens, materials, prototypes, software, and instruments in school subjects that is designed to spark interest amongst the visitors to engage with the activities and foster a spirit of scientific enquiry. All the tools and aids housed in the resource room are professionally prepared, keeping ethical and safety regulations in mind. This platform also offers opportunities for in-service and pre-service teachers from various disciplines to discuss and collaborate on possible interdisciplinary projects that can evoke students to think from different perspectives.

Theme park have always appealed to students because of the educationally enriching and entertaining experience they provide. It has been demonstrated in several studies that the key dimensions of awareness, monitoring and evaluation are critical to the resilience and sustainability of individual capacity to engage in meaningful learning. These dimensions can be developed, resulting in primary students being empowered in their learning, who visits the theme park can achieve. It has been seen by Nielsen and co-workers (2009) that visits to such kinds of theme parks can evoke three types of metacognitive engagement during group learning tasks: collaborative and consensus-seeking, highly argumentative and eclectic, resulting from high levels of dissonance. In both cases, evidence of individual students' deeper understandings, which manifested through students' cognitive and social behaviours, demonstrated the invocation of metacognition to varying degrees. The theme park developed at R.I.E., Bhubaneswar, has several exciting interactive exhibits that allow the primary and upper primary students to think about the underlying phenomena from a deeper perspective.

The disadvantage of classroom learning is that it is constrained by the rigidity of the curriculum, time, and a lack of resources - all of which prevent children from fully exploring their environment. On the other hand, the interactive environment provided by the resource centre and

the theme park, on the other hand, is rich in activities and exhibits with which to explore and experiment, whilst students can follow their interests unconfined for as long as their concentration lasts. Thus, the joyful, participatory, and flexible environment facilitated by the hands-on platforms provide spatial- rather than time-frames. Piaget's developmental theory of learning has contributed to the spread of the hands-on movement, with interactive exhibitions providing a framework that meets the three areas of learning identified in Bloom's 'taxonomy of learning': that is, they encourage cognitive learning (knowledge and understanding), affective learning (attitudes, interests and motivation) and psychomotor development (physical skills of manipulation and coordination). The vision of developing hands-on activities through T.L.M.s has clear educational objectives that encourage individuals or groups to work together to understand natural objects or phenomena through physical exploration, which involves choice and initiative. The informal learning environment of interactive exhibits also allows individuals with different teaching learning skills to learn effectively.

The activities are designed to be such that students and teachers can conduct activities, gather evidence, select options, form conclusions, test skills, provide input, and can alter a situation based on information. Studies by Rennie and McClafferty (2008) have traced the evolution of science centres through time and the impact on education and student learning patterns. Their work reflects how such learning centres not only enhance cognitive, affective and psychomotor domain of learners but also play a crucial role in professional development of teachers, where they can be involved in pedagogical demonstrations, development of kits and toy-based activities as well as workshops to include exciting technological aids and models in their teaching-learning process.

Medicinal plants have played a significant role in human healthcare as the essential ingredients of traditional medicines for thousands of years. More than 80% of the world's population still relies on medicinal plants as a source of primary healthcare. The known fact is that India is a treasure house of medicinal plants that can cure many dreadful diseases and ailments without any side effects. India is blessed with varied agro-climatic conditions which permit medicinal plants' enormous biodiversity. No other country has this many medicinal plants against their existing flora.

Since times immemorial, Indians have been using a variety of medicinal plants for curing different diseases/ailments of humans and animals. Natural products isolated from medicinal plants have played an essential role as a source of modern drug discovery and development. Medicinal and aromatic plants are widely used as foods and spices and in cosmetics, aromas, and perfumes. Phytochemicals isolated from plants have more extensive applications as food preservatives, colourants, sweeteners, etc.

Continuous harvesting of medicinal plants from forest resources for the past decades has resulted in the decline of many high-value species, and many are on the verge of extinction. The critical threats are an unsustainable collection of species, forest fires, animal grazing, climate change, exploding human population, genetic erosion, industrialisation and trade, land use and sociocultural changes. In contrast, the demand for herbal medicines has been increasing in developed and developing countries since they do not have any side effects and are available at affordable prices.

Realising the resurgence of Indian traditional medicines across the world and the corresponding increase in demand for medicinal plants, the Department of AYUSH, Ministry of Health and Family Welfare set up a Medicinal Plants Board in November 2000 under the Chairmanship of Union Health and Family Welfare Minister for the overall development of this sector. The Board is responsible for coordinating all matters relating to medicinal plants, including drawing up policies and strategies for in-situ conservation, ex-situ/in-situ cultivation, proper harvesting, research and development, processing and marketing of raw material etc., to protect, sustain and develop this sector. The Board has been implementing Promotional and Commercial schemes and providing Central Assistance for such purposes.

Herbal Garden refers to growing Medicinal and Aromatic plants (M.A.P.s) which have preventive and curative properties against diseases or ailments. The herbal garden at R.I.E., Bhubaneswar, has been developed to sensitise the students about the conservation of the rich biodiversity and in particular the role of medicinal plants in providing holistic health care both in traditional and modern systems of medicine.

Objectives

Nature is the best laboratory to promote innovative ways of learning outside the four walls of a classroom. Eventually, our effort:

- To encourage and promote Herbal Garden, Resource Room and Theme Park concepts to all students of D. M. School and Institute and provide them with an opportunity to work closely with their teachers.
- To communicate general principles better (i.e. more clearly) to children or masses.
- To communicate general principles more interestingly by teachers.
- To communicate known principles at much lower costs or by using familiar things available in the child's environment
- To make an activity much more straightforward so that children can do it to get direct concrete experience.
- To make an activity safer to do.
- To modify an existing experiment to demonstrate a particular concept, increase its validity for explaining the idea, and so on.
- To sensitise all the school students about the importance of medicinal plants in daily life
- To develop skills among pre-service students to develop and maintain the herbal garden, Resource Room and Theme Park
- To inculcate a sense of responsibility for biodiversity and its conservation among in-service and pre-service teachers, especially through plants in Herbal gardens
- To educate school children and pre-service trainee teachers in identifying different types of herbs and their uses, including growing them in a garden.
- To encourage all students to use herbs in food.

With this vision in mind, the Regional Institute of Education, Bhubaneswar, has indigenously developed a unique resource room to address various pedagogical challenges and foster critical thinking and decision-making skills in pre-service and in-service teachers through exposure to quality instructional materials and experiments. Its mission is to promote experiential learning

for innovation in teaching techniques by providing a flexible interface where participants can inculcate demonstration, model-building and experiment design skills to appeal to students of multiple learning styles and aptitudes. This is in tandem with the ROLE psycho-pedagogical integration model, where learners can select, engage, analyse, and reflect on the learning resources. It showcases a diverse collection of indigenous teaching-learning charts, models, specimens, materials, prototypes, software, and instruments in the areas of physics, chemistry, mathematics, life sciences, and geography that is designed to spark interest amongst the visitors to engage with the experiments and foster a spirit of scientific inquiry. All the tools and aids housed in the resource room are professionally prepared, keeping ethical and safety regulations in mind. This platform also offers opportunities for teachers from various disciplines to discuss and collaborate on possible interdisciplinary projects that can evoke students to think from different perspectives.

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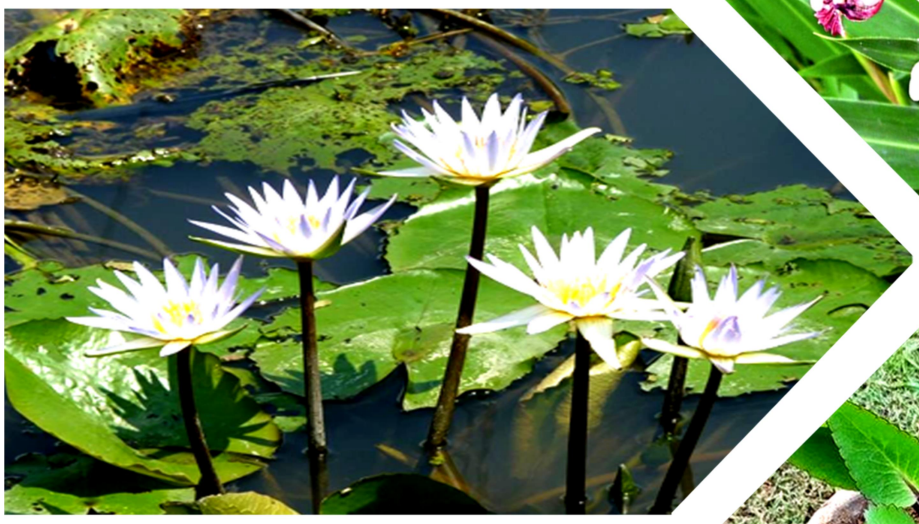
Herbal Garden



All that man needs for health and healing has been provided by God in nature;
the Challenge of science is to find it.
(**Paracelsus**)

Praised be You, my Lord, through our Sister, Mother Earth, who sustains and governs us,
producing varied fruits with coloured flowers and herbs.
(**Francis of Assisi**)

One impulse from a vernal wood
May teach you more of man,
Of moral evil and of good,
Than all the sages can.
(**Wordsworth**, 'The Tables Turned')

All good things are wild and free.
(**Henry David Thoreau**)

To speak truly, few adult persons can see nature. Most persons do not see the sun. At least they have a very superficial seeing. The sun illuminates only the eye of the man but shines into the eye and the heart of the child. The lover of nature is he whose inward and outward senses are still truly adjusted to each other, who has retained the spirit of infancy even into the era of manhood.
(**Ralph Waldo Emerson**)

Introduction

The Herbal Garden in R.I.E., Bhubaneswar, would create awareness among students, visitors, and others about the conservation and traditional uses of herbs and medicinal plants and can help them learn how to identify and conserve these important medicinal plants. The primary intent is informative, educative and inspirational.

Charaka, the great ancient physician, had once commented: "There is no such plant in this earth which does not have any medicinal value". This simple statement implies that all plants have certain ingredients that can be used as medicines. Ancient Indians were aware of this fact. Hence, they started worshipping certain plants like Neem, Banyan, Pipal, Tulsi, Bael, Mango, etc.

Neem is a very common plant, which contributes maximum to humans and their environment. Its leaves, bark, flowers, fruits, seeds and even roots are used as medicines directly or indirectly. It sterilises the environment from air-borne viral diseases like measles, chickenpox, etc. **Peepal** is considered a sacred plant and is worshipped by Indians. It is the only plant which can purify the polluted air to the maximum. Without a small leafy twig of the **Mango** tree, Hindu rituals and pujas cannot be performed. The mango tree is given such respect because it is a fruit-producing plant and because its log is used as timber, and bark and leaves that have anti-microbial properties are used as medicines. Even **Doobra** (popularly known as *doob* grass), a little herb, can be used as an antibiotic.

With the increase in our population, the demand for medicinal plants also increases. Thus, to meet the increased demand for medicinal plants **National Medicinal Plant Board** (**NMPB**) has emphasised the establishment of Herbal Gardens of various types to popularise the use of commonly available and frequently used medicinal plants among present generations and to sensitise the lay public about our traditions.

Ministry of **AYUSH**, Government of India, to promote medicinal plants, has started School **Herbal Garden Scheme** in our school system. According to the Ministry, setting up a herbal garden in school is a good way of acquainting the school children with the commonly available and frequently used medicinal plants. Under this project, the schools will be encouraged to set up herbal gardens within their complex. The objective is to promote and include the usage of medicinal plants in food and lifestyle.

Indigenous Knowledge Related to Herbal Garden

Indigenous knowledge incorporates all aspects of life - spirituality, history, cultural practices, social interactions, language, and healing. We call our country the Botanical garden of the world because there is a considerable wealth of herbal medicines.

India has a rich diversity of animals and plants due to its wide range of topographic and climatic diversity (Bhattacharya, 1997). People used medicinal plants from ancient times. “From around 1500 B.C., *Rig Veda* is one of the earliest documents that emphasise herbal medicinal knowledge”. (Choudhury et al. 2012). Indian Herbalists like Maharshi Charaka and Sushruta continued their research on different medicinal plants to cure many ailments of the human body (Jain et al., 2010, Jeyaprakash et al., 2011). After that, it is stated that “traditional healers use nearly about 2500 plant species and 100 species of plants serve as regular sources of medicine”.

The World Health Organization (WHO, 2005) has declared that 80% of the world’s population depends on conventional medicine for its prime health care, which has become essential for its continued existence. Since times immemorial, plants have been put to remedial use by the habitual medicine man (meaning of each), *Hakims, Vaidays, Ayurvedic* specialists and the ordinary person. For the past century, there has been a speedy expansion of allopathic medicinal treatment in India. Still, the use of natural products as medicine, particularly products from plants, is extensively used among different tribal peoples of India. The information connecting the medicinally functional species, their uses, and conventional understanding and practices is incomplete.

What is Herbal Garden?

It is a dedicated space in a garden devoted to growing a specific group of plants called herbs or medicinal plants. They can be dedicated patches where such herbs grow randomly or may also be carefully designed. Herbal gardens could be purely functional for growing these essential plants or include a blend of functional, medicinal, and ornamental plants. Medicinal plants and herbs are considered valuable and important ingredients that can be used in developing life-saving drugs. Apart from that, these plants also play a vital role in the health, well-being and human cultures of people worldwide. It is also called a Medicinal Garden or Botanical Garden.

Objectives of Herbal Garden :

1. Herbal Garden can contribute knowledge about nature, environment, relevance, education quality, and life skills.
2. Gardening will improve the knowledge about planting, poly pots, soil mixtures and nutritional aspects to develop the Home Garden.
3. Herbal Gardens offer a great opportunity to improve education quality and learn basic life skills.
4. Herbal Gardens can serve as a laboratory for teaching biology and environmentalstudies.
5. Pre-service learners have to develop an appropriate lesson plan that can link the theory and practical work, which is a prerequisite for the successful implementation of Herbal Gardens.

6. The sole motto is to collect, conserve and propagate available medicinal plants in and around Bhubaneswar.

Importance of Medicinal Plants

1. Medicinal plants have played an important role in human healthcare as the essential ingredients of traditional medicines for thousands of years. It is reported that more than 80% of the world population still relies on medicinal plants as a source of primary healthcare (Fitzgerald et al., 2019; Kunwar and Bussmann, 2008).
2. Natural products isolated from medicinal plants have also played an important role as a source of modern drug discovery and development (Atanasov et al., 2015; Newman and Cragg, 2020).
3. Medicinal and aromatic plants are widely used as foods and spices and in cosmetics, aromas, and perfumes. Phytochemicals isolated from plants have more extensive applications as food preservatives, colourants, sweeteners, etc. (Negi, 2012; Pawar et al., 2013; Sarkic and Stappen, 2018; Voon et al., 2012).
4. Out of more than 460,000 plant species worldwide, at least 28,187 plant species were documented to be used for medicinal purposes (Willis, 2017). Of these medicinal plants, only 4,478 were mentioned in regulatory publications (Willis, 2017).
5. However, with the decreasing number of plants worldwide due to climate change and anthropogenic disturbances, many medicinal plants are on the verge of extinction.
6. Medicinal plant gardens primarily focus on the conservation, cultivation, research and educational activities related to plant species known for medicinal purposes.

Current Status of Herbal Garden for Medicinal Plants of R.I.E., Bhubaneswar :

Inside the R.I.E, Bhubaneswar campus, adjacent to the Institute's main building, the Herbal Garden of Medicinal Plants has been developed within about 1.5 acres. More than 160 common, rare and endangered species of medicinal plants have been planted and grown with utmost care and devotion. The main objective is to disseminate the knowledge of herbal medicines and medicinal plants among school children, institute students and the lay public.

Some of the Common Medicinal Plants Present in R.I.E., Bhubaneswar

Herbal Garden

01. Mother Wort

Local Name : Dayana (O)
Botanical Name : *Artemisia Vulgaris*
Family : Asteraceae (Composite)

Description : This amazing shrub is a tall herbaceous perennial with a woody root. The leaves are smooth with a dark green tint on the upper surface but covered with dense cotton beneath. The erect stem often has a red-purplish tinge. Aromatic, pubescent, profusely branched under shrubs; often stems purplish. Leaves oblong-lanceolate, sometimes linear. Flowers yellow, in auxiliary and terminal panicle heterogamous heads

(Mother Wort)

Uses : It has traditionally been used to treat digestive disorders and as a tonic for various remedies: whole plant-Annorexia, dysmenorrhea, headache, Leaf-asthma, anthelmintic, antiseptic, expectorant.

02. Common Indian Aloe

Local Name : Ghee kuanri (O), Ghee Kunvar (H), Indian Aloe (E)
Botanical Name : *Aloe vera* (L.) Brum
Family : Liliaceae

Description : Common in hedges, undergrowth of scrub jungles and cultivated in gardens, gregarious, stoloniferous, succulent, xerophilic herb. Leaves are juicy, fleshy, rosette, margin spiny, apex gradually tapering, spine-tipped, and base truncated. Flowers bisexual, reddish-yellow, in terminal racemes; bracts lanceolate. Perianth tube terete, campanulate, somewhat. Aloe vera can be propagated with suckers having 4-6 leaves. A healthy mother plant produces about six suckers ata time.

(Common Indian Aloe)

Uses : Aloe vera has been used to treat various skin conditions such as cuts, burns and eczema. Leaf-abdominal disorders, worm infestation, dysuria, skin diseases, spleen diseases, blood disorders, anorexia, cathartic, refrigerant, liver disorders, eye troubles, chronic constipation, and diabetes.

03. Sweet Flag Bacha

Local Name : Sweet Flag Bacha
Botanical Name : *Acorus Calamus* L.
Family : Araceae

Description : Rhizomatous aromatic creeping herbs with leaves distichous, ensiform with striate venation. Inflorescence on a leaf-like peduncle; spathe erect, leaf-like. Flowers's bisexual, densely arranged sessile punctuate. Fruits – Berries, ellipsoid; seeds few. This aquatic herb canbe propagated through rhizomes.

(Sweet Flag Bacha)

Uses : It is used as a rhizome-Sedative, analgesic for epilepsy, mental ailments, chronic diarrhoea, dysentery, glandular and abdominal tumours, dyspepsia, cold, bronchitis, fever, skin diseases, emetic, stomachic, expectorant, rheumatism, earache, psychosis, anorexia, distaste, inflammation of the throat, piles, hoarseness of voice, urinary calculi, obesity, typhoid, diabetes.

04. Agaru Bacha

Local Name : Agaru bacha (O)
Botanical Name : *Alpinia galangal*
Family : Zingiberaceae

Description : Rootstock horizontal, leafy stem is tall. Leaves oblong-lanceolate, acuminate, glabrous, very shortly petiolated; ligule short, rounded, ciliate. Flowers greenish white, in open, lax panicles; red, orbicular. Capsules globose, orange-red; seeds globose, aromatic.

(Agaru Bacha)

Uses : Rhizome-Rheumatism, stomachic, aphrodisiac, diuretic, expectorant, carminative, lumbago, sore throat, diabetes, appetiser, bronchial catarrh. Seeds-colic, diarrhea, vomiting.

05. Satavari (Wild Carrot)

Local Name : Satavari (O, H), wild Carrot
Botanical Name : *Asparagus racemosus* Wild
Family : Liliaceae

Description : Armed, much-branched herbs with numerous carrots like aromatic, fascicled root tubers; spines straight or recurved; branch lets angular. Leaves reduced to scales, triangular, stiff-acuminate—Cloded3-6, linear, triquetrous or slightly compressed, entire, acuminate, base narrow. Flowers bisexual, white, fragrant, in axillary racemes; peduncle much reduced; terminal, Berries globose, red when ripe; seeds 3-6, globose or angled. This sun-loving species is propagated either by seeds or vegetatively by tillers.

(Satavari (Wild Carrot))

Uses : Asparagus is described as a cleansing and healing plant. Its stocks are high in antioxidants. Leaves of Asparagus are a good source of vitamin C. In urinary and nervous system diseases, hyperacidity, eye diseases, diarrhea, pain, rheumatic complaints, aphrodisiac, and regulates Hyper cholesteric conditions. The roots are bitter, sweet, emollient, cooling, nervine, tonic, constipating, ophthalmic, anodyne, and aphrodisiac. They are useful in nervous disorders, dyspepsia, tumors, scalding of urine, throat infections, tuberculosis, cough bronchitis and general debility.

06. King of Bitters / Chireitta

Local Name : Bhui Nimba (O), Chireitta (H), King of Bitters (E)
Botanical Name : *Andrographis paniculata* (Burm. f.) Wall. ex Nees in
Family : Acanthaceae

Description : It is an annual, branched, erect, and herbaceous plant which grows in hedge rows throughout plane lands, hill slopes and farms. Its leaves are linear-obovate and acuminate at both ends. Flowers white with pink-tinge, in axillary or terminal zigzag panicles; bracts lanceolate, acute; bracteoles 2. Calyx lobes 5, glandular-hairy. Corolla tubular, deeply blipped, lobes 5, granular- hairy. Stamens 2, bearded; anthers obovoid, bearded. Capsule's oblong, compressed, hairy, beaked; seeds 10-12. Seeds and stem cuttings can propagate it. It prefers loose, loamy soil.

(King of Bitters / Chireitta)

Uses : Chireitta is one of the world's most highly used potential medicinal plants. It works for the whole plant-Febrifuge, astringent, anodyne, tonic, diabetes, leaf-chalogogue, anthelmintic, malarial fever, skin disease, general debility, discontinuation of the menstrual cycle. This plant is traditionally used for treating the common cold, diarrhea, and fever due to several infective causes, jaundice, as a health tonic for the liver and cardiovascular health, and as an antioxidant. All parts of this plant are used to extract the active photochemical, but the compositions of phytoconstituents are: Plants widely differ from one region to another and with the place, season, and time of harvest

07. Bael Fruit Tree

Local Name : Baela (O), Bael (H)
Botanical Name : *Aegle marmelos* (L.)
Family : Rutaceae

Description : Common in backyards and temples, often planted in the temples. Deciduous thorny trees; bark grey-white with longitudinal wrinkles; spines reddish-brown, axillary. Leaves-foliolate, leaflets elliptic, glabrous, subcrenulate, obtuse. Flowers are white and fragrant in axillary panicles—sepals and petals, five each. Stamens are numerous: Ovary more than ten locular; ovules numerous per locule, axile. Berries ovoid or globose, woody; seeds numerous, Oblong.

(Bael Fruit Tree)

Uses : Whole plant-venereal diseases, digestive and abdominal disorders, eye diseases, stupor, pyrexia, dropsy, vomiting, piles, aphrodisiac, intermittent fever. Leaf- diabetes, Fruit- astringent, digestive, stomachic, diarrhea, dysentery, cooling agent.

08. Brahmi / Herb of Grace

Local Name : Brahmi (O, H), Herb of Grace (E)
Botanical Name : *Bacapa monnieri* (L) Pennel
Family : Scrophulariaceae (Snapdragon family)

Description : Succulent prostrate herb, rooted at nodes with Leaves fleshy, decussate, oblong, spathulate, entire, obtuse. Flowers's blue or white, in axillary, solitary, pedicellate Calyx-lobes-5 unequal. Corolla- lobes 5, with blue and green bands inside the throat. Stamens 4, didynamous; anthers oblong. Ovary oblong-globose; style slightly deflexed. Capsule's oblong-globose, septicidal or loculicidal, 2 or 4- evolved; seeds oblong. This herbaceous creeper is propagated mainly by stem cuttings. Sometimes it can also be propagated by seeds.

(Brahmi / Herb of Grace)

Uses : The whole plant is reported to improve intellect and treat asthma, hoarseness, insanity, and epilepsy. It is a potent nervous tonic and is anantianxiety agent. It is considered suitable for the heart, a memory booster, dysuria, cough, convulsion, constipation, venereal diseases, eye problems, anemia, stomach disorders in children, tonic, rejuvenator, inflammation, laxative, tumor, ascites, enlargement of spleen, scabies, leucoderma, syphilis, diarrhea, expectorant, epilepsy, hoarseness,diuretic, aperients, elephantiasis, diabetes.

09. Lemon Grass

Local Name : Lemon Grass
Botanical Name : *Cymbopogon citrates*
Family : Poaceae

Description : Cultivated for its aromatic oil and also grown in the wild. Perennial, tufted, aromatic herbs; culms erect, slender; internodes coated with wax. Leaf blades in a dense tuft from short rhizome broad, rough on both sides. Leaf-sheaths loose at base, cinnamon coloured inside. Panicle pyramidal. Spikelets awnless or reduced to a bristle. Sessile spikelet: linear-lanceolate. Lower glume linear-lanceolate, acuminate.

(Lemon Grass)

Uses : Leaf oil-pyrexia, distaste, carminative, stomach, vomiting, arthritis, nerving stimulant, laxative, fever, leprosy, appetiser, alexipharmic, anthelmintic, bronchitis, gastric irritability, flatulence, rheumatism,neuralgia.

10. Clerodendrum

Local Name : Clerodendrum, Bhargi(O), Brahmajusti (H)
Botanical Name : *Clerodendrum indicum*
Family : Verbinaceae

Description : Clerodendrum species is a hollow, erect, less branched shrub, 1.5 - 3.0 cm tall. The roots are light brown and more than 2.5 cm in diameter. The stem is herbaceous, ridged, fluted and hollow. Leaves are axillaries, fascicular or terminal and hang from upright branches. Flowers occur in axillary or terminal racemes. The calyx is 7.5 mm with cleft half down; lobes are oblong or ovate acute. Corolla tube is 7.5-10 cm long, curved and very slender, with up to 1.5 cm long and ovate-oblong lobes. Fruit is up to 1.5 cm across, dark bluish green when ripe and seated on the enlarged red fleshy calyx. It is propagated by the stem and root cuttings.

(Clerodendrum)

Uses : The root of chingari is stomachic, expectorant, anti-inflammatory, anti-bronchitis, febrifuge, and useful in asthma, cough, and scrofulous affections; the roots increase appetite and lowers fever. The leaves and roots are used externally to treat tumors and certain skin diseases.

11. Golden Eye Grass

Botanical Name : *Curculigo orchiiodes*
Family : Hypoxidaceae

Description : Stemless herbs with long, stout, short or elongated tubers rootstocks with fleshy root fibres. Leaves radical, lanceolate, plicate or flat, entire, acuminate, base narrow, prominently nerved below, membranous, glabrous or sparsely softly, hairy, the tip sometimes rooting and reaching the ground; leaf-sheaths persistent, fibrous, imbricating; scapes 3-5, or more, slender, hidden by leaf sheath. Flowers sessile, bright-yellow in racemes; the lowest in the raceme bisexual, the upper male; bracts lanceolate, spacious, glabrous, densely imbricating. Perianth6-lobes oblong-elliptic, outer ones pilose without, inner ones sparsely pilose along nerves. Stamens 6; filaments filiform. Ovary tricarpellary, trilocular; Ovules numerous per locule, axile; styles columnar-filiform; stigma 3, lobes elongate. Capsule oblong, glabrescent; seeds 6-8, globose, glossy, beaked. Propagation of this plant is through rhizomes.

(Golden Eye Grass)

Uses : Tuberous Roots are used for skin troubles, demulcent, diuretic, tonic, diarrhea, piles, jaundice, asthma, Root-diabetes, leucoderma, pain, Wasting diseases, aphrodisiac, sprue, piles, disorders of the blood, rejuvenator.

12. Crepe Ginger

Local Name : Insulin plant
Botanical Name : *Costus speciosus* (Koen.) Smith
Family : Costaceae

Description : Succulent erect herbs with tuberous, horizontal rootstock; stems spirally twisted, so the leaves appear spirally arranged. Leaves sub-sessile, oblong, oblong-lanceolate or oblanceolate-oblong, entire, acute or acuminate, base rounded, glabrous above, silky pubescent below. Flowers white, in very dense soil, bracts ovate, reddish, acuminate, mucronate; bracteole solitary below the calyx. -Calyx tubular, glabrous, trilobed. Corolla white, lobes elliptic-oblong; labellum white, with a yellow centre, broadly obovate with incurved margins, base densely hairy; staminodes medium on an elliptical, petaloid process. Ovary tricarpellary; ovules many, axile; style filiform; stigma crescent-shaped depression, margin ciliate. Fruits globose, ovoid; seeds ovoid; or sub-globose, black.

(Crepe Ginger)

Uses : Rhizome-tonic, antihelix, bronchitis, fever, dyspepsia, inflammations, anemia, rheumatism, lumbago, and hiccough. Rhizome-purgative, tonic, fever, piles, skin diseases, headache, leprosy, cough, polyuria, hemorrhage and fever.

13. Butterfly Pea

Local Name : Aparajeeta (O, H), Butterfly pea (E)
Botanical Name : *Clitoria ternatea*
Family : Fabaceae

Description : Common and also planted in the herbs; branch lets tomentose. Leaves odd-pinnate leaflets 3-7, ovate, entire, obtuse. Flowers white or deep blue in axillary racemes. Sepals tubular, membranous. Petals excreted; standard erect, wings falcate-oblong, connate at the middle of the keel. Stamens 9+1, pods linear, flattened, oblong, compressed apically beaked; seeds 10-15, rein forms.

(Butterfly Pea)

Uses : Root-Laxative, diuretic, eye diseases, anthelmintics, tuberculous glands, filariasis, headache, ulcers, leucoderma, alexiteric, Leaf-fever, diabetes, dog bite, earache. Seed-purgative, aperients, cathartic. Root and stem-bone fractures, abdominal disorders, diarrhea, dysentery. Stem-gout, piles, venereal diseases, leucorrhea, work infestation and anorexia.

14. Adamant Creeper

Local Name : Hadjod (O, H), Adament Creeper
Botanical Name : *Cissus quadrangularis* (L.)
Family : Vitaceae

Description : Common in scrub jungles and wastelands. It is a climbing herb. Rambling shrubs; stems 4-angled, contracted at the nodes; tendrils stout. Plants with simple, entire, opposite Leaves. Leaves simple, ovate-suborbicular, ramiform, bilocular; ovules 2 per locule, Berries globose red when ripe. Flowers are disposed of in terminal panicles, small and polygamous. The calyx is short, entire and deciduous. Petals are 4-5, imbricate. Stamens. The ovary is unilocular with a solitary ovule; the style is filiform. Fruit is a large succulent drupe. Flowers are in short peduncle Cymes with spreading umbrella branches. Stem cuttings propagate the plant.

(Adamant Creeper)

Uses : The roots and stems are most useful for healing fractures of the bone. The branch is bitter. It is given punctually and applied topically to broken bones. The plant has been documented in Ayurveda for treating osteoarthritis, rheumatoid arthritis and osteoporosis.

15. Thalkudi / Brahma Manduki

Local Name : Thalkudi (O), Brahma Munduki (H)
Botanical Name : *Centella asiastica* (L.)
Family : Apiaceae

Description : Common trailing in moist places often forming mats. Prostrate herbs with perennial rootstock; stems creeping with long stolons, rooting at nodes. Leaves are simple in rosettes, orbicular reniform, crenate-dentate, and rotund. Flowers purplish in simple umbels. Sepals 5, triangular. Petals 5. Stamens 5. Ovary bilocular; ovule1 per locule, pendulous; stylopodium depressed. Mericarps laterally fattened, vittae obscure.

(Thalkudi / Brahma Manduki)

Uses : Root-dandruff. Whole plant-memory booster, polyuria, distaste, psychosis, fever, epilepsy, leprosy, rejuvenator, hepato protective. Leaf urinary disorders, diabetes, dyspnea, fever, mental Retardation, fainting, vomiting, blood purifier, appetiser.

16. Sada Bahar

Local Name : Sadabihari (O), Sadabahar (H)
Botanical Name : *Catharanthus roseus* (L.) G. Don.
Family : Apocynaceae

Description : Perennial herb or undershrub. Leaves elliptic-obovate to oblong, entire, obtuse, apiculate, base cuneate or acute, glabrous to puberulous, lateral nerves 10-12 pairs. Flowers rose or white, solitary or paired in the axils. Sepals 5, subequal, acuminate, Petals 5, united, tubular, ovate-triangular, apiculate. Stamens 5, epipetalous, Ovary bicarpellary subapocarpous, bilocular; ovules numerous per locule, marginal. Follicle's pubescent; seeds black.

(Sada Bahar)

Uses : Its alkaloids are hypotensive and sedative, have tranquilising properties and are anti-cancer. The chemotherapy agent vincristine is extracted from sada bahar and is used to treat some leukaemias, lymphomas, and childhood cancers. Root insomnia, cancer, diabetes, stomachic, menorrhagia, blood pressure, cardiotonic, tranquiliser,sedative.

17. Camphor Tree

Local Name : Karpura (O), Kapur (H), Camphor (E)
Botanical Name : *Cinnamomum camphora* (L.) J.S.Presl.
Family : Lauraceae

Description : Evergreen trees of camphoraceous odour. Leaves ovate or elliptic-lanceolate, glabrous, dark green above, glaucous waxy below, entire, acuminate, 3-5 veined, bullate at vein axils. Flowers are whitish, very sweet scented in pseudo terminal panicles. Perianth lobes 6, equal, ovate. Fertile stamens 9. Berries black, subglobose.

(Camphor Tree)

Uses : Heart Wood-Analgesic, convulsion, antiseptic, anodyne, throat infection, diaphoretic.

18. Coleus

Local Name : Rukuna Hatapochha (O), Coleus (E)
Botanical Name : *Coleus forskohlii*
Family : Lamiaceae (mint family)

Description : Perennial, aromatic, erect scabrid herbs. Leaves broadly ovate, oblong or elliptic, crenate, acute, base cuneate thin fleshy. Flowers blue, in whorls, in terminal spikes or racemes. Calyx tube villous within, lobes 5, corolla lobes 5. Stamens 4; filaments connate below. It is propagated through seeds as well as stem cuttings.

(Coleus)

Uses : The whole plant treats worm infestation, piles, cough, and hemorrhage. Using coleus also provides therapeutic benefits in angina, asthma, psoriasis and prevention of cancer.

19. Datura

Local Name : Dudura (O), Datura (H, E)
Botanical Name : *Datura stramonium*
Family : Solanaceae

Description : Common in fallow lands, waste places and rare in the hill regions. Erect undershrub or herbs: stems green, glandular-hairy; branch lets glabrous or sparsely pubescent; leaves broadly ovate or elliptic, shallowly lobed or irregularly dentate, acute or obtuse, base unequally truncate. Flowers white, solitary axillary or at the forks of branches. Calyx tubular, lobes 5. Corolla tubular or funnel-shaped, 10-toothed, Stamens 5, Capsules straight, globose or oblong, covered with long, slender spines.

(Datura)

Uses : Seed-Narcotic, antispasmodic, mydriatic, febrifuge, anodyne; Leaf- asthma, wounds, swelling, sciatica, abscess, skin diseases and psychosis.

20. Putranjiva / Child Life Tree

Local Name : Putrajaya (O, H)
Botanical Name : *Drypetes*
Family : Euphorbiaceae

Description : Dioecious moderate, sized, evergreen trees; branch lets pendulous, lenticular. Leaves coriaceous, elliptic-oblong, serrulate, acute, base obtuse, somewhat oblique, glabrous, secondary nerves 11 pairs, flowers unisexual, greenish-yellow, dense, sessile, in axillary fascicles around branches. Perianth lobes 5, oblong, imbricate, truncate, ciliate, obtuse. Stamens 3; filaments thick, anthers ovate, hairy. Ovary globose, 3-locular, ovules 2 per locule, pendulous; styles, stigma copular. Drupes are globose or ellipsoid, yellowish, pubescent, seed solitary, and crustaceous.

(Putranjiva / Child Life Tree)

Uses : Whole plant- Aphrodisiac, laxative, diuretic, biliousness, thirst, erysipelas, elephantiasis, Leaf rheumatism, fever, cold, thrust. Seed - abortifacient, snake bite.

21. Rudraksha

Local Name : Rudraksha (O, H, E)

Botanical Name : *Elaeocarpus ganitrus* Roxb

Family : Eleocarpaceae

Description : Rudraksha is a large, evergreen broad-leaved tree found in tropical and sub-tropical areas, about 50-200 feet tall, depending on the location and the climate. In nature, a leafy crown of a Rudraksha tree takes a pyramidal shape, and the leaves are like mango tree leaves. They shine green on the upper side with a dull, leathery dorsal side. Morphology flowers show white with fringed petals and exhibit mild aromas or fragrances like Raat ki Rani. Fruits formation is observed only when the tree is seven to eight years old. Rudraksha fruits are rounded in shape with a fleshy exterior. The fruit size is 2 cm to 4 cm in diameter and is green. After maturity, the colour of the fruit starts turning into bluish violet from green, deep brown, and black.

(Rudraksha)

Uses : Helpful in managing high blood pressure, diabetes, restlessness due to fever, chicken pox, tuberculosis, chronic cough, asthma, sciatica, heart diseases and memory loss. They are also used in the preparation of jewellery and for religious purposes.

22. Amla / Indian Goose Berry

Local Name : Aanla (O), Amla (H, E)
Botanical Name : *Emblica officinalis* Gaertn
Family : Euphorbiaceous

Description : Deciduous trees; branches are spreading, branch lets glabrous, finely pubescent. Leaves sub-sessile, leaf-lets narrowly oblong, entire, obtuse, base truncate glabrous, light green. Flowers unisexual, greenish-yellow, in auxiliary clusters, on leaf-bearing branch Perianth lobes 6, valvate, stamens 3, connate; disc glands 6. Drupes, indehiscent, depressed-globose, fleshy, juicy, yellow when ripe; seeds 3-generous, Testa crustaceous. Amla is generally propagated by shield budding. They yield big-sized fruits.

(Amla / Indian Goose Berry)

Uses : Whole plant- coryza, fainting, polyurea, constipation, hypertension. Fruit -a rich source of vitamin C, astringent, diuretic, laxative cooling used against blood-related disorders, diuretic, laxative, cooling, febrifuge, dyspnea, a blood disorder, cough and eye diseases. Amla is an antioxidant with free radical scavenging properties, which may be effective in treating peptic ulcers, dyspepsia, diabetes, etc.

23. Ayapan

Local Name : Ayapan
Botanical Name : *Eupatorium triplinerve* Vahl
Family : Compositae (Asteraceae)

Description : A perennial herb, semi-woody at the base, partly decumbent, to 60 cm high, native to tropical America and widely dispersed by man in the tropics. The generic name is taken from a Brazilian vernacular. It has long been esteemed as a medicinal plant, but its virtues are overrated. It is used as a digestive stimulant and sudorific in infusion. A leaf decoction is hemostatic, and an aqueous extract of the dried leaves and shoots is a cardiac stimulant. A substance called ayapanin, which has hemostatic properties, has been isolated from the leaves.

(Ayapan)

Uses : They are generally healing: sedatives, stomach troubles, emetics plant laxatives, aromatic substances: ornamental, cultivated or partially tender.

24. Bhringraj

Local Name : Bhringraj
Botanical Name : *Eclipta prostrate* (L.) Mant.; Eclipta alba (L.) Hassk.
Family : Asteraceae (Compositae)

Description : Very common in a moist clay ground, like bunds of paddy fields, by water courses. Prostrate or erect herbs; stems hairy. Leaves opposite, simple, lanceolate-oblong, irregularly serrate-dentate, acute, base cuneate, decurrent, subsessile or shortly petiolate, strigose hairy. Flowers heads white or pale blue, heterogamous, axillary terminal, solitary or in pairs; involucres cupular; bracts biseriate. Outer ray florets; female, biseriate. Corolla tubular, 3-toothed. Ovary triquetrous, unilocular; ovule one, basal. Inner disc florets; bisexual. Corolla campanulate, lobes 5. stamens, exserted, syngenecious. Ovary unilocular; ovules one, basal. Aches oblong or triquetrous, compressed.

(Bhringraj)

Uses : Whole Plant-Hair tonic, dandruff, skin diseases, dental disorders. Root- emetic, purgative. Leaf jaundice, rejuvenator, infections of the head, bronchial asthma. Seed-anthelmintic eye diseases. The whole plant is hepatic protective.

25. Gudumari

Local Name : Gudumari (O), Gudmar (H)
Botanical Name : *Gymnema sylvestre* (Retz.)
Family : Asclepiadaceae

Description : Common in dry deciduous forests. Perennial, woody climber with milky latex. Leaves ovate or elliptic-ovate, entire, acute, base rounded or cordate, pubescent along nerves beneath. Flowers yellow, in terminal corymbose. Calyx lobes 5, imbricate, obovate, obtuse. Corolla lobes 5, acute to recurved, twisted towards the right in the bud. Follicles slender, beaked at apex; seeds obovate, coma brownish-white. Seeds, cuttings, and apical shoots can propagate this plant.

(Gudumari)

Uses : The leaf extracts contain gymnemic acid, which is said to inhibit hyperglycemia. It has also been shown to have a regenerative effect on pancreatic beta cells and is insulinotropic. Gudmari is regarded as one of the plants with potent antidiabetic properties, Fruit-stomachi, alexiteric, anthelmintic, bronchitis, and cardiac diseases. Leaves, after chewing, arrest the sense of taste temporarily. This plant is also used for controlling obesity in the form of Gymnema tea.

26. Anantamula

Local Name : Anantamula (O), Hemidesmus (E)
Botanical Name : *Hemidesmus indicus* L.
Family : Asclepiadaceae

Description : Very common and gregarious on bushes, hedges, and open forests, trailing on the ground. Twining herbs or undershrubs; roots aromatic and spicy; stems wiry, brown or greenish-brown or greenish-brown; latex milky. Leaves decussate, often whorled, variable in shape, linear, oblong-lanceolate or broadly elliptic, entire, obtuse, mucronate, base rounded, glabrous, green and white along nerves. Flowers or greenish- purple, in axillary, crowded, subsessile cymes; bracts linear. Calyx lobes 5, imbricate, glandular within. Corolla rotate, lobes 5, valvate, thick, rugose within. Stamens 5, connivant around style; filaments incurved. Follicle divaricate, terete, slender, acuminate; seeds oblong, flattened, ventrally rigid.

(Anantamula)

Uses : It works on the root-Cardio tonic, cooling beverage, hemorrhage, gout, dysuria, urinary disorders, rheumatism, skin troubles, and diabetes.

27. Barbados Nut

Local Name : Baigoba (O), Barbados Nut (E)
Botanical Name : *Jatropa curcas* L.
Family : Euphorbiaceae

Description : Common in forests and villages and grown as hedge plants along roadways and wastelands. Monoecious shrubs; branch lets glabrous; latex watery. Leaves orbicular-cordate, glabrous, shallowly 3 to 5 lobed, lobes triangular, entire, acuminate, base cordate, flowers greenish white, unisexual or polygamous, in auxiliary or terminal cymes, perianth lobes 5+5, outer imbricate, inner twisted. Stamens 10, biseriate, 5+5, free stamens, ovary globose, 3-locular; ovules 3, pendulous; styles 3; disc glands 5, free, yellow. Capsules subglobose or rugose when dry.

(Barbados Nut)

Uses : Whole Plant-Eczema, ulcer, wounds, leucorrhea, rat-bite, abdominal disorders. Leaf-rubefacient, catalogue. Seed oil-dropsy, paralysis, sciatica, skin diseases and rheumatism.

28. Basanga / Malabar Nut

Local Name : Basanga (O), Adatoda (H), Malabar Nut (E)
Botanical Name : *Justicia adhatoda* L.
Family : Acanthaceae

Description : Bushy shrubs with a foetid smell. Leaves elliptic-lanceolate, entire or undulate, and acuminate at both ends—Flowers white, throat red or yellow, in axillary and terminal spikes. Calyx lobes 5, equal imbricate. Corolla lobes 5, blipped 2+3, imbricate, laterals recurved, obtuse. Stamens 2, epipetalous, exserted; filaments villous below; anthers basally apiculate. Ovary bicarpellary, bilocular; ovules 2 per locule; style filiform; stigma 2-fid. Capsules basally beaked; seeds 4, orbicular.

(Basanga / Malabar Nut)

Uses : Root and leaf are used for Bronchial asthma, cough, hemorrhage, fever, delirium, diabetes, etc.

29. Apamaranga

Local Name : Apamaranga (O)
Botanical Name : *Achyranthes*
Family : Acanthaceae

Description : The plant is an annual herb commonly finds weeds and distributed throughout India. The plant is erect and herbaceous. Leaves are ovate. Spikes are long, and flowers are polished and green.

(Apamaranga)

Uses : The plant is purgative. The root is used for piles, boils and skin eruptions. The root is also used for snakebites.

30. Amarpoi / Pashanabheda

Local Name : Amarpoi (O)
Botanical Name : *Kalanchoe pinnata* (Lam.)
Family : Crassulaceae

Description : Erect succulent herbs; branch lets are swollen at modes; leaves decussate, crowded in young shoots, often 3-5 foliolate; leaflets oblong or ovate-elliptic, thick- coriaceous, crenate, obtuse, greenish. Flowers greenish in a panicle cyme; bracts foliar; bracteoles linear. Calyx tubular, lobes 4, triangular, green with reddish loathes, petals 4, tubular, granular within eight folded, base greenish, apex reddish, stamens 8, inserted above the constriction of the corolla. Fruit follicles; seeds numerous, linear.

(Amarpoi / Pashanabheda)

Uses : The leaf is used in dysentery, leprosy, wounds and menorrhagia.

31. Curry Leaf Plant

Local Name : Bhrusunga (O), Curry Leaf Plant (E)
Botanical Name : *Murraya koenigii* (L.) Spr.
Family : Rutaceae

Description : They are cultivated for their aromatic leaves. Aromatic shrubs or small trees. Leaves pinnate, smaller; leaflets 15-25, oblique, oblong-lanceolate. Flowers' white, fragrant, in corymbose panicles. Sepals and petals, five each. Stamens 10. Ovary bilocular, ovules 1 per locule, axile. Berries subglobose, black when ripe, pulp whitish; seeds 1 or 2, green.

(Curry Leaf Plant)

Uses : It addresses root-renal pains, leaf-dropsy, diabetes, dysentery, diarrhea, dyspepsia, chronic fever, mental disorders, nausea, vomiting, tonic, aromatic and cancer.

32. Night Jasmine

Local Name : Ganga siuli (O), Siuli (B), Raat Ki Rani (H), Night Jasmine (E)
Botanical Name : *Nyctanthes arbortristis*
Family : Oleaceae

Description : Common in deciduous forests and often cultivated in gardens. Erect shrubs or small trees; branch lets four angular, often pendent. Leaves coriaceous, ovate or elliptic, entire to coarsely toothed, acute to acuminate, base obtuse or rounded, scabrous with short bulbous hairs above, pubescent below, secondary nerves 3-5 pairs, prominent below. Flowers white-orange, very fragrant, trichotomous, axillary and terminal cymes. Sepals 5, valvate. Petals 5, salver form the tube orange, lobes 5-7, white twisted. Ovary globose, bilocular; ovules 2 or one per locule, basal. Capsule's brown, elliptic-oblong or orbicular, compressed, 2-valved, glabrous, epicarp thick. Seeds-2.

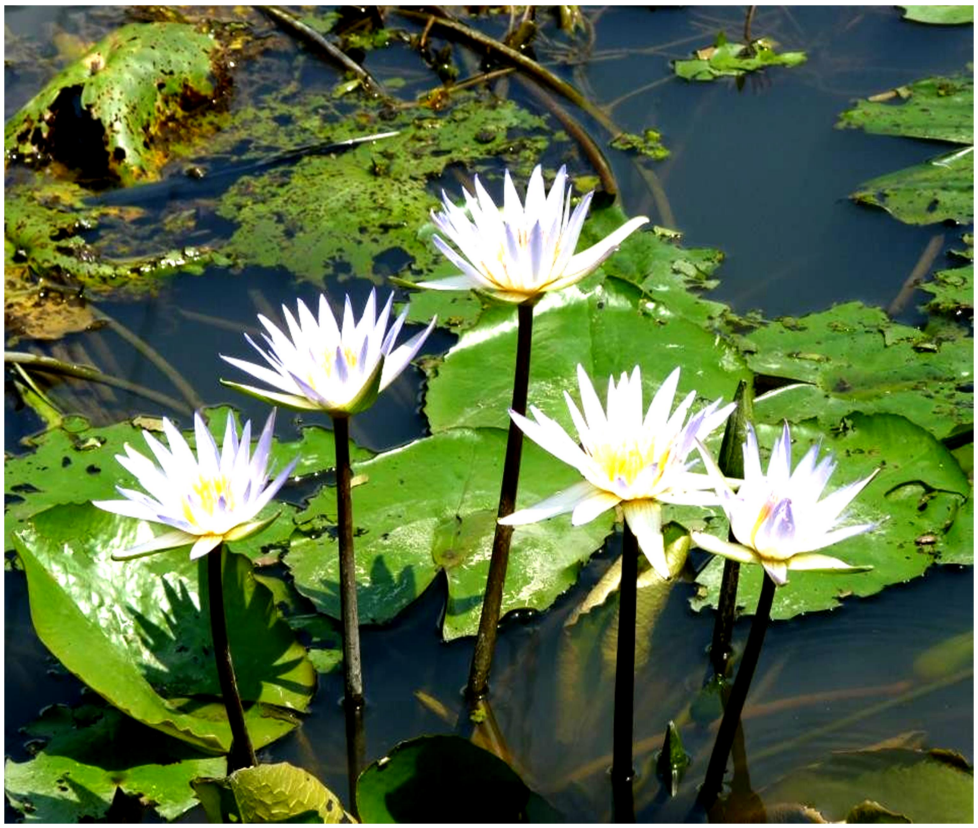
(Night Jasmine)

Uses : The leaves are antibacterial, anti-inflammatory and anthelmintic. Further, a dye extracted from the corolla tube is used to lend colour to Tussore Silk. The flowers are bitter astringent, ophthalmic, stomachic and carminative. It is an expectorant, bitter, tonic, febrifuge, and mild purgative. It is used in bilious and obstinate remittent fever, sciatica, and rheumatism. The bark is used in the treatment of malaria.

33. Water Lily (Blue)

Local Name : Neela Koin (O), Jal Kumudini (H), Water Lily (E)
Botanical Name : *Nymphaea stellata*
Family : Nymphaeacae (Water lily)

Description : Wild, ditches and water stagnant areas, ponds and tanks. Rhizomatous aquatic herbs. Leaves floating, peltate, entire. Flowers's blue or purple, sometimes white or rose, in long axillary peduncles. Sepals 4. Petals numerous. Stamens numerous filaments petaloid. Carpels numerous, accessible, covered by fleshy torus; ovules numerous. Berries spongy; seeds many, enclosed in a sac-like aril.



(Water Lily (Blue))

Uses : Rhizome-Dyspepsia, dysentery, demulcent. Whole plant ulcers, thirst, boils poisoning, menorrhagia, erysipelas, diarrhea.

34. Tulsi (Black) / Sweet Basil

Local Name : Kala Tulasi (O), Tulsi (H), Sweet Basil (E)
Botanical Name : *Ocimum basilicum* L.
Family : Lamiaceae

Description : Aromatic herbs leaves elliptic-ovate ovate or lanceolate, entire to serrate. Flower white or pale, in long close racemes. Peduncle stout. Calyx lobes 5, hairy within. Corolla tube inflated below, lobes 5. Stamens 4. Calyx enlarged in fruit; seeds mucilaginous when wet, fruiting pedicel recurved—propagation by seeds.

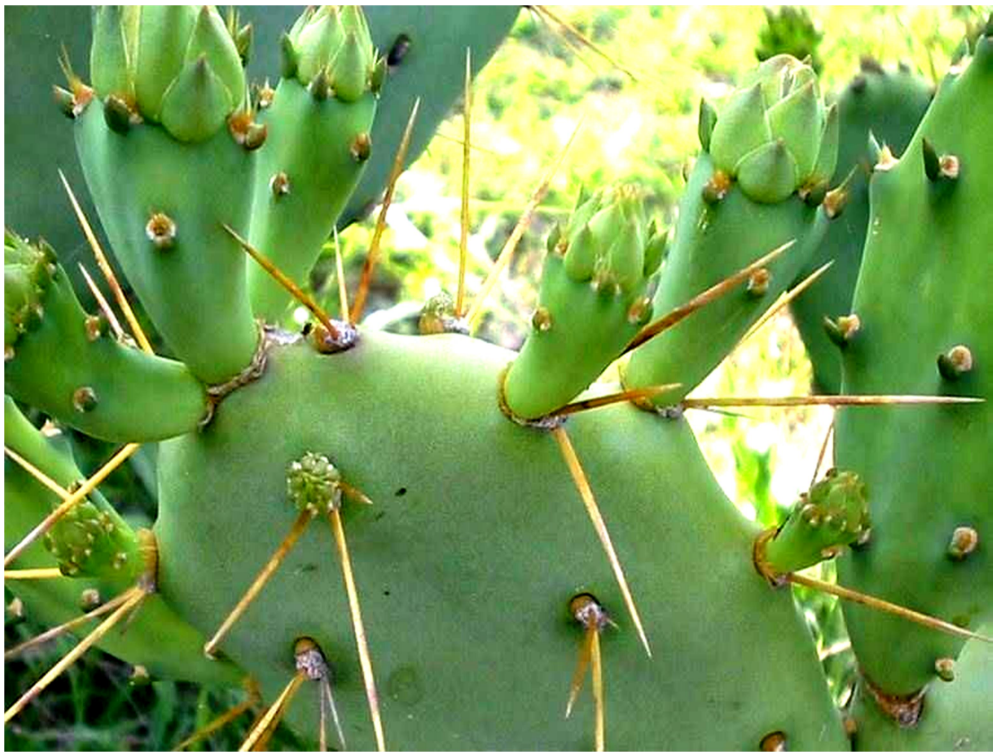
(Tulsi (Black) / Sweet Basil)

Uses : Whole Plant- Gonorrhea, nasal disorders, diarrhea, dysentery, earache, diuretic. Leaf- inflammation. ringworm, digestive, mouth and throat inflammation. Seed- carminative, demulcent, piles, diaphoretic.

35. Cactus / Slipper Thorn

Local Name : Nagpheni (O), Nagphoni (H), Cactus (E)
Botanical Name : *Opuntia dilleni*
Family : Cactaceae

Description : Shrubs; stems succulent, glaucous, spines yellow, 5-8 per areole, raised, leafless; flowers showy or yellow. Perianth lobes numerous, yellow; outer tepals ovate, inner one's obovate stamens numerous, inserted on the receptacle; filament unequal; anther oblong. Ovary tuber collates, multicarpellary, unilocular, ovules numerous on many partial placentae; styles 3-5; apically branched; Berries obovoid, reddish to purple, seeds many.



(Cactus / Slipper Thorn)

Uses : Stem- inflammation, boils, guinea worms, abscesses: fruit- whooping cough, antispasmodic, expectorant, ophthalmia, cough, leucorrhea, constipation and poisoning.

36. Dhala Tulasi / Holy Basil

Local Name : Dhala Tulasi (O), Tulasi (H), Sacred Basil (E)
Botanical Name : *Ocimum sanctum* L.
Family : Lamiaceae

Description : Cultivated as a sacred plant in pots or on pedestals at all Hindu homesteads and temples and frequently found running wild. Aromatic, erect, much-branched herbs or under shrubs; branch lets hispid. Leaves elliptic-ovate or oblong, serrate, undulate, acutely apiculate, base truncate, pubescent, pale green above and pinkish below. Flowers small, white with purplish-tinge, in verticils on interrupted spikes, peduncles slender, purplish-green. Calyx purplish, lobes 5. Corolla tubular, lobes 5, stamens 4, filaments villous at the base of upper pair, calyx not much enlarged in fruit, pedicel spreading, longer than calyx.Nutlets are ovoid.

(Dhala Tulasi / Holy Basil)

Uses : Root- Diaphoretic. Leaf-antiperiodic, expectorant, diaphoretic, bronchitis, ringworm, stimulant, stomachic. Seed demulcent, genitourinary disorders, cough, leucorrhea, nausea, vomiting.

37. Plumbago / Lead Wort

Local Name : Plumbago (H, E), Koola (O)
Botanical Name : *Plumbago zeylanica*
Family : Plumbaginaceae

Description : Common in wastelands, fallow fields, and scrub forests. Erect, sub erect or diffuse undershrubs. Leaves elliptic-ovate, entire, acute, base truncate, glabrous—Flowers white, in the terminal, simple, panicle spikes. Calyx tube fully covered with stalked glands. Corolla tubular, long, slender, lobes 5, imbricate. Stamens 5, free; anthers oblong, dorsifixed. Ovary 5-gonous, unilocular; ovule one, basal; stigma 5-forked. Capsule's oblong, grooved, and glandular; seeds solitary, dark brown, cylindric, and flat.

(Plumbago / Lead Wort)

Uses : Root-Abortifacient, skin diseases, rheumatism, dyspepsia, anasarca, sudorific, digestive, piles, diarrhea, dysentery, leprosy, laxative, stomachic, coryza, expectorant, diuretic, filariasis, abscess, obesity vitiligo, splenomegaly, hepatomegaly, relive horsiness of voice, sore throat, leucoderma, ringworm. Leaf- scabies, ulcers and psoriasis.

38. Pipli / Long Pepper

Local Name : Pipali (O), Pipli (H), Long Pepper (E)
Botanical Name : *Piper longum* L.
Family : Piperaceae

Description : They are cultivated for their fruits in Botanical Garden. Small prostrate or erect somewhat climbing herbs; branch lets glabrous, nodes swollen, slightly brown, leaves alternate, ovate, deltoid or triangular, entire, acute, long petiole, greenish above, tomentose below, 6-7 nerved from the base. Flowers in axillary or terminal globose, pyramidal or elongated spikes.Fruit nut.

(Pipli / Long Pepper)

Uses : Root and fruit—counter-irritant, diabetes, analgesic, expectorant, inflammations, carminative, insomnia, abortifacient, tonic, emmenagogue, cough, cold, bronchitis, stimulant, liver disorders, feverand indigestion.

39. Karanj

Botanical Name : *Pongamia pinnata* (L.)
Local Name : Karanja (O)
Family : Fabaceae

Description : Very common near streams and cultivated as an avenue tree throughout the country. Deciduous trees; branch lets spreading. Leaves odd-pinnate; leaflets ovate-oblong, opposite, thin, coriaceous, entire, acute. Flowers pinkish white in axillary, racemose panicles. Sepals glabrous, minute. Standard orbicular; keel obtuse, Stamens Monadelphous (10), pods obliquely oblong, woody, compressed, indehiscent.

(Karanj)

Uses : Root- Paralysis, ulcers, fistulous sores, gum teeth. Bark- night blindness, piles, Flower- diabetes. Seeds-eczema, ear diseases, abdominal disorders, snake bite, skin diseases, venereal diseases, glandular swelling, polyuria, stomach disorders.

40. Rosemary

Local Name : Rosemary
Botanical Name : *Rosmarinus officinalis*
Family : Lamiaceae

Description : The herb grows wild on dry, rocky slopes near the sea. Its name is derived from the Latin ros marinus, meaning "sea dew." Other herb names include polar plant, compass-weed, or compass plant. Rosemary is an evergreen perennial shrub best known for its aromatic, needle-like evergreen leaves. The flowers are purplish white, strongly two-lipped, and have two long-exerted (protruding) stamens. The fruit consists of four dry nutlets and one-seeded section.

(Rosemary)

Uses : It has astringent properties due to its tannin content, which may help treat diarrhea and reduce excessive menstrual flow. Rosemary can be used as a carminative to ease the discomfort of colic and dyspeptic disorders. An infusion of rosemary, combined with Salvia Officinale (sage), makes an excellent sore throat gargle.

41. Sarpagandha

Local Name : Sarpagandha (O, H)
Botanical Name : *Rauwolfia serpentiana* (L.) Benth.ex Kurz.
Family : Apocynaceae

Description : They are cultivated in the botanical garden. Shrubs. Leaves in whorls of 3, thin, broadly oblanceolate, undulate, acute, acuminate, base attenuated, lateral nerves 8-12 pairs, primary nerves somewhat distant, oblique. Flowers white, in axillary corymbs; pedicel red. Calyx 5-lobed, lobes short. Corolla tubes are long, slender, narrow, and dilated slightly above the middle, tubes 5. Stamens 5. Drupes purplish-black, connate except at top; seed 1, ovoid. It is propagated through seeds, stems and root cuttings. It grows on clayey loam or clayey soil with humus and good drainage.

(Sarpagandha)

Uses : Root – Nervous disorders, diabetes, hypertension, tranquiliser, psychosis, insomnia, labour pains, poisonous bites, intestinal problems, pains, anorexia, epilepsy and anthelmintic.

42. Gulab / Rose

Local Name : Golapa (O), Gulab (H), Rose (E)
Botanical Name : *Rosa centifolia* L.
Family : Rosaceae

Description : Very common; cultivated in the garden, parks, and evergreen shrubs. Leaves alternate, imparipinnate, pubescent above; leaflets serrate; stipules adnate to the petiole. Flowers rose red in the terminal, solitary or corymbose. Petals are usually large, numerous, and very fragrant. Stamens numerous, inserted in the disk. Ovule's solitary, pendulous. Fruits are fleshy calyx-tube covering a cluster of coriaceous achenes.

(Gulab / Rose)

Uses : The flowers are bitter, astringent, sweet, cooling, emollient aromatic, cardiotonic, anti-inflammatory, expectorant, digestive, carminative, depurative, febrifuge, intellect-promoting styptic, rejuvenating and tonic. Several rose products are used to make creams, lotions, and other cosmetics.

43. Garden Rauvolfia / Barachandrika

Local Name : Patala Garuda (O), Barachandrika (H), Garden Rauvolfia (E)
Botanical Name : *Rauwolfia tetraphylla*
Family : Apocynaceae

Description : They are cultivated in gardens—shrubs, tender parts puberulous. Leaves 4, in whorls, elliptic, entire or undulate, subacute to acute at both ends, pubescent above, densely so beneath, lateral nerves 8-12 pairs. Flowers 5-4, in axillary or terminal corymbs. Sepals 5, cupular, equal, ovate, ciliate, subacute. Corolla tubular, pubescent along the throat, lobes 5, ovate-rounded, obtuse. Stames 5, epipetalous, included. Ovary bicarpellary, bilocular; ovules 2 per locule, marginal. Drupes connate to the top, seeds ovoid.

(Garden Rauvolfia / Barachandrika)

Uses : Root-Skin diseases, snake and insect biting, used as a substitute or adulterant to Sarpagandha.

44. Bheji Baigana / Black Night Shade

Local Name : Bhelibaigan (O)
Botanical Name : *Solanum nigrum* L.
Family : Solanaceae

Description : Black nightshade is a plant, an annual weed that grows up to 60cm -3m tall, is branched and usually erect, growing wild in wastelands and crop fields. Alternate leaves are deep ovate green with an indented margin and acuminate at the tip. The flowers are white with a yellow-coloured centre. The berries are green at an early stage and turn orange or black when ripened.

(Bheji Baigana / Black Night Shade)

Uses : Black nightshade is used for skin diseases, rheumatism, and gout. Juice of the herb is given in chronic enlargement of the liver. It can cure ear and eye diseases. It is sometimes prescribed to “remove the effect of old age.”

45. Ashoka Tree

Local Name : Ashoka (O, H)
Botanical Name : *Saraca asoca* (Roxb.) Wilde.
Family : Caesalpiniaceae (birds of paradise: sub-family)

Description : Rare and planted in avenue plantations. Evergreen trees. Leaves paripinnate; leaflets 4-6 pairs, oblong or oblong-lanceolate, entire, acuminate. Flowers yellow-orange-red, in corymbose panicle, fragrant during nights. Sepals are petaloid. Petals 0. Stamens 7. Pod's oblong, leathery, black.

(Ashoka Tree)

Uses : Stem / bark-Febrifuge, leprosy, worm infestation, polyuria, gynaecological disorders, menorrhagia, diarrhea, bleeding, piles, astringent, uterine affections, uterine fibroids, leucorrhea, hemorrhagic dysentery. Flower-uterine tonic, biliousness, hemorrhagic dysentery, diabetes.

46. Sandal Wood Tree/ (Chandan)

Local Name : Chandan (O, H)
Botanical Name : *Santalum*
Family : Santalaceae

Description : Evergreen trees, Wood aromatic odour, leaves opposite below, alternative above elliptic–ovate to lanceolate, subcoriaceous, base rounded to a cute, apex gradually acute, lateral nerves 10-12 pairs, faint, irregularly arching near margin. Flowers 5-merous, brownish purple, in axillary and terminal trichotomous paniculate cymes. Perianth lobes 5, basally connate into a campanulate tube, lobes ovate, minutely ciliate. Stamens 5. Ovary half inferior, unilocular; ovule 2- 3, pendulous; a disk of 5, fleshy, oval, obtuse, brown, scale-like process looking like petals or 2nd whorls of the perianth, alternating with the stamens; stigma 3- lobed. Drupes globose, annulate above, beaked with the basal part of style black when ripe; seed ovoid or globose. Propagation by seeds and grafting.

(Sandal Wood Tree/ (Chandan))

Uses : It is an astringent and a cooling agent used in several skincare preparations. Heartwood and wood-Diabetes. Oil-venereal diseases, refrigerant, expectorant, herpes, worm-infested eruptions, diuretic, diaphoretic. dysuria, cooling, debility, Skin eruptions, diuretic, diaphoretic. The wood is used for making fancy articles and is much more carved.

47. Teak / Indian Oak

Local Name : Saguan (O, H)
Botanical Name : *Tectona garandis* L.
Family : Verbenaceae

Description : This is the popular timber-yielding tree called teak. Large deciduous tree; branch lets 4-angled, stellate tomentose. Leaves broadly elliptic, entire, acute or obtuse, base rounded to acute, rough above, tomentose beneath, lateral nerves 8-9 pairs. Flowers white, in terminal, large, dichotomously branched panicles. Flowers actinomorphic. Calyx campanulate, 5-7 lobed. Corolla subrogates, lobes 7. Locule, axile. Drupes globose, enclosed in enlarged, stellate-pubescent calyx; seeds oblong.

(Teak / Indian Oak)

Uses : Heartwood- Leprosy, polyuria, diabetes, hemorrhage, inflammations, dyspepsia, skin diseases, ulcer.

48. Guduchi

Local Name : Giloy (O, H), Guduchi
Botanical Name : *Tinospra Cordifolia* (wild.)
Family : Menispermaceae (Moon seed family)

Description : A large glabrous, deciduous climbing shrub found throughout India. Leaves membranous, deeply co-airdate with a broad sensual. Dioecious, climbing woody shrubs; stems succulent; bark papery, cocky when mature. 5-7 nerved, entire, acuminate with granular- papillose patches on the lower surface in basal nerve-axils; Flower small, yellow or greenish-yellow, appears when the plant is leafless. Flowers unisexual, yellow, in racemes or panicles, axillary, terminal on old stems. Sepals 6 (3+3), petals 6, stakes 6, staminodes 6, carpels 3; stigma forked. Drupe's round-oval, sessile, red when ripe. Stem cutting, planting time, rainy season. The plant is propagated either through seeds or through cuttings.

(Guduchi)

Uses : The leaves are suitable as fodder for cattle, rich in proteins, relatively in calcium, and prosperous. Root-Emetic, leprosy. Stem dyspepsia, anemia, leprosy, jaundice, diabetes, fever, urinary disorders. Leaf-gout, health tonic. Fruit-tonic. Whole plant-polyuria, digestive problems, diarrhea.

49. Red Sandal Wood

Local Name : Rakta Chandan (O)
Botanical Name : *Pterocarpus santalinus*
Family : Fabaceae

Description : It occurs in dry deciduous forests at an elevation of 500-1000 meters in the woods. According to International Union for Conservation of Natural Resources (IUCN), the species has been categorised as critically endangered since it will go extinct in the wild in the immediate future. Large deciduous trees. Bark exudes blood-red juice on the incision. Leaves 3 foliolate; leaflets very rarely two pairs, coriaceous, entire, obtuse. Flowers yellow, in axillary, racemose panicles. Standard ovate. Stamens (10), Pods obliquely orbicular, becoming narrowed into shortstalks, narrowly winged.

(Red Sandal Wood)

Uses : Heartwood– Diabetes, stomach ulcers, skin diseases, anthelmintic, bilious affections, astringent, tonic, diaphoretic, diarrhea, inflammations, headache.

50. Arjun Tree

Local Name : Arjun
Botanical Name : *Terminalia arjuna* Roxb.ex DC.
Family : Combretaceae

Description : Ordinarily along streams and dry water courses and also planted as avenue trees. Evergreen trees, often buttressed, outer bark flaking off in pieces, inner smooth, white. Leaves alternate or sub-opposite, oblong or oblanceolate, thick-coriaceous, crenate-serrate, obtuse, nerves 15- 17 pairs; petiole with two glands close to the base of the leaf blade. Flowers's pale yellow, in axillary panicles, Drupe's ellipsoid, reddish brown, 5- angled, 5-winged, apex notched.

(Arjun Tree)

Uses : Bark- Cardiotonic, blood disorders, chronic fever, polyurea, obesity, skin diseases, styptic, anti-dysenteric, symptomatic hypertension, diuretic, cirrhosis of the liver. Fruit-DE obstruent, diabetes, leucorrhea, leprosy, pain ulcer, worm infections, diabetes.

51. Behere

Local Name : Bahada (O)
Botanical Name : *Terminalia bellirica* L (Gaertn.) Roxb.
Family : Combretaceae

Description : Common in deciduous forests and fringe areas. Large deciduous trees; bluish bark grey, cracks vertical; branch lets white-pubescent with persistent leaf scars, Leaves alternate, ovate obovate or broadly elliptic, densely clustered at the end of branch lets, entire, nerves 6-8 pairs. Flowers' cream, scented, in axillary, solitary or pair spikes. Drupes globular, obscurely five-angled when dry, horned, wings 0. This plant is propagated through seed, root-shoot cuttings and stump planting. It grows on a wide range of soils with sufficient moisture under extreme light conditions.

(Behere)

Uses : Stem Bark- Diuretic, cardio-tonic. Fruit- astringent, diabetes, tonic, digestive, laxative, rheumatism, swell-ins, ophthalmia, bronchial asthma, tachyphemia, diseases of the throat, oedema, worm infections, leucorrhea, venereal diseases, hypertension, dyspnea. Gum-demulcent, purgative. The roots are bitter, sweet, emollient, cooling, nervine, tonic, constipating, ophthalmic, anodyne, and aphrodisiac. They are useful in nervous disorders, dyspepsia, tumors, scalding of urine, throat infections, tuberculosis, cough bronchitis and general debility.

52. Harida / Hilikha

Local Name : Harida (O)
Botanical Name : *Terminalia chebula* Retz.
Family : Combretaceae

Description : Common in deciduous forests. It is a moderate-sized or large deciduous tree with a round crown and spreading branches, branch lets glabrescent. Leaves alternate or subopposite, thin-coriaceous, ovate, elliptic-obovate, entire, obtuse, two glands just below the leaf blade—Flowers white, in simple spikes. Drubs yellowish-green, obovoid, pendulous, faintly 5-angled, glabrous, wings. Seeds can propagate the tree. Treated seeds germinate on an average within 15-20 days of sowing and get ready for planting in the field within 75-90 days. Pretreated fruit is sown in the nursery, and transplanting of the one-year-old seedling is more successful. Grafting is commonly done to reduce the juvenile period and enhances early bearing.

(Harida / Hilikha)

Uses : The stem/bark is diuretic and cardiotonic. Fruit- laxative, diabetes, tonic, alternative, anorexia, constipation, tympanites, abdominal disorders, piles, jaundice, sprue, coryza, tachyphemia, rejuvenator, obesity, polyuria, cough, dyspnea, ascites, urinary infections, carcinoma.

53. Begunia / Nirgundi

Local Name : Begunia (O)
Botanical Name : *Vitex negundo*
Family : Verbenaceae

Description : Common by river banks and moist localities. Shrubs, branch lets, grey pubescent. Leaves 3-5 foliolate; leaflets oblanceolate, entire, acuminate, base acute chartaceous, glabrous above, grey pubescent below, lateral nerves 14 pairs. Flowers, bluish in pedunculate branched, tomentose cymes in terminal panicles. Calyx white spotted without, 5- toothed—Corolla tubular, bilipped, lobes 5, stamens 4. Drupes are globose.

(Begunia / Nirgundi)

Uses : Root – rheumatism, febrifuge, diuretic, anthelmintic, demulcent, dyspepsia, piles. Leaf - rheumatic, vermifuge, tonic, headache, tranquilliser. Flower-liver complaints, diarrhea, fever.

54. Aswagandha

Local Name : Aswagandha (O, H)
Botanical Name : *Withania somnifera*
Family : Solanaceae

Description : Cultivated, erect, branched undershrub; branch lets, hairy tomentose. Leaves elliptic ovate, entire, acute, base truncate-acute, softly appressed pubescent, lateral nerves 6-8pairs, Flowers's yellow, in axillary clusters. Calyx campanulate, lobes5, lanceolate. Corolla narrowly campanulate, lobes 5, triangular oblong, connate, below the middle, acute, valvate. Stamens 5, exserted. Ovary bicarpellary, bilocular; ovules numerous on single swollen axile placentation; style liner; stigma capitates. Berries globose, orange when ripe, overtoppedby the inflated accrescent calyx; seeds discoid, pitted.

(Aswagandha)

Uses : Root – Blood disorders, aphrodisiac, general debility, tonic, worm infestation, nervous disorders, goitre. Leaf- fever, glandular swelling, erysipelas.

55. Ginger

Local Name : Adda (O), Adarak (H)
Botanical Name : Zingiber officinale Rose
Family : Zingiberaceae

Description : Cultivated, perennial herbs, rootstock horizontal, tuberous, aromatic, stem leavy. Leaves are linear, sessile, acuminate, and glabrous. Flowers yellowish green, in dense cone-like spikes; Peduncles slender, sheathing scales glabrous; lip 3-lobed, dark purple, often spotted with yellow—fruit's oblong; seeds, globose.

(Ginger)

Uses : Rhizome- Carminative, diabetes, stimulant, flatulence, colic, indigestion, hyperacidity, cough, asthma, dyspnea, diarrhea, edema, stomach disorders, anemia and cardiac diseases.

56. Kadamba

Local Name : Karamanga(O), Kamarak(H)
Botanical Name : *Averrhoa carambola* L
Family : Oxalidaceae

Description : A small evergreen tree. 9 m height with close drooping branches, leaves compound, alternate, leaflets 5-11, glabrous, flowers variegated with white and purple in racemes, axillary, fruits, ovoid's, five angled, indehiscent.

(Kadamba)

Uses : The leaves are antipyretic and anthelmintic. They are helpful in scabies, various types of poisoning, intermittent fevers and intestinal worms. The fruit is sweet, sour, thermo genic, antipyretic, antiscorbutic and tonic. They are helpful in diarrhea, vomiting, jaundice, hyperpiesia, hemorrhoids, intermittent fever, hypertonia, scabies, various kinds of poisoning and general debility.

57. Neem

Local Name : Nimba(O), Neem(E)
Botanical Name : *Azadirachta Indica* A. Juse
Family : Meliaceae

Description : A Medium to large sized tree, 15-20 m in height, leaves compound, leaflets sub-opposite, serrate, flowers cream or yellowish-white in axillary panicles, one-sided fruit drupes with woody, endocarp, greenish-yellow when ripe, seeds ellipsoid, cotyledons thick, fleshy andoily.

(Neem)

Uses : The bark is bitter, astringent, acrid, refrigerant, depurative, demulcent, insecticide, liver tonic, expectorant and urinary astringent. It is used in the vitiated condition of pitta, hyperpiesia, leprosy, skin diseases, eczema, leucoderma, intermittent and malarial fever, wounds, burning sensation, cough, bronchitis, etc. The leaves are bitter, astringent, acrid, depurative, antiseptic, ophthalmic, anthelmintic, appetiser, and refrigerant.

58. Mango

Local Name : Amba(o), Aam(H), Mango (E)
Botanical Name : *Mangifera indica* L
Family : Anacardiaceae

Description : A large spreading evergreen tree up to 45 m in height with a heavy dome-shaped crown, straight, leaves simple, crowded, linear, oblong, acute flowers small, reddish-white or yellowish green fruit large, fleshy drupes green, orange, yellow or red in colour, seed solitary with hard compressed fibrous endocarp.

(Mango)

Uses : Root and bark are astringent, acrid, refrigerant, antisyphilitic, vulnerary, antiemetic, anti-inflammatory and constipating. They are useful in vitiated conditions of pitta, metrorrhagia, diarrhea, dysentery, diphtheria and rheumatism. Leaves are astringent, refrigerant, and constipating; they are useful in vitiated conditions of pitta, hyperpiesia, burning sensation, hemorrhages, wounds, ulcers, dysentery, diarrhea etc. The flowers are astringent, refrigerant, styptic, and constipating; they are useful in vitiated pitta conditions, hemorrhages, wounds, ulcers and dyspepsia.

59. Cashew Nut

Local Name : Kaju (O, H), Cashew tree
Botanical Name : *Anacardium occidentale* L
Family : Anacardiaceae

Description : A small tree with short thick woody trunks that leaves oblong, hard, glabrous, obtuse, cuneate at the base, flowers small, yellow with pink stripes, terminal panicles with staminate and bisexual. The fruit is a kidney-shaped nut. The cashew apple is a thin bright yellow to scarlet shine in colour and soft juicy flesh. The nut is greyish green, hard, smooth, shining pericarp enclosing a curved white kernel.

(Cashew Nut)

Uses : The roots are purgative. The bark with an inflorescence is used for the treatment of snake bites. The bark and leaves are useful in odontalgia and elitist. The bark's gum is useful in treating leprosy, ringworm and obstinate ulcers. Fruit is acrid, sweet, thermo genic, aphrodisiac, trichogens, and anthelmintic and helps cure kappa, skin diseases, dysentery, hemorrhoids and anorexia, preventing hair loss and increasing hair growth. The kernel is highly nutritious and concentrated food.

60. Babul

Local Name : Babul (O, H)
Botanical Name : *Acacia Nilotica Wild*
Family : Minosaceae

Description : A medium-sized tree with a short trunk. Leaves bipinnate with spinescent stipules, flowers crowded in the long peduncled globose heads, forming axillary clusters of 2-5 heads, fragrant, golden yellow to off-white fruit containing 8-12 seeds.

(Babul)

Uses : Pod's decoction is beneficial in urinogenital diseases. Infusions of tender leaves are used as an astringent and remedy for diarrhea and dysentery. Bark decoction is used as a gaggle in sore throat and toothache. The dry powder can be applied externally in ulcers. The gum is astringent andstyptic.

61. Betel Nut

Local Name : Gua (0), Supari (H), Betel Nut(E)
Botanical Name : *Areca catechu L*
Family : Arecaceae

Description : Slender palm, stem erect surrounded by a crown of pinnate leaves, petiole broadly expanded at the base, inflorescence in spadix encased in spathe-flowers yellowish white in much-branched recame which bears both male and female flowers, fruit ovoid, pericarp hard and fibrous, kernel (seed) brown.

(Betel Nut)

Uses : The pericarp treats flatulence, edema, dysuria, and hyperemesis during pregnancy. The kernel is used to treat diarrhea, dysentery and malaria.

62. Argemone

Local Name : Agora (O), Argemone
Botanical Name : *Argemone Mexicana* L
Family : Papaveraceous

Description : A Strong branched prickly annual with yellow latex, leaves, simple, senile, spiny, sinuate-pinnatifid, variegated with white spinous veins white flowers; large, bright yellow, terminal on short leafy branches, fruit prickly capsules, oblong-Ovid and seeds numerous.

(Argemone)

Uses : The plant is bitter, acrid, cooling vulnerary, diuretic, depurative anodyne, anthelmintic, antipyretic ophthalmic, stomachic and sedative. The roots are helpful in guinea-worm infestation, skin disease, leprosy, pruritus', all types of poisoning, constipation flatulence, colic and malarial fever. The leaves are useful for coughs, wounds, ulcers and skin diseases. The seeds are beneficial in vitiated conditions of cough, asthma, leprosy, ulcers, wounds, dental caries, constipation, rheumatism, etc. Latex is used in dropsy jaundice, skin diseases and burning sensation. The oil is useful in indolent ulcers, wounds, skin diseases, colic, constipation, etc.

63. Papaya

Local Name : Amrutabhanda (o), Papita (H), Papaya (E)
Botanical Name : *Carica papaya* L
Family : Caricaceae

Description : A small soft wooded, fast-growing, short-lived laticifers tree with astraight cylindric stem bearing leaf scars with a tuft of leaves at the top. Leaves are deeply lobed, palmlike with long hollow petioles; Flowers are unisexual, white or yellowish-white, males in long drooping panicles, females in short clusters, fruits-one chambered, indehiscent, succulent, spherical or cylindrical, seeds many, yellowing brownish or black.

Parts Used : Fruit and latex

(Papaya)

Uses : Fruits are bitter, acrid, thermo genic analgesic, aphrodisiac, stomachic, digestive, carminative, styptic, antifungal, and diuretic; they are useful in vitiated conditions of cough, bronchitis, dyspepsia, ringworm and skin disease.

64. Chrysan Themum

Local Name : Sevati (O), Chrysanthemum
Botanical Name : *Chrysanthemum Indicum* L
Family : Asteraceae

Description : Annual or perennial herb, stem sulcate, glabrous, leaves alternate, deeply lobed and irregularly toothed, the inflorescence is an axillary or terminal corymb of many heads, flowers are usually yellow.

(Chrysan Themum)

Uses : The flowers possess antibacterial and anti-hypertensive properties. They are utilised in medication for photopsia, vertigo, fever, headache, ophthalmia and phlegm on. Washing with decoction and poultices of flowers is effective in furunculosis and impetigo.

65. Doob Grass

Local Name : Dooba (O), Doob grass (E)
Botanical Name : *Cynodon dactylon Pers*
Family : Poaceae

Description : A prostrate, extensively creeping herb, glabrous, highly branched, perennial grass rooting at every node forming a netted tuft, leaves narrow, linear, soft, smooth, inflorescence terminal spikes, green or purplish, rachis slender, fruits grains, oblong, laterally compressed.

(Doob Grass)

Uses : The plant is astringent, sweet, cooling, hemostatic, depurative, vulnerary, constipating, diuretic and tonic. It is used in vitiated pitta conditions, burning sensation, wounds, hemorrhages, leprosy, skin diseases, vomiting, diarrhea, dysentery, and debility.

Results and Discussion

A total of 111 plant species were reported belonging to 98 genera of 53 families from the R.I.E. Campus, Bhubaneswar. Of these, monocots were represented by 10 species belonging to seven genera and eight families, while dicots contributed by 101 species belonging to 104 genera and 45 families.

The Floristic composition shows that the vegetation of Medicinal plants includes as many as 51 herbs, 8 shrubs, 43 Trees, and 9 climbers (Table 1, Table 2, Fig. 1, and Fig. 4).

The plant parts and the disease used were recorded in Table 1 and compared with the research work published by Satapathy, K. B. (2015) for the Jajpur district of Odisha. In 2011, 72 medicinal plants had been identified in the R.I.E. campus by previous workers (Kumar S *et al*., 2011)**.** Euphorbiaceae (10), followed by Lamiaceae (5), was the most dominant family among economically essential plant species recorded (Fig. 2).

Genera wise *Phyllanthus,* followed by *Ficus, Ocimum*, and *Terminalia,* were the dominant genera in the present study (Fig.3**)**. From the study area, 4 plants species were found to be vulnerable, Endangered and critically endangered. Table 3 highlights these species along with their Botanical name, family, local name and IUCN status. It is critical to conserve these medicinal plants locally, if not globally. This may be through in-situ or ex-situ conservation methods for preserving the biodiversity of the state of Odisha. Suit conservation methods should be implemented to conserve medicinal plant resources in their natural habitat.

Table: 1 - List of Common Medicinal Plant Species and their Uses Recorded from the Herbal Garden of R.I.E., Bhubaneswar.

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
1.	*Abutilon indicum* (L.) Sweet	Pedi-Pedika	S	Malvaceae	Root, Leaves, Seeds	Piles, Dysuria, Toothache
2.	*Acalypha indica* L.	Khokhali	H	Euphorbiaceae	Whole plant	Cough, Scabies, Bronchitis
3.	*Acacia nilotica*(L.) Willd. S.S.P. Indica (Benth)	Babul	T	Mimosaceae	Bark, Gum	Diarrhea, Dysentery, Diabetics, Astringent
4.	*Achyranthes aspera* L.	Apamaranga	H	Amranthaceae	Root	Cough, Asthma, Bronchitis
5.	*Aegle marmelos* (L.) Corr.	Bela	T	Rutaceae	Fruit, leaves and root	Constipation, Indigestion, Fever, Cough, Piles, Filariasis
6.	*Aerva lanata* (L.) Juss.	Paunsia	H	Amaranthaceae	Whole plant	Boils, Cough, Diabetes, Lithiasis, Ulcers, Rheumatic, Swelling
7.	*Ageratum conyzoides* L.	Dengsingi	H	Asteraceae	Whole plant	Uterine hemorrhage, Rhinitis, Sinusitis, Inflammation
8.	*Alstonia scholaris* (L.) R.Br.	Chatiana	T	Apocynaceae	Bark, Leaves, Fruit	Diarrhea, Asthma, Cardiac troubles
9.	*Anacardium occidentale* L.	Kaju badam	T	Anacardiaceae		Preventing hair loss, Snakebite, Skin disease, Dysentery
10.	*Andrographis paniculata* (Burm.f.) Wall. ex Nees	Bhui nimba	H	Acanthaceae	Whole plant	Dysentery, Fever, Tonsillitis, Hypertension, Snakebite
11.	*Annona reticulate* L.	Ramphal	T	Annonaceae	Root, Bark, Stem, Fruit, Seed	Diarrhea, Indigestion
12.	*Annona squamosa* L.	Saripha/ Ata	T	Annonaceae	Root, Leaves, Bark, Fruit	Mental depression, Spinal disorder, anemia

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
13.	*Argemone mexicana* L.	Odosamari	H	Papaveraceae	Root, seeds	Jaundice, Leprosy, Conjunctivitis
14.	*Argyreia nervosa* (Burm.f.) Boj.	Mundanoi	C	Convolvulaceae	Root, Leaves, Seed	Anorexia, Colie, Piles, Synovitis, Cerebral disorder, Cardiac problem
15.	*Aristolochia indica* L.	Iswara mula	T	Aristolochiaceae	Root, Stem, Leaves	Ulcer, Inflammation, Colic, Cough, Leukoderma
16.	*Artocarpus heterophyllus* Lam.	Panasa	T	Moraceae	Root, Pulp, Fruit, Seed	Pharyngitis, Fever, Boils, Wounds, Skin diseases
17.	*Asparagus racemosus* Willd.	Satabari	C	Liliaceae	Entire plant	Rheumatism, Gastritis, Menorrhagia, Eye diseases
18.	*Azadirachta indica* A. Juss.	Nimba	T	Meliaceae	Bark, Leaves, Flower, Fruit, Seed	Eczema, Scabies, Ring worm
19.	*Bauhinia variegate* L.	Kanchana	T	Caesalpiniaceae	Bark, Root, Bud	Skin diseases, Cough, Leprosy, Diabetes
20.	*Boerhavia diffusa* L.	Puruni	H	Nyctaginaceae	Whole plant	Leucorrhoea, Cardiac trouble, Jaundice, Constipation, General debility
21.	*Bombax ceiba* L.	Simuli	T	Bombacaceae	Root, prickles, seed, bark, young fruit, gum, leaves and flower	Menorrhagia, Urinary disorder, Fever, Abdominal disorder
22.	*Borassus flabellifer* L.	Tala		Arecaceae	Roots, leaves, inflorescences and fruit	Burning sensation, Colic, Constipation
23.	*Butea monosperma* (Lam.) Taub.	Palash	T	Fabaceae	Bark, leaves, flowers, seeds and gum	Anorexia, Dyspepsia, Diarrhea, Intestinal worms

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
24.	*Calotropis gigantean* R. Br.			Asclepiadaceae		Scabies, Acne, Pimples
25.	*Capparis zeylanica* L.	Kantikapali	S	Capparaceae	Root, Bark, Leaves	Skin troubles
26.	*Cassia fistula* L.	Sunari	T	Caesalpiniaceae	Fruit, leaves, bark and root	Tuberculous glands, Constipation, Diabetes, Burning sensation
27.	*Chenopodium album* L.	Bathua	H	Chenopodiaceae	Entire plant	Peptic ulcer, Helminthiasis, Eye disorders, Seminal weakness
28.	*Cissus quadrangular* L.	Hadavanga	H	Vitaceae	Whole plant	Anorexia, Colic, Leprosy, Skin disease, Tumors, Eye disorders
29.	*Cleome viscosa* L.	Bana sorisa	H	Capparaceae	Leaves and seeds	Fever, Diarrhea, Worm infestation, Dyspepsia, Cardiac disorders
30.	*Clerodendrum viscosum* Vent.	Sweta bhaunarmala	S	Verbenaceae	Root and leaves	Tumour, leprosy, Skin disease, Cough, Bronchitis
31.	*Clitoria ternatea* L.	Aparajita	Tw	Fabaceae	Roots, leaves and seeds	Ophthalmopathy tubercular glands, Helminthiasis, Elephantiasis, Otalgia
32.	*Coccinea grandis* (L.) Voigt.	Kunduri	C	Cucurbitaceae	Leaf	Vomiting, Uterine discharges, Leprosy, Jaundice, Cough
33.	*Cocos nucifera* L.	Nadia	T	Arecaceae	Root, Fruit	Rheumatism, Back pain, Difficult pregnancy, Stomachache

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
34.	*Costus speciosus* (Koenig) Sm.	Kudha		Zingiberaceae	Rhizome	Erache, Bile disorders, Urinary disorders
35.	*Curcuma longa* L.	Haladi	H	Zingiberaceae	Rhizome	Hepatitis, Jaundice, Menstrual disorder, Duodenal ulcer
36.	*Cynodon dactylon* (L.) Pers.	Duba	H	Poaceae	All parts	Conjunctivitis, Wounds, Leprosy, Skin disease
37.	*Cyperus rotundus* L. var. *rotundus* Kern.	Mutha	H	Cyperaceae	Tuber	Leprosy, Malaria fever, Diarrhea, Wounds, Ulcers
38.	*Dalbergia sissoo* Roxb.	Sisso	T	Fabaceae	Roots, leaves, bark and heartwood	Gonorrhoea, Menorrhagia, Colic, Piles, Burning Sensation
39.	*Delonix regia* (Boj. Ex Hook) Raf.	Krushnachuda	T	Caesalpiniaceae	Stem wood, Bark, Leaves	Diabetes, Reduces blood sugar level, Anti-inflammation
40.	*Dillenia Indica* L.	Ou	T	Dilleniaceae	Fruit	Antidiabetic, Laxative
41.	*Dioscorea pentaphylla* L.	Banaalu	C	Dioscoreaceae	Tubers	Syphilis, Dysentery, Piles, Aphrodisiac, Worm infestation
42.	*Eclipta prostrate* (L.) L.	Keshadura	H	Asteraceae	Root, Leaves	Promote hair growth, Leucorrhoea, Eruption, and Graying of hair
43.	*Euphorbia hirta* L.			Euphorbiaceae	Aerial parts	Conjunctivitis, Cough, Asthma, Dysentery, Warts
44.	*Evolvulus alsinoides* (L.) L.	Bichhamalia	H	Convolvulaceae	Whole plant	Fever, Loss of memory, Nervous debility, syphilis, Weakness

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
45.	*Ficus benghalensis* L.	Bara	T	Moraceae	Bark, aerial root, leaves, fruits and latex	Rheumatism, Acidity, Stomach disorders, Lumbago, Diarrhea, Diabetes, vomiting, Urinary disorders
46.	*Ficus hispida* L.f.	Dimiri	T	Moraceae	Bark, aerial root, leaves, fruits and latex	Jaundice, Leukoderma, Piles, Wounds, Haemorrhoea
47.	*Ficus religiosa* L.	Usta	T	Moraceae	Leaves, seeds, bark, fruits, tender shoots and latex	Constipation, Ulcers, Wounds, skin and lungs disease, Asthma
48.	*Gmelina arborea* Roxb.	Gambari	T	Verbenaceae	Leaves, fruit, bark and root	Stomachache, Galactogouge, Laxative, Antihelminthic
49.	*Heliotropium indicum* L.	Hatisundha	H	Boraginaceae	Leaves	Ringworm, Rheumatism, Ulcer Would, Gonorrhoea
50.	*Hemidesmus indicus* (L.) R.Br.			Asclepiadaceae	Roots, leaves, stem and latex	Rheumatism, Urinary trouble, Skin disease, Diabetes Dysuria
51.	*Ipomoea aquatica* Forssk.	Kalama saga	C	Convolvulaceae	Entire plant	Blood sugar lowering effect
52.	Jatropha gossypifolia Linn.	Nali baigaba	S	Euphorbiaceae	Leaves, bark, Seeds	Boils, carbuncles, Emetic Purgative
53.	*Justicia adhatoda* L.	Basanga	S	Acanthaceae	Leaf, Bark	Cough, Asthma, Bronchitis, Malarial fever
54.	*Lawsonia inermis* L.	Manjuati	S	Lythraceae	Leaves, Bark	Necrotic, Purgative, Astringent, Stimulant
55.	*Leucas aspera* (Willd.) Link	Gaisa	H	Lamiaceae	Leaves, Flower	Catarrh in children, Chronic skin infection, Dysmennoroea

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
56.	*Leucas cephalotes* (Roth.) Spreng.			Lamiaceae	Plant	Filariasis, Inflammation, Antioxidant, Liver ailment, Diabetes
57.	*Limonia acidissima* L.	Kaintha		Rutaceae	Whole Plant	Indigestion, Filaria, Asthma, Piles, Liver sore
58.	*Ludwigia prostrate* Roxb.	Latkera	Herb	Onagraceae	Plant	Dyspepsia, Dropsy, Cough, Cervical adenitis, fever
59.	*Mallotus phillippensis* (Lam.) Muell.	Sinduri		Euphorbiaceae	Stem, Leaves, Seed	Cough, Renal disorder, Ringworm, Herpes, Scabies, Wound ulcer
60.	*Mangifera indical* L.	Amba	T	Anacardiaceae		Dysentery, Diabetes, Asthma
61.	*Marsilea minuta* L.	Sunsunia saga	C	Marsiliaceae	Entire plant	Diarrhoea, Cough Bronchitis, Leprosy
62.	*Melia azedarach* L.	Maha nimba	T	Meliaceae	All parts	Ascariasis, Vaginal infection, Trichomoniases
63.	*Michelia champaca* L.	Champa	T	Magnoliaceae	Root, Leaves, bark, Flower, Seeds, Fruit	Brain disorder, Syphilis, Gonorrhoea, Dysmenorrhoea, Helminthiasis
64.	*Mimosa pudica* L.	Lajakuli	H	Mimosaceae	Root,Stem, Leaves, Flowers, Fruit	Syphllis, Stomach worm, Urinary infection, Leprosy, Insomnia
65.	*Mirabilis jalapa* L.	Rangini	H	Nyctaginaceae	Root, Leaves	Diuretics, Purgative, Would healing
66.	*Momordica charantia* L.	Kalara	C	Cucurbitaceae	Leaves	Diabetes, Hypertension, Dysentery, Malignant ulcer, Leprosy

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
67.	*Moringa oleifera* Lam.	Sajana	T	Moringaceae	Root and leaves	Rheumatism, Cardiac problem, Scurvey, Circulatory, Stimulant
68.	*Nelumbo nucifera* Gaertn.	Padma	H	Nymphaeaceae	Rhizome	Neurasthenia, Spermatorrhoea, Metrorrhhoea, Liver diseases
69.	*Neolamarckia cadamba* (Roxb.) Bosser.	Kadamba	T	Rubiaceae	Leaves, bark	Wounds and bruises, Rheumatic Headache, Liver diseases
70.	*Nerium oleander* L.	Karabira	T	Apocynaceae	Leaves, Root	Ophthalmia, Ringworm, Scabies, Copius Lacrimation, Leprosy
71.	*Nyctanthes arbor-tristis* L.	Gangasiuli	T	Oleaceae	Leaves, flowers and seeds	Bile fever, Malarial fever, Cold, Cough, Rheumatism
72.	*Nymphaea nouchali* Burm.f.	Nali Kain	H	Nymphaeaceae	Rhizome, Tuber	Diarrhoea, Dermatopathy, Cardiac disorders
73.	*Ocimum basilicum* L.	Kapur Kranti	H	Lamiaceae	Whole plant	Cold, Cough, Fever, Ringworm, Cancer, Stress, Asthma, Diabetes
74.	*Ocimum gratissimum* L.	Rama tulasi	S	Lamiaceae	Whole plant	Headache, Sunstroke, Influenza
75.	*Ocimum sanctum* L.	Tulasi	H	Lamiaceae	Whole plant	Asthma, Vomiting, Hiccup, Lumbago, Verminosis
76.	*Paederia foetida* L.	Pasaruni	H	Rubiaceae	Fresh leaves	Rheumatism, Bacillary dysentery, Dysuria, Gastritis, Dyspepsia

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
77.	*Phoenix sylvestris* (L.) Roxb.	Khajuri	T	Arecaceae	Root, Fruit, Heartwood	Burning sensation, Fever, Cardiac debility, Gastropathy
78.	*Phyllanthus acidus* (L.) Skeels.	Narakoli	T	Euphorbiaceae	Root, Leaves, Seed	Poultice, Lumbago, Rheumatism, Purgative
79.	*Phyllanthus emblica* L.	Amla	T	Euphorbiaceae	Root bark, bark, leaves and fruits	Eye diseases, Indigestion, Piles, Diabetes, Polyuria, Dental carries
80.	*Phyllanthus fraternus* Webster	Bhuin anla	H	Euphorbiaceae	Root, Stem, Leaves	Viral hepatitis, Oedema, Dysentery
81.	*Phyllanthus reticulatus* Poir.	Jajanga	S	Euphorbiaceae	Whole plant	Stomach disorders in cows, Burn, Skin infection, Obesity, Gastropathy
82.	*Phyllanthus niruri* L.	Bhuiamla	H	Euphorbiaceae	Root, Stem, Leaves	Jaundice, Dysentery, Stomachic
83.	*Phyllanthus virgatus* Forst. f.	Bhui anla	H	Euphorbiaceae	Fruit	Diarrhea, Dysentery, Gastropathy, Scabies, Ulcers
84.	*Piper longum* L.	Pipal	H	Piperaceae	Root, Fruit	Gynaec problems, Diarrhoea, Indigestion, Jaundice, Asthma, Fever, Cough, Sinusitis
85.	*Plumeria rubra* L.	Katha Champa	T	Apocynaceae	Whole plant	Cough, Constipation, Acute enteritis, Dysentery, Haemophilia
86.	*Pongamia pinnata* (L.) Pierre.	Karanja	T	Fabaceae	Root, Bark, Leaves, Seed	Antihelminthic, Earache, Whooping cough, Hydrocele, piles

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
87.	*Psidium guajava* L.	Pijuli	T	Myrtaceae	Root, Bark, Leaves, Fruit	Diarrhea, Dysentery, Cough, Stomachache, Bleeding gum, Constipation
88.	*Quisqualis indica* L.	Madhumalati	C	Combretaceae	Root, Leaves, Seed	Diarrhea, Liver, Anthelminthic
89.	*Rauwolfia serpentine* (L.) Benth.ex. Kurz.	Patala garuda	H	Aaapocynaceae	Root	Snakebite, High B.P., Scorpion sting
90.	*Ricinus communis* L.	Jadda	H	Euphorbiaceae	Seeds and leaves	Skin diseases, Inflammation, Constipation
91.	*Saccharum officinarum* L.	Akau	H	Poaceae	Stem, Root	Sore eyes and throat
92.	*Santalum album* L.	Chandana	T	Santalaceae	Heart wood	Skin disease, Jaundice, Cough, Gastric irritability, Menorrhoea, Leucorrhoea, General debility
93.	Saraca asoca (Roxb.) de wilde	Ashoka	T	Caesalpiniaceae	Bark, Flower	menorrhagia, leucorrhoea, bleeding haemorrhoids, dysfunctional uterine bleeding
94.	*Semecarpus anacardium* L.f.	Kaju badam		Anacardiaceae	Fruit, Seed	Leprosy, Nervous debility, Rheumatism, Epilepsy, Psoriasis, Diabetes, Tumors
95.	*Sesamum orientale* L.	Rasi	H	Pedaliaceae	Leaves, Seed	Ophthalmic and Cutaneous complaints
96.	*Sida acuta* Burm.f.	Bajarmuli	H	Malvaceae	Root and leaves	Diabetes, Toothache, Ulcer, Piles
97.	*Sida cordifolia* L.	Bisiripi	H	Malvaceae	Root, Leaves, Bark, seeds	Urinary troubles, Sciatica, Dysentery, Facial paralysis

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
98.	*Streblus asper* Lour.	Sahada	T	Moraceae	Root, bark, latex, leaves	Ulcers, Sinusitis, Elephantiasis, Sore heals, Boils, Hemorrhoids, Syphilis
99.	*Strychnos nux-vomica* L.	Kochila	T	Loganiaceae	Bark, leaves and seeds	Cholera, Asthma, Anemia, Malarial Fever, Paralysis, Stomachache
100.	*Syzygium cumini* (L.) Skeels.	Jamukoli	T	Myrtaceae	Leaves, Bark, Fruit, Seed	Diabetes, Diarrhea, Leucorrhoea, Oedema
101.	*Tamarindus indica* L.	Tentuli	T	Caesalpiniaceae	Fruit	Hyper-acidity, Leucorrhoea, Oedema
102.	*Tectona grandis* L.f.	Saguan	T	Verbenaceae	Whole plant	Arthritis, Leukoderma, Leprosy, Dysentery, Piles, Eczema, Ringworm
103.	*Tephrosia purpurea* (L.) Pers.	Soroponkha	H	Fabaceae	Root, Leaves	Dysmenorrhoea, Chronic fever, Anemia, Gingivitis, Pimples, Elephantiasis, Boils
104.	*Terminalia arjuna* (Roxb. ex DC.) Wight	Arjuna	T	Combretaceae	Bark	Heat disease, Diarrhea, Cough, Diabetes, Leucorrhoea
105.	*Terminalia bellirica* (Gaertn.) Roxb.	Bahada	T	Combretaceae	Seed	Anemia, Leukodermia, Constipation, Dyspepsia, Greyness of hair
106.	*Tinospora cordifolia* (Willd.) Hook.f.	Guduchi lata	C	Menispermaceae	Whole plant	Flatulence, Stomachalgia, Chronic fever, Jaundice, Seminal weakness, diabetes

Sl. No	Plant name	Common name	Ha-bit	Family	Plant parts used	Disease for which used
107.	*Tridax procumbens* L.	Bisalya Karani	H	Asteraceae	Aerial parts	Gonorrhoea, Gleet, Rheumatoid arthritis, Skin disease
108.	*Vetiveria zizannioides* (L.) Nash.	Bena	H	Poaceae	Root, Leaves	Burning sensation, Ulcers, Vomiting, Cough, Asthma, Gout, Lumbago
109.	*Vitex negundo* L.	Begunia	S	Verbenaceae	Root, Leaves	Rheumatism, Dyspepsia, Catarrh, Headache, Piles
110.	*Zingiber officinale* Rosc.	Adda	H	Zingiberaceae	Rhizome	Cough, Cold, Flatulence, Colic Hiccup, Anorexia, Piles, Dysuria, vomiting.
111.	*Ziziphus mauritiana* Lam.	barakoli	S	Rhamnaceae	Root, Bark, Leaves, Fruits	Swelling of bone, Chest trouble, Vomiting, Diarrhea, Abdominal pain

Table 2: List of division-wise distribution of Medicinal plants present in the Herbal Garden

Plant Groups	Number of Families	Number of Genera	Number of Species
Dicotyledons	45	104	101
Monocotyledons	08	07	08

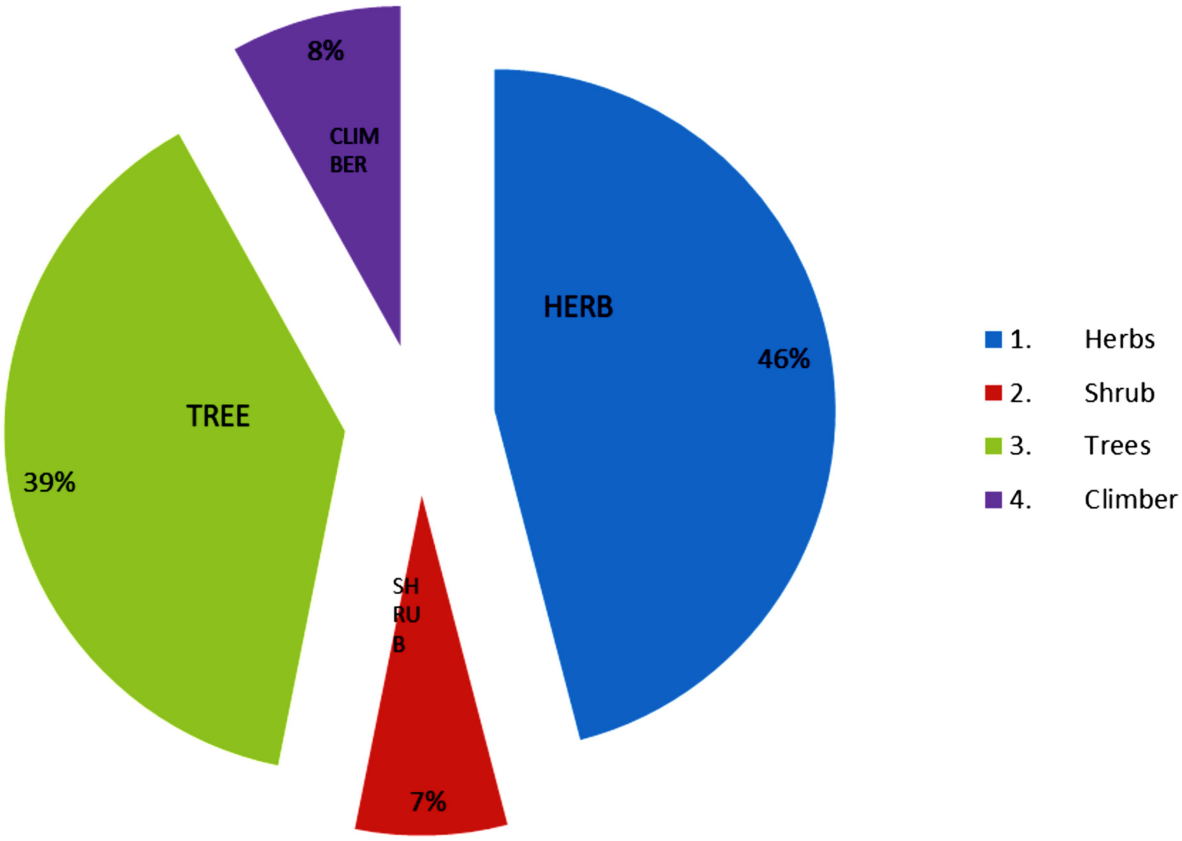


Fig 1: Diversity of plant species by habitat

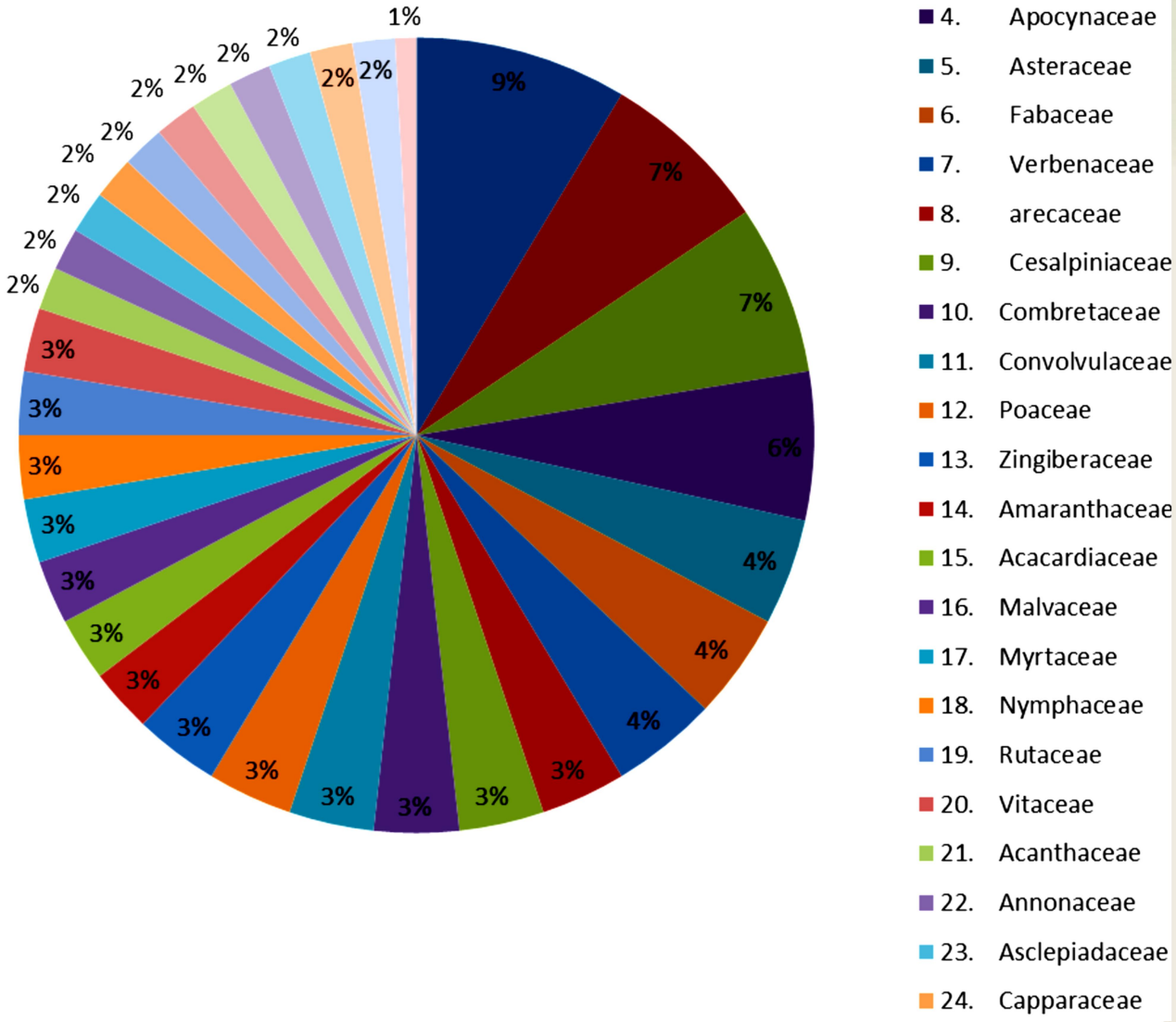


Fig: 2 Family-wise distribution of medicinal plant species (in %) recorded in Herbal Garden of R.I.E. Campus, Bhubaneswar

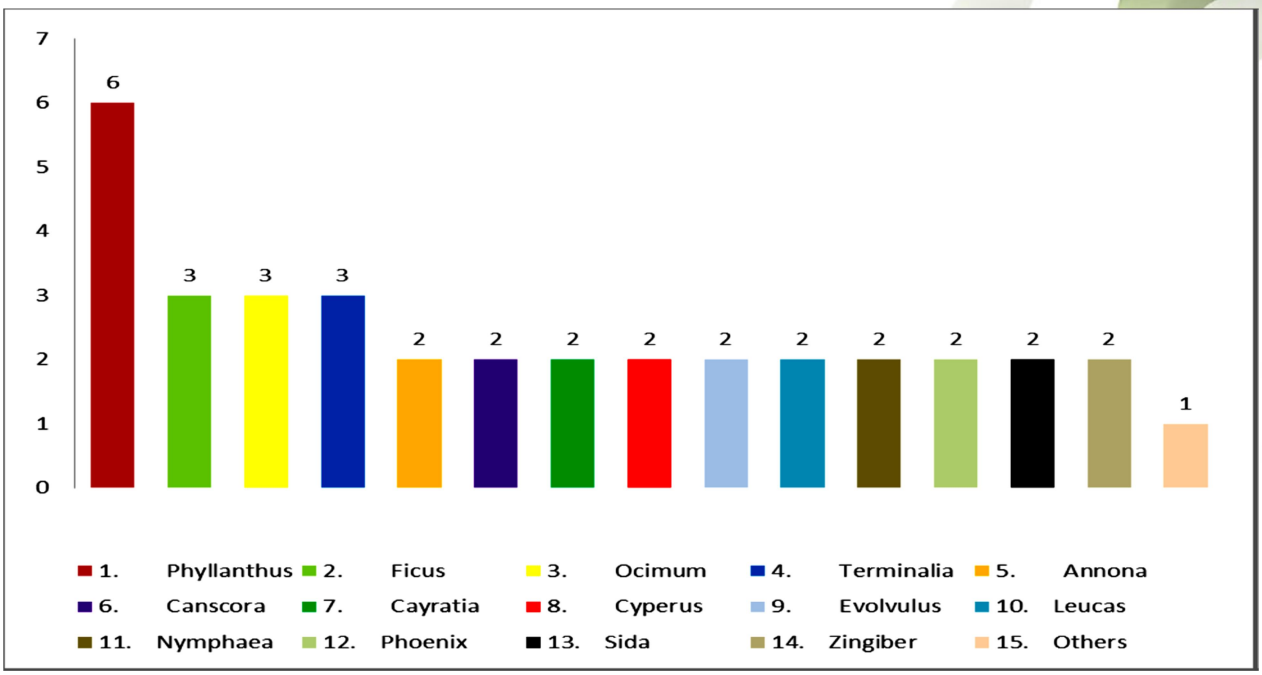


Fig :3 Genus-wise Distribution of Medicinal Plants recorded in the Herbal Garden of R.I.E. Campus, Bhubaneswar

Table 3: List of Endangered, Vulnerable Medicinal Species Recorded in Herbal Garden of R.I.E., Bhubaneswar

Sl. No.	Botanical name	Common name	Family	IUCN status
01	*Paederia foetida L.*	Pasaruni	Rubiaceae	Endangered
02	*Piper Longum L.*	Pipali	Piperaceae	Endangered
03	*Rauwolfia serpentine* (L.) Benth. Ex Kurz.	Patalagaruda	Apocynaceae	Critically Endangered
04	*Saraca Asoca* (Roxb.) de Wilde	Ashoka	Caeslpiniaceae	Vulnerable

(A) **(B)** **(C)**

(D) **(E)** **(F)**

Fig 4: (A) Flowers and fruits of *Melia azedarach* L., **(B)** Flowers of *Paederia foetida* L. **(C)** Flowers and leaves of Saraca asoca (Roxb.) de wilde, **(D)** Fruits of *Terminalia bellirica* (Gaertn.) Roxb., **(E)** Fruits of *Phyllanthus emblica* L., **(F)** Flowers of *Rauwolfia serpentine* (L.) Benth. ex. Kurz.

Future Perspectives :

- More exotic herbal plants will be planted.
- Demonstration of the uses of the plants available will be conducted.

Students will be encouraged to conduct research on the medicinal values of the plants and different parts of the plants.

Herbal Garden, R.I.E. (NCERT), Bhubaneswar

R.I.E.(NCERT), Bhubaneswar acknowledges the In-Charge, Botany Section and his team for their support in the development process of the Herbal Garden.

*****

Resource Centre

In science, the impossible does not exist. Inventions and discoveries are the products of constant endeavour by creative minds, envisioning ever-new outcomes. With a vivid imagination and consistent effort, the forces of the universe can work for an inspired mind. How do we fire up the minds of India's youth, who are the foundation for cutting-edge research and usher in a renaissance in Indian science?

(**A P J Abdul Kalam**)

Learning Resources, being sources of knowledge, can be used by teachers and teacher educators to co-construct cognition and comprehension as part of the continuous development of students.

(https://www.teachingenglish.org.uk/article...)

Effective educational resources convey essential ideas about teaching and learning in ways that can be understood and implemented in the classroom. They are deliberately designed to help teachers understand the insights from research and their implications for practice.

(**https://www.education.govt.nz/assets/Documents...**)

A scientific model is a physical and mathematical conceptual representation of a system of ideas, events or processes. Scientists seek to identify and understand patterns in our world by drawing on their scientific knowledge to offer explanations that enable the designs to be predicted.

(**https://www.education.vic.gov.au/school/teachers/teachingresources...**)

Modelling is a critical process in the development of scientific knowledge. To conduct a more authentic science education, i.e., to make the processes it entails successively approximate to those of science per se, it is advocated that it should be conducted from a modelling-based perspective. From an analysis of how modelling is generally performed in science, a scheme to represent such a process was previously proposed: the 'Model of Modelling' diagram. It has been used as a framework for developing and teaching strategies for some abstract concepts.

(**https://www.sciencedirect.com/science/article...**)

PHYSICS

Introduction

The relevance of models in the teaching-learning process is recognized worldwide. There are two types of models: conceptual and pedagogical models. Need based conceptual models are designed and shared with pre-service and in-service teachers, which are precise, complete and consistent.

Innovation is a gift of nature for everyone, each individual likes to do things, activity which may be unique and useful for others. In the growing society, quality of life, the value of education, has importance of traditional ways of learning as well as make a leading role in identifying any one to be distinguishable.

In order to enhance the creativity and skill in Education, it is believed that centre like Educational Resource Centre is very essential part of Quality Education, where stakeholders can get a feel that how the great innovations might have evolved through small efforts of the beginner. The Educational Resource Centre, is an independent place of learning, inspiration, motivation, recreation, discussion , observation , information, imagination and thinking.

Model: -1: Kinetic Theory Model

Concept:
The kinetic energy of gas molecules varies with the temperatureof the gas.

Description:

An electric motor running at 4-12 Volt DC vibrates a small platform inside the Perspex tube, causing the steel balls to move randomly.

The principle behind the model:

If the temperature of the matter (gas) increases, then the random motion of the molecules of the matter (gas) also increases and vice-versa.

Fig.1: Random motion of steel balls depicting Kinetic Theory of gas molecules

Conceptual Understanding:

The kinetic theory of gases can explain each of the experimentally determined gas laws—the pressure of a gas result from collisions between the gas particles and on the walls of the container.

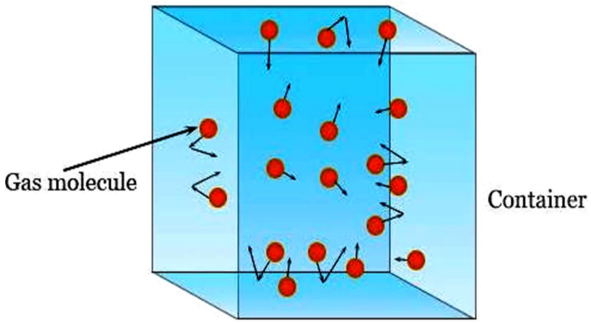


Fig.2: Collision of gas molecules on the walls of the containers

Each time when a molecule of gas hits the wall, it exerts a force on the wall. The kinetic molecular theory of matter states that: Matter is made up of molecules in constant random motion. All molecules have energy, but the energy varies depending on their temperature. This, in turn, determines whether the substance exists in the solid, liquid, or gaseous state.

Model:-2: Maxwell's wheel

Concept behind the model:

Conservation of Mechanical energy.

Description:

The complete set-up of Maxwell's wheel model consists of a spindle made up of iron and is hung using two strings from a rigid support. The model is operated by winding the strings around the spindle until some height is achieved. Then the wheel is released to unwind and fall.

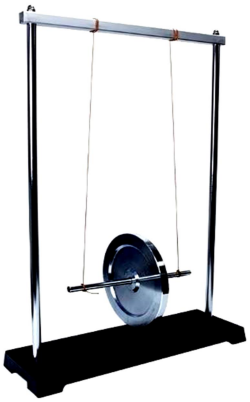


Fig.3: Rotational motion of a solid circular disc

As the wheel unwinds completely, it again rewinds in the opposite direction and goes up to a certain height but lesser than the previous height and comes to rest and immediately comes down due to unwinding.

This up-and-down motion of the spindle continues with decreasing height each time and finally comes to rest.

Principle:

Law of conservation of energy:

It states that energy can neither be created nor destroyed but can only be transferred from one form to another form of energy. The sum total of energy of the universe remains constant.

Conceptual Understanding:

When the strings are wound around the spindle to some height, the work is done against gravity. This work is stored as potential energy in the spindle. As the spindle is released, the unwinding starts due to the pull of gravity. During this process, the angular velocity of the spindle about its axis (axle) and the linear rate is increased, and the spindle accelerates.

Fig.4: Upward motion and downward motion of the disc

This process gradually converts the stored potential energy to kinetic energy. When the spindle is completely unwound, the spindle acquires some momentum and, in accordance inertia of motion with it, starts rewinding in the opposite direction and moves up to a certain lesser height than the previous one due to work done against gravity and friction. In this process, the kinetic energy possessed by the spindle is converted to potential energy. As this process repeats, the energy conservation continues until the spindle comes to rest as the sum. Total mechanical energy remains constant; it can be represented as Potential energy stored = Translational energy + Rotational energy

$mgh = mgx + \frac{1}{2}mv^2 + \frac{1}{2} I\omega^2$

Where mgh is gravitational Potential energy stored due to work done,

mgx is Potential energy at any instant at a distant x from the top.

$\frac{1}{2} mv^2$ is kinetic energy at a distance

$\frac{1}{2} I\omega^2$ is rotational kinetic energy.

This explains the law of conservation of energy.

Model:-3 : Magnet Spring

Concept behind the model:

Like poles repel and unlike bars attract each other.

Description:-

The magnetic spring model consists of a number of (5 to 7 nos.) angular circular permanent magnets kept co-axially through a non-magnetic vertical rod fixed on a stable stand. The magnets are so arranged that the like poles (N-N/S-S) face each other. When the force on the top magnet is applied by the pressure to compress the whole magnets, all the magnets tend to come to the original position through a spring action.

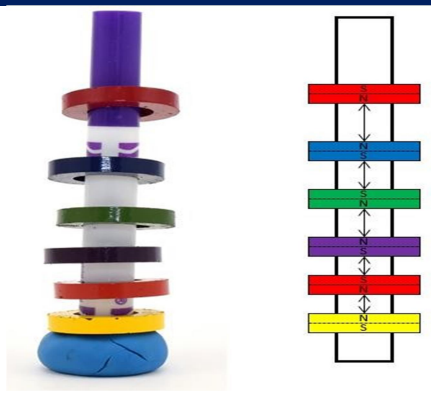


Fig.5: Magnets are arranged with its N-N/S-S poles face towards each other

Principle:

The repulsive force between the like poles provides the necessary restoring force against the applied force resulting in the spring action of thesystem of magnets.

Conceptual Understanding:

Springs are elastic bodies (generally metals) that can be twisted, pulled or stretched, compressed by applying some external force, and returned to their original configuration when the force is released. In this model, the magnets are so arranged that the poles face each other. Due to the repulsive force between the magnets, a gap is created between the two magnets. By applying a down ward force the gap is decreased between the magnets which is analogous to compression of a metal wire spring. The repulsive force acts opposite to the applie0d force like restoring force in a spring. When the applied force is removed, due to restoring force, again the original gaps between the magnets are restored. This explains the spring action of the system.

Model-4 : Coupled Strip Oscillator

Concept behind the mode :

Phenomena of beat.

Fig.6 : Coupled oscillation of two metallic vibrators producing beat

Description:

This model consists of two metallic strips attached with sliding mass fixed to a vertical rigid stand. The sliding masses attached at the free ends of the strips are connected with two small permanent magnets with like poles facing each other. When one strip is made to oscillate horizontally, the other strip oscillates with a lightly different frequency due to magnetically coupling.

Principle:

When two sound waves with a small difference in frequency superimpose each other, the intensity of maxima and minima do not remain fixed with time. Every point undergoes a periodic change of intensity between maximum and minimum. Periodic variation of amplitude obtained from the superposition of two waves of slightly different frequencies is known as the phenomena of beats. One maximum and the following minimum combined is called one beat. If 'm' is the number of beats per second, then. $m=n_1- n_2$ where n_1 and n_2 are the frequencies of two waves.,

Conceptual Understanding:

To observe the phenomena of beats, the upper strip of the model is slightly made to oscillate horizontally. Since the lower strip is magnetically coupled with the upper strip, the lower strip starts oscillating with a slightly different frequency. In this way, two waves generated from the strips superpose each other. The vibration of the strips with maximum amplitude and minimum amplitude can be observed with a constant interval of time. Thus the phenomena of beats can be observed and explained through this model.

Model -5 : Laplace rail

Concept behind the model:

Force on current carrying conductor & Flemings left-hand rule.

Description:

This model consists of two parallel conducting rods (rails) to which potential differences are applied at the two free ends. Another conducting rod with two discs at its ends is made to roll over the two current-carrying conducting rails in the vertical magnetic field.

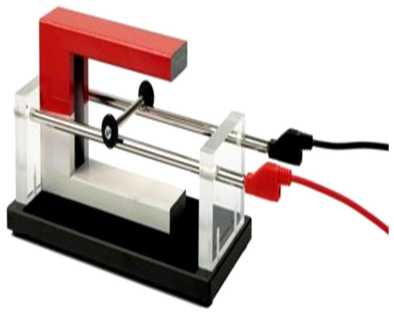


Fig.7 : Motion of a metallic current carrying rod in a magnetic field

The principle behind the model:

When a current-carrying conductor is placed in a vertical magnetic field, a force is experienced on the conductor. The direction of force is governed by Fleming's left-hand rule.

Conceptual Understanding:

This model demonstrates force on a current-carrying conductor in a magnetic field. When a power supply of 4-12 v DC is connected to the two ends of the rails and the rolling rod with discs at the two outer ends is kept on the rails in the presence of a vertical magnetic field, a force is experienced on the rolling bar due to current flow from one rail to the other through the rolling rod.

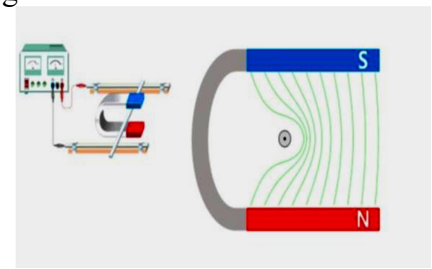


Fig.8 : Motion of the current carrying rod depicting & left hand rule

It is observed that the rolling rod roles in one direction. By reversing the polarity of the power supply, it is observed that the rolling rod rolls in the opposite direction. From this, it is concluded that a force is experienced on the current-carrying rolling rod in the presence of the magnetic field. Direction of force can be determined by applying Fleming's left-hand rule. According to this, if the first finger, central finger and the thumb of the left hand are stretched mutually perpendicular to each other and if the first finger points towards magnetic field, the central finger points towards electric current, then the thumb gives the direction of force acting on the conductor.

Hence force on a conductor carrying current in a magnetic field and hence Fleming's left hand rule can be demonstrated by using this model.

Model-6 : Fleming's Right-hand rule

Concept behind the Model:

The direction of current through a coil/ conductor moving in a magnetic field

Description:

This model consists of a coil wound on an iron core suspended from a rigid support between two pole pieces of a permanent magnet. The two ends of the coil are connected to a galvanometer.

The principle behind the model: This model works on the principle of electromagnetic induction; whenever magnetic flux linked in a coil changes, an induced EMF produced in the coil.

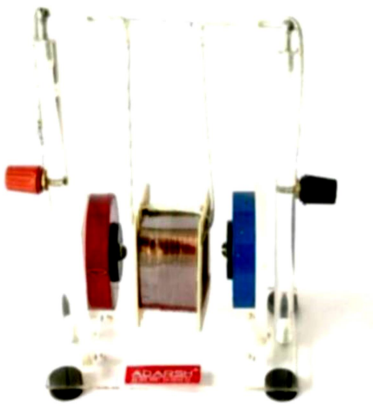


Fig.9 : The direction of the current in a conductor due to its motion in a magnetic field.

Conceptual Understanding: -

In this model, a galvanometer is connected across the two ends of the coil. When the coil is moved in forward direction the pointer of the galvanometer shows a deflection to a particular direction. When the coil is moved to backward direction the pointer of Galvanometer shows a deflection in a direction opposite to that of previous case.

According to Fleming's Right-hand rule. If the first finger central finger and the thumb of right hand are held perpendicular to each other and if the first finger points toward magnetic field, thumb points towards the direction of motion of the coil, then the direction of central finger gives the direction of induced current set up in the coil/ conductor.

Hence by using this model, the direction of induced Current can be determined.

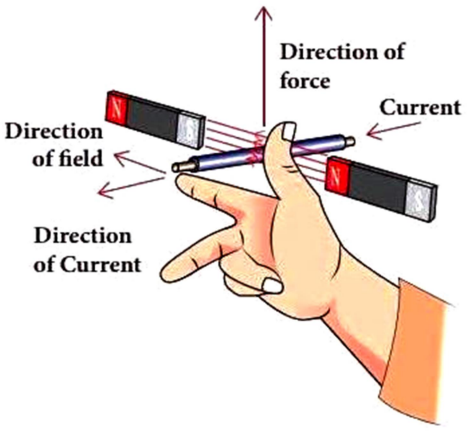


Fig.10 : Fleming's right hand rule

Model:-7 : Electromagnet

Concept behind the model: Magnetic effect of circulating current.

Description:-

This model consists of a core of magnetic material surrounded by a coil through which electric current is passed. In this model magnetic field is produced by an electric current through the coil. The strength of the magnetic field generated is proportional to the amount of current through the cool coil.

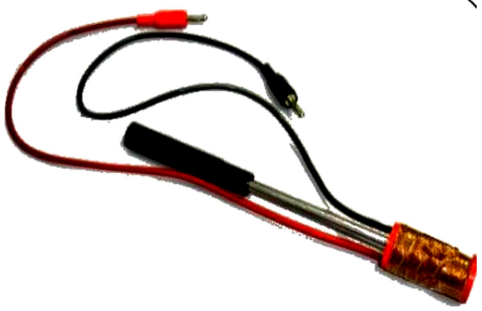


Fig.11 : Electromagnet

Principle behind the model:

An electric current flowing in a coil (copper) creates a magnetic field all around the wire of the coil .The direction of magnetic field can be found by right hand thumb rule according to which, if the fingers of right hand are curled around the coil in the direction of current then the thumb points in direction of magnetic field inside the coil.

Conceptual Understanding:

In this model when potential difference is applied between the two terminals of the coil, the current starts circulating in the coil. Such current produces a magnetic field in the core of the coil can be observed by placing a small magnetic needle near the pole. The polarity of the ends can be determined by a magnetic needle compass, as shown in the figure.

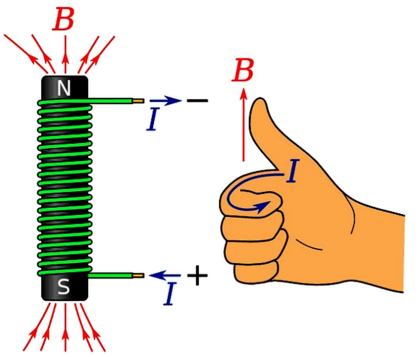


Fig.12 : Direction of current in a coil and right hand thumb rule

Model -8: Magnetization and demagnetization of a coil.

Concept behind the model: Magnetic effect of current

Description:

This model consists of a Copper coil wound on an insulating cylinder. The two ends of the coil are connected to 4-12 VDC power supply.

Fig.13: Magnetising a coil

The principle behind the model: When an electric current exists in the wire of the coils, a magnetic field is associated around it. Increasing the number of turns in the coil, the magnetic field strength can be increased.

Conceptual Understanding:

When 4-12 VDC power supply is connected across the two terminals of the coil due to which magnetic field is produced around the coil? The magnetic field strength is proportional to the amount of current flow and number of turns of the coil.

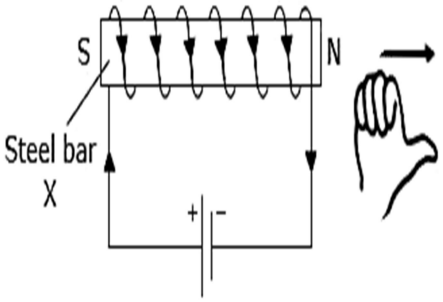


Fig.14 : Polarity of the magnetic field produced in an electromagnet

The polarity of the ends of the coil can be found out by using a magnetic needle compass as well as by applying right hand thumb rule. The process of developing magnetism in the coil is called magnetization. When the power supply is switched off magnetism vanishes. This process is called demagnetization.

Model-9 : Hydraulic press

Concept behind the model:

The concept behind the model is that a small force applied on a smaller area is emerged as a larger force on a bigger area.

Description:

Hydraulic press is a device in which two cylinders of different area of cross- section fitted with pistons and communicating with each other through a pipe. In the above fig.1, A_1 is the smaller area and A_2 is the bigger area, F_1 is the force applied on the smaller area A1, F2 is the force generated on the larger area A2 and P is the pressure transmitted throughout the liquid uniformly.

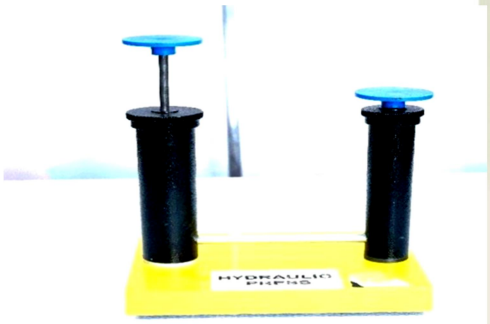


Fig.15 : Hydraulic press

The principle behind the model:

The principle behind the model rests on Pascal's law that the pressure applied anywhere in an enclosed fluid is transmitted equally in all directions. Consequently, this gives rise to the principle of multiplication of force.

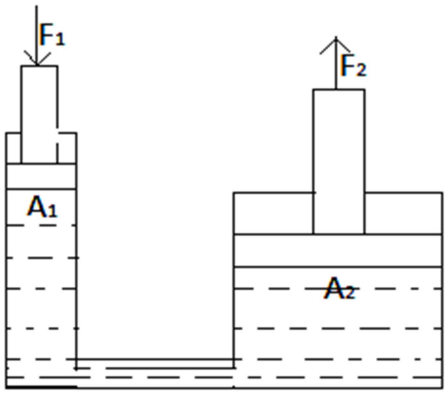


Fig.16 : The transmission of force through the fluid in hydraulic press

Conceptual Understanding:

A force F_1 is applied to the small piston having area A_1 creates a pressure (P), which is transmitted through the fluid to a larger piston having area A_2 ($>A_1$), where it gives rise to a larger force F_2.

Thus, $F_2 = (F_1/A_1)\ A_2$

Where transmitted pressure P is F_1/ A_1

The principle of the hydraulic press is widely used in jacks, vehicle break, presses, and earth-moving machinery, usually with oil as the working fluid.

The mechanical advantage of the hydraulic press is given by the force ratio, that means the ratio of the output force (load) of the machine to the input force (effort). Here in the machine under our consideration, the mechanical advantage (MA) is given by.

M.A. = output force (load) / input force (effort) = F_2 /F_1

Model-10: Circular Motion of a Ball

Concept behind the model: Centripetal Force

Description:

A rubber ball of diameter about 2 to 3 cms was put inside the plastic tub and fixed on the free wheel of bicycle through its axel. The free wheel could be rotated by crank-chain arrangement with the free wheel of a cycle. The speed of the rotating tub can be increased by increasing the speed of the crank by using the cycle pedal attached to the crank. The rubber ball inside the tub also rotates in a circular path along with the rotation of the tub. As speed is increased the radius of the circular path of the ball is gradually increasing.

Fig.17 : Rotation of a ball in a tub due to centripetal force

A centripetal force is a force that makes a body follow a curved path. Its direction is always orthogonal to the motion of the body and towards the fixed point of the instantaneous center of curvature of the path. Isaac Newton described it as "a force by which bodies are drawn or impelled, or in any way tend, towards a point as to a centre. In Newtonian mechanics, gravity provides the centripetal force causing astronomical orbits.

Principle behind the model:

A centripetal force is a force that makes a body follow a curved path. Its direction is always perpendicular to the motion of the body and towards the fixed point of the instantaneous center of curvature of the path. So, if a body is moving along a circle with constant speed, there is a change in velocity by virtue of direction. As such the body experiences an acceleration which is directed towards the center of the circle. According to Newton's second law of motion, a body which experiences an acceleration must also be experiencing a net force called centripetal force. The direction of the net force is in the same direction as the acceleration. The centripetal force for uniform circular motion alters the direction of the object without altering its speed. The idea that an unbalanced force can change the direction of the velocity vector but not its magnitude may seem a bit strange. How could that be? There are a number of ways to approach this question. One approach involves to analyze the motion from a work- energy standpoint. We also know that work is a force acting upon an object to cause a displacement. The amount of work done upon an object is found using the equation

Work = (Force) x (displacement) x cosθ

where the Theta in the equation represents the angle between the force and the displacement. As the centripetal force acts upon an object moving in a circle at constant speed, the force always acts inward as the velocity of the object is directed tangent to the circle. This would mean that the force is always directed perpendicular to the direction that the object is being displaced. The angle θ in the above equation is 90 degrees and the cosine of 90 degrees is 0. Thus, the work done by the centripetal force in the case of uniform circular motion is zero. Also, it is known that when no work is done upon an object by external forces, the total mechanical energy (potential energy plus kinetic energy) of the object remains constant. So, if an object is moving in a horizontal circle at constant speed, the centripetal force does not do any work and cannot alter the total mechanical energy of the object. For this reason, the kinetic energy and therefore, the speed of the object will remain constant. The force can indeed accelerate the object - by changing its direction - but it cannot change its speed. In fact, whenever the unbalanced centripetal force acts perpendicular to the direction of motion, the speed of the object will remain constant. For an unbalanced force to change the speed of the object, there would have to be a component of force in the direction of (or the opposite direction of) the motion of the object.

Conceptual Understanding:

Any motion in a curved path represents accelerated motion, and requires a force directed toward the center of curvature of the path. This force is called the centripetal force which means "center seeking" force. The forcehas the magnitude

$$F_{centripetal} = m\frac{v^2}{r}$$

Swinging a mass in a circular path on a string requires string tension, and the mass will travel off in a tangential straight line if the string breaks.

Model-11: Free fall of a magnet inside a copper tube.

Concept behind the model: Eddy current

Description:

A copper tube of length 30 cms and diameter 1.5 cms is mounted vertically on plastic base. A cylindrical solid magnet and iron Piece identical shape and size are allowed to fall freely inside the tube.

The time of free fall of the magnet was found to be less than that of theiron piece.

Fig.18 : Free fall of a cylindrical magnet in a copper tube

Principle behind the model:

When a metal is exposed to varying magnetic field, eddy current is setup in the metal. An induced magnetic field is also produced due to eddy current which is opposite to the applied varying magnetic field.

Conceptual Understanding:

According to Faraday's laws of electromagnetic induction, whenever magnetic flux changes through a coil, induced emf is produced in oppositedirection.

The induced emf is not only produced in coil but also produced on the inner surface of metallic disc or pipe. According to Lenz's law of electromagnetic induction, the direction of induced emf or current in a closed circuit is such that it opposes the cause that produce it.

When a cylindrical piece of iron is dropped inside a copper tube, there is no change in magnetic flux through the copper. But when a cylindrical magnet is dropped inside the copper tube, there is indued emf in the copper as a result of which eddy current is produced which opposes the motion ofthe magnet.

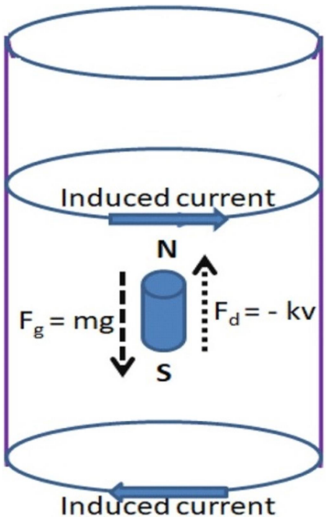


Fig.19 : Eddy current

Model-12 : Ray box with mirrors and lenses

Concept behind the model:

- Reflection of light
- Refraction of light

Description:

It consists of 4-12 V DC power source (battery eliminator), ray box, plane mirror, concave mirror, convex mirror, concave lens and convex lens.

Fig.20 : Optical ray box kit

Principle behind this model:

Reflection of light:

When a ray of light incident on a smooth polished surface (obstacle), the ray of light bounces back, it iscalled the reflection of light.

Refraction of light:

When ray of light is travelling obliquely from one medium to another, then the direction of propagation of light changes in the second medium, this phenomenon is known as refraction of light.

Conceptual Understanding:

Reflection of light:

The ray of light that approaches the mirror is known as incident ray.

The ray that leaves the mirror is known as reflected ray.

At the point of incidence where the incident ray strikes the mirror, a perpendicular line is drawn known as the normal.

The angle between incident ray and normal is called angle of incidence. The angle between normal and reflected ray is called angle of refection.

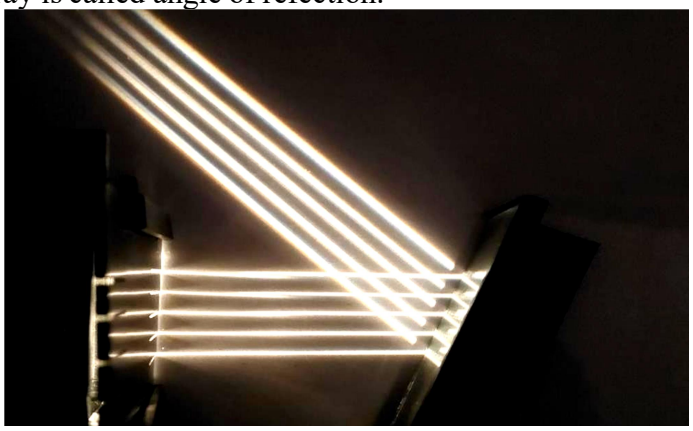


Fig.21 : Reflection of light in plane mirror

When parallel rays of light are made to incident at an angle with the normal of a plane mirror, the rays are reflected at the same angle with the normal and parallel to each other. That means angle of incidence is equal to angleof reflection.

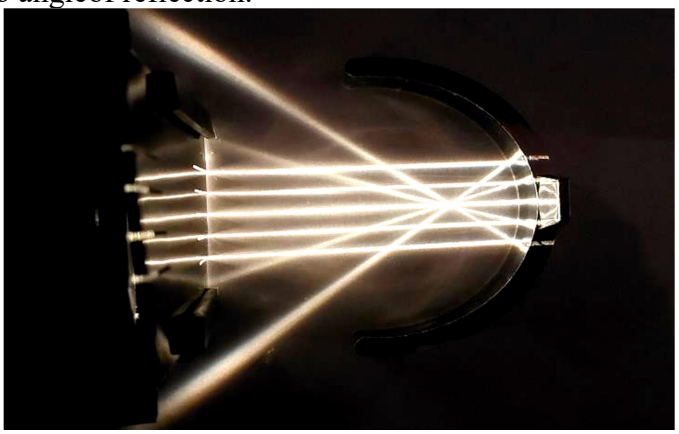


Fig.22 : Reflection in concave mirror

Parallel rays of light are propagating parallel to principal axis after reflection from the concave mirror converges at a point on the principal axis called focus or focal point. Focus of concave mirror is real.

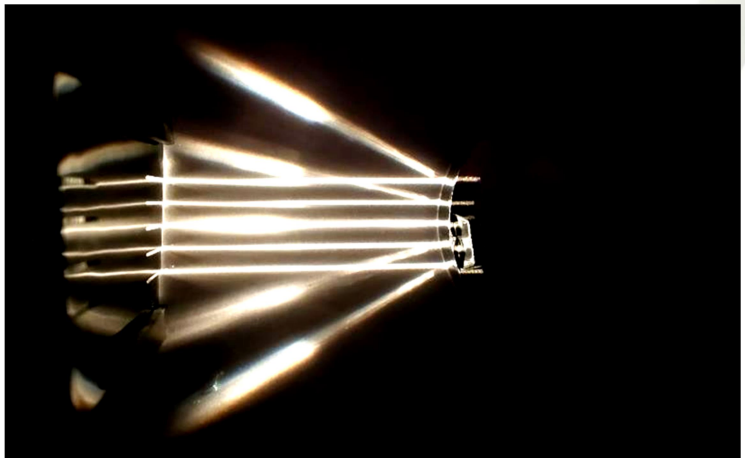


Fig.23: Reflection in convex mirror

Parallel rays of light parallel to principal axis after reflection from the convex mirror diverges and appears to meet at point in opposite sides of mirror on the principal axis called focus or focal point. Focus of convex mirror is virtual.

Refraction of light:

The ray of light incident on the surface separating two mediums is called incident ray.

The ray of light traveling in another medium is called refracted ray.

At the point of incidence where the incident ray strikes to the refracting surface, a perpendicular line is drawn known as the Normal.

The angle between incident ray and normal is called angle of incidence. The angle between normal and refracted ray is called angle of refraction.

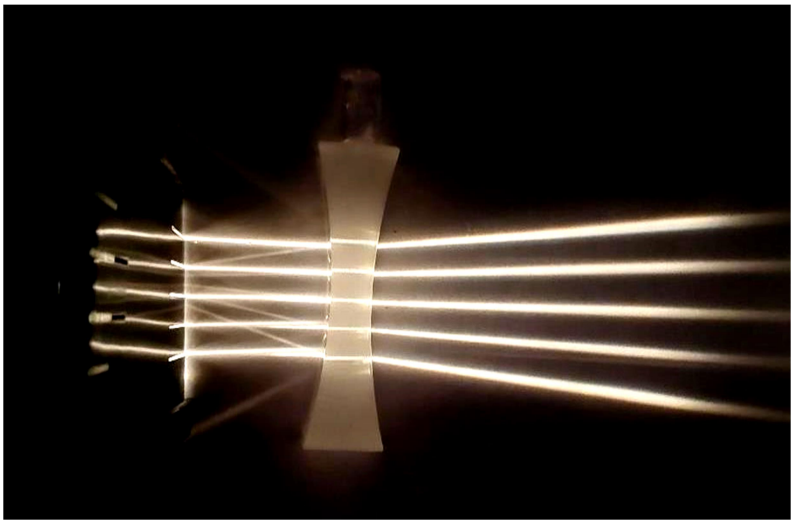


Fig.24 : Refraction in concave lens

Parallel rays of light are propagating parallel to principal axis after refraction through the concave lens diverges and appears to meet at point in opposite sides of lens on the principal axis called focus or focal point. Focus of concave lens is virtual.

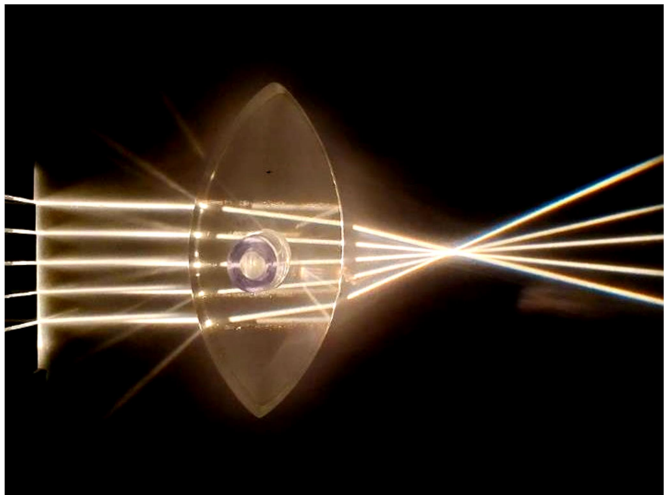


Fig.25: Refraction in convex lens

Parallel rays of light are propagating parallel to principal axis after refraction through the convex lens converges a point on the principal axis called focus or focal point. Focus of convex lens is real.

Model-13: Kaleidoscope

Concept and Basic principles:

A kaleidoscope is a toy that uses light and mirrors to reflect objects and create beautiful, fascinating repeating patterns. Multiple reflections brings up beautiful patterns of material.

Reflection :

When light, traveling in a homogenous medium, falls on the surface of another medium, a part of the incident light is sent back into the first medium. The phenomenon is known as reflection and it takes place according to the laws of reflection.

Multiple reflections :

We know that when light reflects from off a plane mirror, the image appears left/right reversed. Once you bring in another mirror and change the angle between them, it is much harder to keep track of what orientation each image will have.

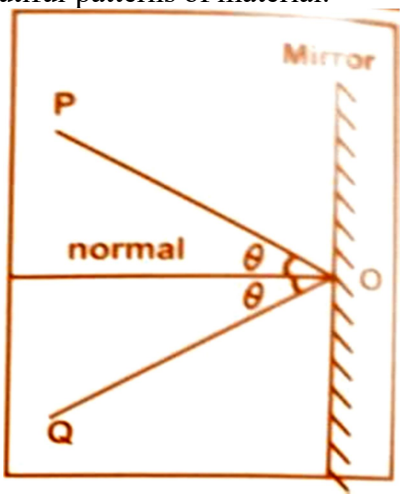


Fig.26 : Reflection on a plane mirror

If you make the angle between the mirrors smaller, you see more images. The relationship between the number of images and the angle between themirrors is ,

$$\text{No. of Images} = \left(\frac{360^0}{\text{Angle between mirrors}}\right) - 1$$

Multiple reflections are difficult to understand and visualize. If you have one flat mirror, light from the object will reflect from the mirror once and leave the system. When you have more than one mirror, you can create multiple reflections. These multiple reflections can lead to multiple images.

Kaleidoscope operate on the principle of multiple reflection. Typically, there are three rectangular lengthwise mirrors of same length . Setting the two mirrors at a 45-degree angle creates 7 images of the objects, so you can see the objects 8 times. When 2 mirrors are making 60-degree angle, we will get, (360/60)-1 = 5 images of the objects using a pair of mirrors. That means, you will see the pattern of 6 considering actual objects and their 5images.

As the tube is rotated, the tumbling of the coloured objects presents the viewer with varying colours and patterns. Any arbitrary pattern of objects shows up as a beautiful symmetrical pattern created by the reflections in the mirrors.

Kaleidoscope :

A Kaleidoscope is a tube or mirrors containing loose, coloured objects such as beads or pebbles and bits of glass. As the viewer looks into one end, light entering the other end creates a colourful pattern, due to the reflection of objects in the mirrors. Coined in 1817 by English inventor Sir David Brewster, the word "Kaleidoscope" is derived from the Ancient Greek and its meaning is, "Observer of beautiful forms".

Assembly Instructions :

Take a cardboard tube. Paste decorative paper with the help of cello tape around the tube. Fix the transparent lid, to which colourful sticker with printed design is already pasted, to the plastic cap.

Fig.27 : Accessories of Kaleidoscope

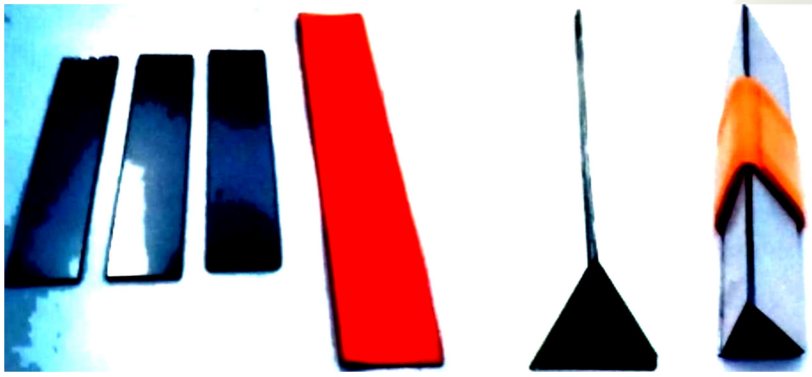


Fig.28: Designing a Kaleidoscope

Fix it from the side, where there is a rim of this cap.

Pour some material from pouch into the cap. Take small quantity of it. Do not empty complete material of the pouch in the cap.

Fix clear transparent lid from other side of the plastic cap. This will form an enclosure for the material placed in the cap.

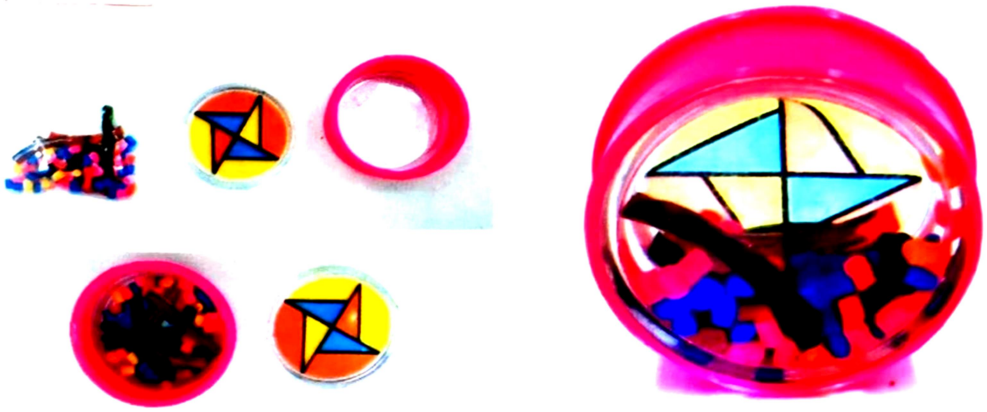


Fig.29 : Enclosure of the Kaleidoscope

Take 3 mirrors and make equilateral triangle with the help of cello tape. Wrap a foam strip around mirror assembly to make the triangular shape firm. This will also help to keep the mirrors in fixed position when they are inserted in cardboard tube.

Insert this assembly into the tube.

Fig.30 : Inserting the assembly in a tube

Fix eye piece and cap with lids at two ends of cardboard tube.

Fig.31 : Fixing the eye piece and cap

Now look through the eyepiece and rotate the tube to see changingdesigns ! !

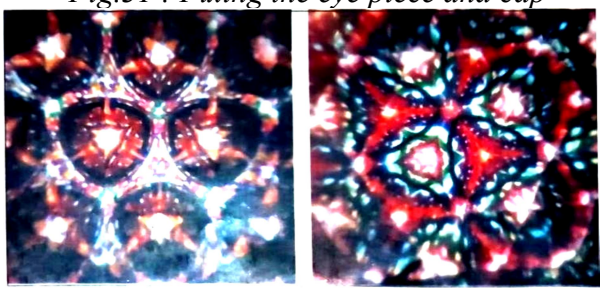


Fig.32 : Pattern of images in the eyepiece of Kaleidoscope

Model-14 : Newton's Disc

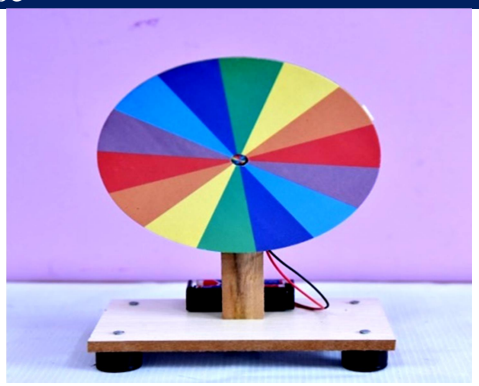


Fig.33 : Newton's colour disc

Concept Behind the Model: White color consists of seven multiple colors.

Description And Conceptual Understanding

- Newton's Disc, named after Sir Isaac Newton, is a disc consists of seven different colors such as red, orange, yellow, green, blue, indigo, and violet. When the disc spins very fast by some external forces, the colors fade to white.
- Once the disc rotates, different colors mixed together which is called temporal optical mixing that can't be visualize by human eye due to persistence of vision.
- Through this demonstration, one can conclude that white color is a mixture of seven different colors found in rainbow.

- This experiment also concludes that light is not colorless.
- As the colors disappear through spinning, such a disc is also called as “Disappearing Color Disc”.

Applications

This experiment shows that white light is the combination of all colors that are found in a rainbow. In addition, white light transmitted through a prism constitutes all these colors in the visible range having wavelengths from 400-700 nm.

Model-15 : Space-Time Curvature

Concept Behind the Model: Space-time curvature influences dynamics of the massive body.

Fig.34: Space-time curvature

Description And Conceptual Understanding

- Space-time is a mathematical description that includes three dimensions of space and one dimension of time into a single four-dimensional manifold.
- The idea of space-time is a part of theory of relativity conceptualized by Albert Einstein.
- According to Albert Einstein's general theory of relativity, gravity is no longer a force that acts on massive bodies, as viewed by Isaac Newton's universal gravitation. Instead, general relativity links gravity to the geometry of space-time itself, and particularly to its curvature.
- Space-time curvature is not a flat surface and is described by Riemannian geometry which plays an important role in general relativity, where gravity is visualized as curved space by the presence of massive bodies.
- One can visualize space-time as a simplified two dimensional surface which is distorted due to the massive body present on its surface. The distortion caused by the body is proportional to its mass.
- When massive bodies move in space-time, the curvature changes and the geometry of space-time is in constant evolution. Gravity thus provides a description of the dynamic interaction between matter and space-time.

Applications

Black Holes are curvatures in space-time where gravity is so powerful that space-time bents far enough to make a hole. The curvature at the black hole centre is infinite and hence the spikes are infinitely long. Anything that falls within the black hole is trapped because of its infinite curvature.

Model-16: Magnetic Levitation

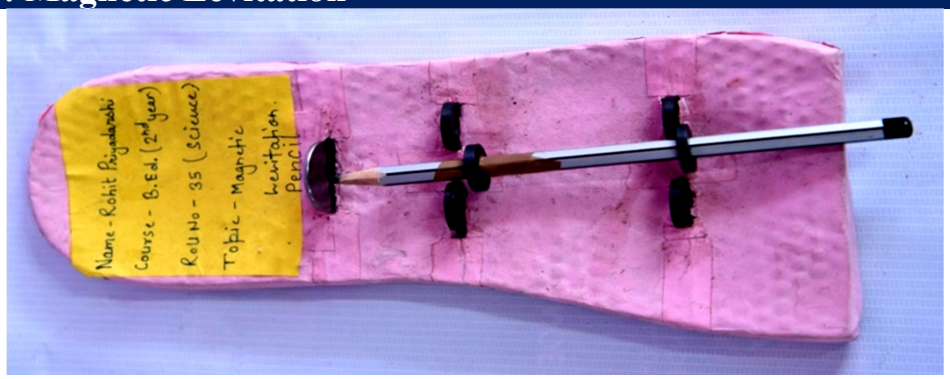


Fig.35 : Magnetic levitation

Concept Behind the Model: Suspension of an object through only 'Magnetic Fields'.

Description And Conceptual Understanding

- Magnetic Levitation (Magnetic Suspension) is a technique by which an object is suspended with the help of magnetic field based on the fundamental property of like poles of a magnet repel each other where one dipole magnet positioned on another dipole magnet.
- In such a suspension, magnetic forces are used to counteract gravitational forces and any other forces through proper alignment of the magnetic poles.
- The two primary issues involved in magnetic levitation are lifting force and stability. Lifting force is an upward force sufficient to oppose gravity provided by magnetic levitation. Stability is provided by a mechanical support to ensure the system does not spontaneously slide or flip so that the lift is neutralized.
- In many physical experiments, all types of magnets (Permanent magnets, Electromagnets, Ferromagnets, Superconducting magnets) have been used to generate lifts for magnetic suspension.

Applications

Magnetic levitation techniques have been used in maglev trains, contactless melting, magnetic bearings, micro robotics, and for product display purposes.

Model – 17: Newton's Cradle

Does the total momentum of a system of bodies remain same during collision?

Concept Behind the Model: According to the law of Conservation of Linear momentum when number of net external force is applied to the total linear momentum of the system always remains constant.

Fig.36 : Newton's cradle

Description And Conceptual Understanding

- 5 pieces of identical steel balls of about 0.5 cm diameter suspended freely by nylon threads each in V-shaped just touching each other when at rest as shown in the Figure.
- Deflect one ball away from the other keeping the two V shaped threads (by which it is suspended) stretched, through angle of at least 30^{o} from vertical.
- Gently release this ball so that it starts its downward motion with zero initial velocity
- Observe what happens when it hits the second ball, you will find that after collision with second ball, the first ball comes to the state of rest and second ball starts moving ahead.
- When the second ball reaches its maximum deflection position, estimate whether this deflection seems to be equal to or less than or greater than the deflection of first ball when it started motion.
- You will see that the two deflections are almost equal. Hence the speed of the second ball after collision is equal to speed of first ball just before collision.
- Hence the total momentum of the balls is same before and after collision.

Extension

- This model can be made by using five identical solid wooden balls. When we involve in the collision process we will see that the first ball does not fully come to rest. When we will estimate how far two balls deflect after collision we can conclude that total momentum after collision in the same before collision. Hence the total momentum of the system remain constant.

CHEMISTRY

Chemical Changes Around Us

Chemical reactions occur when molecules interact and change. Bonds between atoms in molecules break and are reformed in new ways.

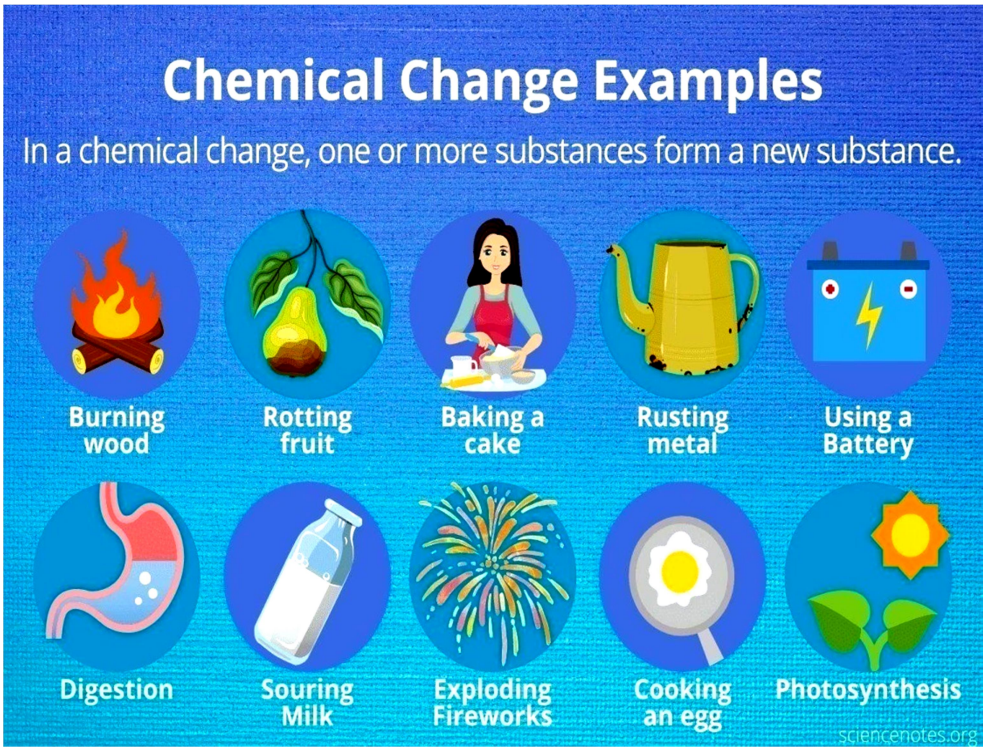


Fig.37 : Various chemical changes around us

Activity:

1) Materials for the activity include glass wares & equipment- beakers, test tubes, watch glass, magnesium ribbon, iron nails, spirit lamp, matchbox, waste box/dustbin, distilled water, sandpaper, wash bottle, test tube holder, spatula, filter papers, test tube brush, tong). Chemicals used are: Quicklime (CaO), Lead nitrate Pb (NO3)2, Copper sulphate (CuSO4), Potassium iodide (KI)
2) Add a little amount of quick lime (approx. 1g) to 2-3ml of water taken in a test tube and observe the change.
3) A pinch of lead nitrate is taken in a clean and dry test tube and is heated strongly over the flame of spirit lamp, and observe the change.

4) New piece of iron nail, with surface scratched by a sand paper is kept immersed for some time in aqueous copper sulphate solution, taken in a test tube and compare the change before and after.
5) Aqueous solution of KI is added drop wise to aqueous solution (1 ml) of lead(II)nitrate and observe the change.
6) Burningofapieceofmagnesiumribbonusingatongoverapieceofwatchglassandobserve the change.

Description:

Formation of a single product from two or more reactants is called combination reaction.

When a single reactant breaks down into two or more simpler products under end to hermic conditions, it is called decomposition reaction.

When a more electropositive metal(cheaper)displaces a less electropositive metal(costlier) from its aqueous salt solution, it is called displacement reaction.

In aqueous solution, the cations and anions of two different salts mutually exchange with each other leading to the formation of a precipitate is called double displacement reaction. It is also called precipitation reaction.

Reactions involving addition of oxygen, removal of hydrogen and loss of electrons are called oxidation reactions while reactions involving addition of hydrogen, removal of oxygen and gain of electrons are called reduction reactions. Neither oxygen nor reduction occurs independently. They always go together and are called redox reactions.

a) Quick lime reacts with water to form calcium hydroxide with the release of large amount of heat (Exothermic change). Since a single product is obtained from two reactants, it is called combination or synthesis reaction. The release of heat can be sensed by holding the test tube in naked hand. Chemical equation for the reaction:

$CaO_{(S)} + H_2O_{(L)} \rightarrow Ca(OH)_{2(S)}$+heat

b) Reddish brown gas is evolved due to the liberation of Nitrogen dioxide (NO_2) gas when Lead nitrate, $Pb(NO_3)_2$ is heated, leaving behind a yellow or red residue of lead oxide (PbO). If a glowing splinter is shown to the mouth of the test tube, it flares up due to the liberation of O_2, which is a supporter of combustion.

$Pb(NO_3)_2 \rightarrow 2PbO(s)+4NO_2(g)+O_2(g)$

c) Iron is more electropositive than copper. So, when an iron nail with a scratched surface is dipped inside of $CuSO_4$ solution, iron (Fe) displaces copper (Cu) from copper sulphate ($CuSO_4$) solution and itself goes into solution as ferrous sulphate ($FeSO_4$).

$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$

The shiny grey surface of the iron nail becomes brown due to the deposition of copper and the blue color of the copper sulphate solution changes into light green color, due to the formation of ferrous sulphate solution.

d) Lead nitrate ionizes as Pb^{2+}(cation) &NO^{3-}(anion). Similarly, KI (potassium iodide) ionizes as K^{+}(cation) and I-(anion). During mutual exchange of the ions, PbI_2(yellow) precipitate is formed.

Formation of a precipitate shows the completion of

$$Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow PbI_2 \downarrow + 2KNO_3 \quad (aq)$$

e) The polished surface of the magnesium ribbon (using a sand paper) burns brilliantly over the flame and forms magnesium oxide (ash) that can be collected in a watch glass. Here the magnesium is oxidized to Mg2+ while O2 gas is reduced to O2-. Hence it is a redox reaction. It is also an example of combination reaction.

$$2Mg + O_2\,(g) \rightarrow 2MgO\,(s)$$

If the mass of magnesium oxide collected in the watch glass and mass of magnesium (metal piece burnt) are compared, then the latter is more in weight.

Applications:

1. Chemical reactions are how new forms of matter are made. While nuclear reactions also may produce new matter, nearly all the substances you encounter in daily life are the result of chemical changes.
2. Chemical reactions help us understand the properties of matter. By studying the way a sample interacts with other matter, we can learn its chemical properties. These properties can be used to identify an unknown specimen or to predict how different types of matter might react with each other.
3. By observing chemical reactions, we are able to understand and explain how the natural world works. Chemical reactions turn food into fuel for your body, make fireworks explode, cause food to change when it is cooked, make soap remove grime, and much more.
4. Chemical reactions help us to solve crimes and explain mysteries. By analyzing blood and tissue samples, for example, police are able to identify the perpetrators of crimes. Chemical reactions are also the tools we use to date fossils, analyze ancient materials, and better understand how our ancestors lived.
5. By observing chemical reactions in outer space, we are able to identify and describe other planets. We can even determine which planets and moons are likely to be able to sustain life.

Displacement Reaction

A displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound.

Activity:

a) Take 50 ml water in a 100 ml beaker,

b) Add 0.5 gm of $CuSO_4$ to make a solution,

c) Add some Zn granules to the $CuSO_4$ solution and observe the colour change,

d) The colour will change from blue to colourless, as shown in Figure 38.

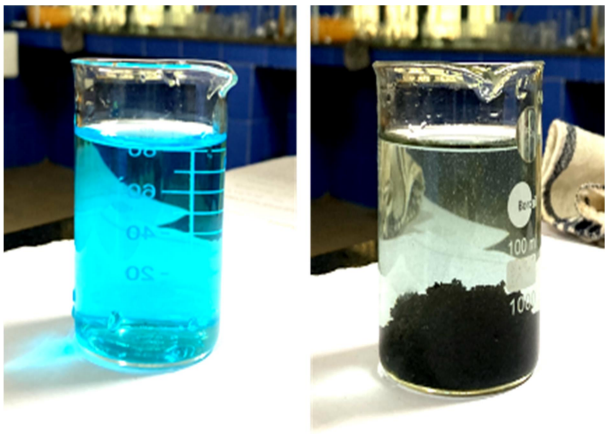


Fig.38 : a)$CuSO_4$ solution, (b)Zn+$CuSO_4$

Description:

A displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound. For instance, when Zn is added to a copper sulphate solution, it displaces the copper metal. In the above example, Zn is added to the solution of Copper sulphate which displaces Cu from its salt solution. This happens due to the higher reactive nature of Zn than Cu. Therefore, addition of Zn to $CuSO_4$ solution results in the displacement of Cu by Zn. The reaction is also indicated by a colour change from blue to colourless, where the $CuSO_4$ solution having a blue colour undergoes a change into the $ZnSO_4$ solution which is colourless.

The overall reaction can be written as: $Zn+CuSO_4 \rightarrow ZnSO_4+Cu$

Examples, $Mg+CuSO_4 \rightarrow MgSO_4+Cu$

Applications:

a. Extraction of Iron from its ore (Fe_2O_3) in blast furnace for making steel

b. Welding of rail tracks by thermite welding

c. Relief from Acid Indigestion by consuming ENO

Decomposition Reaction: Elephant's Toothpaste

A decomposition reaction can be defined as a chemical reaction in which one reactant breaks down into two or more products.

Activity:

- Pour 50 ml of 30% hydrogen peroxide (H_2O_2) in the 1 L graduated cylinder and 3 drops of food colour.
- Add a small layer of liquid dish soap to the coloured hydrogen peroxide (H_2O_2) and add approximately 1gm of potassium iodide (KI) to it.
- Oxygen gas generated from this reaction will create large amounts of coloured foam which will rise out of the graduated cylinder, as shown in Figure 39.

Fig.39: Generation of elephants' toothpaste.

Description:

A decomposition reaction can be defined as a chemical reaction in which one reactant breaks down into two or more products. In this experiment the decomposition of hydrogen peroxide yields oxygen and water. The reaction is catalysed by the iodide ion (I^-) from KI (or NaI) as shown in the two-step process below. The oxygen generated creates bubbles in the soap to produce toothpaste like foam.

$H_2O_2\,(aq) + I^-\,(aq) \rightarrow H_2O\,(l) + IO^-\,(aq)$

$IO^-\,(aq) + H_2O_2\,(aq) \rightarrow H_2O\,(l) + O_2\,(g) + I^-\,(aq)$

Overall Reaction: $2\,H_2O_2\,(aq) \rightarrow 2\,H_2O\,(l) + O_2\,(g)$

Some other examples of decomposition reactions are

$CaCO_3\,(s) \rightarrow CaO\,(s) + CO_2\,(g)$

$H_2CO_3 \rightarrow H_2O + CO_2$

Applications:

a) Extraction of metals from their oxides, chlorides, etc.
b) Manufacture of cement or calcium oxide.
c) Baking of cake

Water of Crystallization

Water that is present in the crystals of a compound is called water of crystallisation. It is defined as the fixed no. of water molecules present in the formula unit of the salt.

Activity :

- Take a small amount of copper sulphate crystals in dry test tube and observe its colour.
- Hold the test tube with a test tube holder and heated over flame of burner.
- The colour of the copper sulphate crystals changed after heating for some time.
- The water droplets along the side of the test tube are noted as shown in Figure 40.

Fig.40: Hydrated and anhydrous $CuSO_4$

Description:

On heating the copper sulphate crystals, their colour changes from blue to white, as shown in Figure 5. And water droplets are condensed on the cooler part of the test tube. Copper sulphate crystals contain water of crystallisation ($CuSO_4.5H_2O$). On heating, hydrated copper sulphate loses its water molecule and forms white coloured anhydrous copper sulphate as shown in Figure 1. $CuSO_4.5H_2O(s) + Heat \Leftrightarrow CuSO_4(s) + 5H_2O(g)$

When salts are heated strongly, they lose their water of crystallisation. By losing water of crystallisation, the hydrated salts lose their regular shape and colour and become colourless powdery substances. On adding water, anhydrous salt changes to it to hydrated form. It is a reversible chemical change.

Applications:

a) Used as desiccant to remove water
b) Used in moisture traps to indicate the saturation level
c) Used in travel bags as a desiccant

Separation of Two Immiscible Liquids

The two liquids which don't mix with each other or not soluble with each other are called as immiscible liquids.

Activity:

a) Take a mixture of two immiscible liquids (toluene and water) in a separating funnel
b) Mix it thoroughly and allow it to stand for some time
c) The mixture of liquids separates into two liquid different layers due to difference in density
d) Collect the lower layer in a beaker by opening the stop-cock of the separating funnel
e) Similarly collect the upper layer in a different beaker
f) Two different liquids are observed to form two distinct layers as shown in the figure as shown in Figure 41.

Description:

The miscibility of the liquids depends upon intermolecular force acting the different molecules. If the intermolecular force acting between the liquids of a single liquid is greater than that of the molecules of two different liquids, the liquids are immiscible with each other and form two phases in the mixture. One such example seen in daily day life is mixture of oil and water. Water has a higher density than oil. Therefore in a mixture, kerosene forms top layer and water forms bottom layer. The separation of such immiscible liquids is performed by a separating funnel. The process of separation using a separating funnel depends on the difference in their densities. A liquid which has lower density floats over a liquid whose density is higher. In the above activity water and toluene are immiscible with each other and this mixture can be separated by using a separating funnel.

Fig.41: Separation funnel showing two different layers if immiscible liquids

Applications:

a. Solvent extraction in pharma industry
b. Separating Liquids
c. Production of pure chemicals

Charle's Law: The Candle-Rising Water Activity

Charle's Law: Charles law states that the volume (V) of a gas is directly proportional to the absolute temperature (T) at constant pressure and number of moles. $V \propto T$.

Activity:

a) Stick the candle in a water jar,

b) Pour water into the jar and mix few drops of food colour,

c) Light the candle and cover it with a glass cylinder.

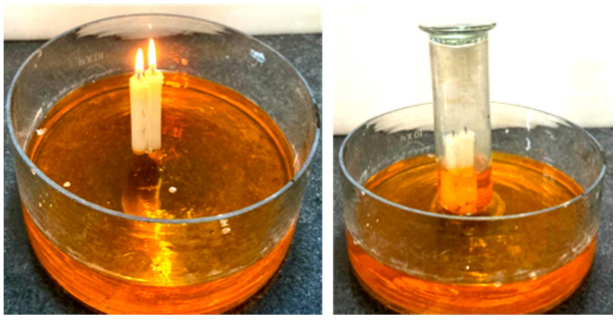


Fig.42: Burning candles in a jar of water, (b). rising of water level]

After some time, you will observe, the candle dims and goes out and the water level rises a few heights inside the Jar.

Description:

When the candles are burning, the temperature of the gas inside the glass cylinder increases, which eventually increases the volume. However, after the flame is extinguished, the gas gets cooled and its volume also decreases. The decrease in volume further decreases the pressure of gas inside the jar than outside. In order to maintain equilibrium, high-pressure air outside the glass pushes on the water, forcing the water level to rise inside the glass cylinder. During the process oxidation of the candle (Paraffin (C_nH_{2n+2})) takes place to water (H_2O) and carbon dioxide (CO_2) as follows.

$$(3n+1)/2\ O_2 + C_nH_{2n+2} \rightarrow nCO_2 + (n+1)\ H_2O$$

It is evident from the reaction that twice of oxygen is consumed than carbon dioxide produced, so the volume of air in the glass decreases. This pressure difference causes the high-pressure air outside the cylinder to push the water into it.

Application:

a) Hot Air Balloon

b) Bakery Products

Acids and Bases

Concept: Acids and bases are common substances found in many everyday items, from fruit juices and soft drinks to soap. A base is thought of as a substance which can accept protons, or any chemical compound that yields hydroxide ions (OH^-) in solution. It is also commonly referred to as any substance that can react with an acid to decrease or neutralize its acidic properties, change the color of indicators (e.g. turn red litmus paper blue), feel slippery to the touch when in solution, taste bitter, react with acids to form salts, and promote certain chemical reactions (e.g. base catalysis). In an operational sense, an *acid* is any substance that increases the concentration of the H^+ ion when it dissolves in water and can turn blue litmus red. Acids are a distinct class of compounds because of the properties of their aqueous solutions. Citrus fruits such as oranges and lemons contain citric acid and ascorbic acid, which is better known as vitamin C. Carbonated sodas contain phosphoric acid. Vinegar contains acetic acid. Your own stomach utilizes hydrochloric acid to digest food.

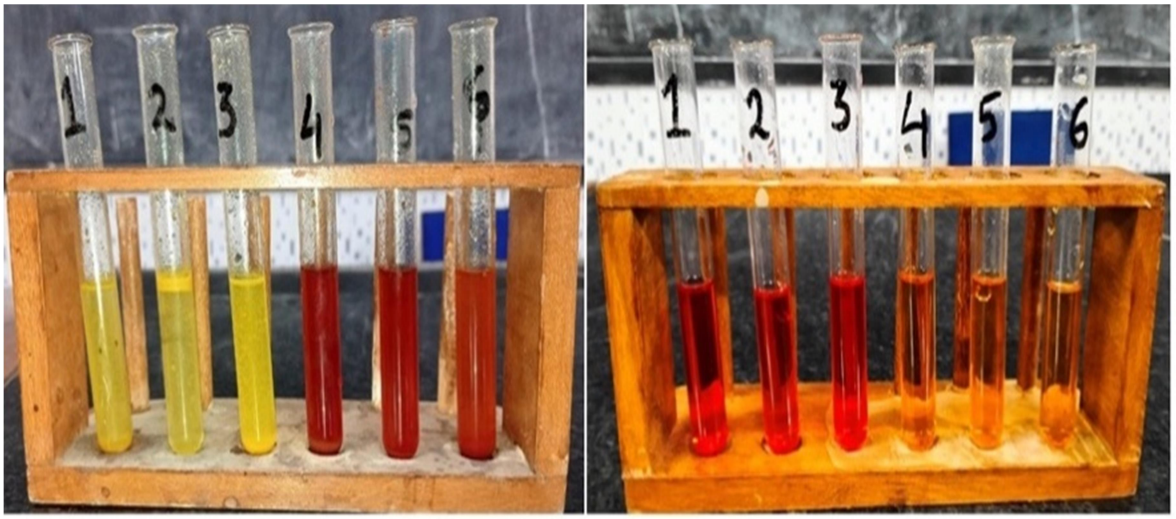


Fig.43: Colour change in acid and bases after addition of indicator

Indicators:

An indicator is a chemical compound which is added to the solution in very small amount to detect its acidic and basic nature. They show color transition in acidic and basic medium and hence, they are called as acid-base indicators.

Activity: Take 5ml of each of the 5 different acid and base solutions in separate test tubes. Test the nature of these solutions by adding two drop of methyl orange indicator and turmeric juice and shake well. Observe the change in color.

Sample solution	Turmeric juice	Methyl orange indicator	Nature of solution
HCl	Yellow	Red	Acidic
H_2SO_4	Yellow	Red	Acidic
CH_3COOH	Yellow	Red	Acidic
NaOH	Red	Yellow	Basic
NH_4OH	Red	Yellow	Basic
$Ca(OH)_2$	Red	Yellow	Basic

Description:

Indicators are vastly used in chemistry in acid and base detection and neutralization reactions to detect the end point. In general, acids are the substances which have sour taste. According to the Arrhenius, acids dissociate in aqueous solution to give H^+ ions. Examples are HCl, H_2SO_4, HNO_3, Citric acid etc. Similarly, bases are the substances which have bitter taste and dissociate in aqueous solution to give OH^- ions. NaOH, $Mg(OH)_2$ etc. are the examples. It is not possible to taste and detect the nature of these substances due to the harmful nature of these chemicals. Therefore, indicators are used for such applications. Some indicators used frequently are phenolphthalein, methyl red, methyl orange etc.

Applications:

a) Endpoint detection in acid-base reaction
b) Detection of pH of any substance

Bohr's Atomic Model

The Bohr model of the atom was proposed by Neil Bohr, a Danish physicist in 1915. It came into existence with the modification of Rutherford's model of an atomic model.

Description:

Bohr's model consists of a small nucleus (positively charged) surrounded by negative electrons moving around the nucleus in orbits. Bohr found that an electron located away from the nucleus has more energy than the electron which is closer to nucleus. The followings are the characteristics of the Bohr's atomic model :

Fig.44: Bohr's Model of an atom

i. In an atom, negatively charged particles i.e electrons revolve around the positively charged nucleus in a definite circular path called orbits o shells.

ii. Each orbit or shell has a fixed energy and these circular orbits are known as orbital shells.

iii. The energy levels are represented by an integer (n=1, 2, 3…) known as the quantum number. This range of quantum number starts from nucleus side with n=1 having the lowest energy level. The orbits n =1, 2, 3, 4… are assigned as K, L, M, N…. shells and when an electron attains the lowest energy level, it is said to be in the ground state.

iv. The electrons in an atom goes to a higher energy level from a lower energy level by absorbing the required energy and an electron moves from a higher energy level to lower energy level by emitting energy.

Applications:

a) The model has some significant impacts on setting up the grounds for quantum mechanics in explaining various observations.

b) The spectrum of hydrogen and hydrogen-like atoms (single electron system) were explained very accurately using this model.

Isotopes of Hydrogen

Elements having same atomic number, but different mass number are called isotopes. They have same atomic number but different mass number. The isotopes have same chemical properties but different physical properties.

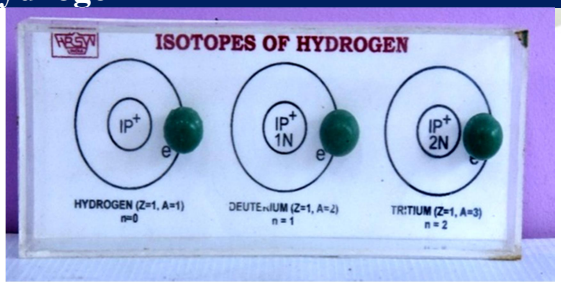


Fig.45: Three different isotopes of hydrogen (a) Protium, (b) deuterium, (c) tritium

Description:

The three types of fundamental particles that make up an atom are: +vely charged protons, neutral neutrons and -very charged electrons. Positively charged center of an atom is called nucleus. Protons and neutrons are present in nucleus are called nucleons. Sum of number of protons and neutrons in an atom is mass number (A). The number of protons (equal to number of electrons in an atom) is atomic number (Z). Atoms of same elements with different number of neutrons are called isotopes. Atoms of different elements having same number of nucleons or Mass no.(A) are called isobars. Hydrogen is the first element in the periodic table and has the atomic number one. There are three isotopes of hydrogen namely, protium $^{1}_{1}H$, deuterium $^{2}_{1}H$ or D and tritium $^{3}_{1}H$ or T.

Protium comprises one proton and one neutron, Deuterium comprises one proton and two neutrons and Tritium comprises one proton and three neutrons in their nucleus. The eminent form of hydrogen is protium. 0.0156% of hydrogen is present on the earth's surface as deuterium. In tritium, the concentration is one atom per 1018 atoms of protium. Small traces of hydrogen 3 or tritium occurs in nature due to the synergy of cosmic rays with atmospheric gases. Out of these three isotopes of hydrogen, only tritium is radioactive in nature which emits low-energy beta particles. As the electronic configuration of isotopes is the same, they all have similar chemical properties. But they have a difference in their rates of reaction, this happens because of the different bond disassociation enthalpies. They have different physical properties because of the large variations in mass.

Applications:

a) Hydrogen is used as a reducing agent in pharma industry, extraction of metals, in semiconductor industry and as a fuel in vehicles.
b) Deuterium is used as a coolant for nuclear reactors and as a fuel in fusion reactors.
c) Tritium is used as a radiolabel in biological labeling experiments and in voltaic devices to create the atomic battery for energy production.

Non-conventional energy Source: Nuclear Fusion Energy

The energy produced in nuclear fusion reaction is called nuclear fusion energy. In a process called nuclear fusion, lighter nuclei combine to form a single heavier nucleus.

Generally, the elements having low atomic number like hydrogen or hydrogen isotopes fuse to create heavy nucleus like helium. The fusion reaction can be written as;

$$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + ^{1}_{0}n + \upsilon$$

It is a highly exothermic reaction and produces energy on a scale which is much higher than the energy released during nuclear fission. As the mass of the product is little less than the sum of the masses of the original individual nuclei, when the nuclear fusion is done, the extra mass is converted to kinetic energy on the basis of Einstein equation and hence, enormous amount of energy is released. The Sun and other stars produce energy using the mechanism of nuclear fusion.

Advantages:

With a very small amount of a nuclear fuel, it produces a large amount of useful energy.

Once the nuclear fuel is loaded into the reactor, the nuclear power plant can go on producing electricity for two to three years at a stretch. There is no need for putting in nuclear fuel again and again.

It is clean and produces a minimal amount of nuclear waste as compared to fission reactions.

This process doesn't produce gases like CO_2 or SO_2 which are the key components of greenhouse effect and acid rain.

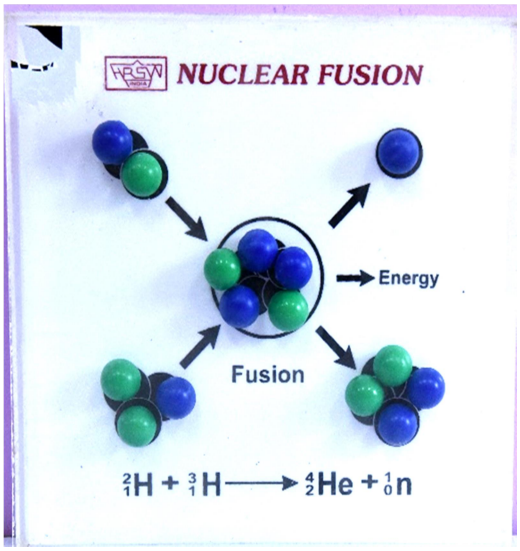


Fig.46: Nuclear fusion reaction

Application:

a) Nuclear fusion energy is the answer to the world's power crisis problem.
b) The source of energy of a hydrogen bomb.
c) Reduces environmental footprints by minimizing the requirement of energy source from the burning of fossil fuels.

Allotropy and Allotropes of Carbon

The phenomenon of the existence of an element in two or more structural forms having distinctive physical properties, however identical chemical properties is called allotropy and the various structural forms are called Allotropes. Carbon exhibits allotropy because of its valency and catenation property. Graphite, Diamond and fullerene are the most popular allotropes of carbon.

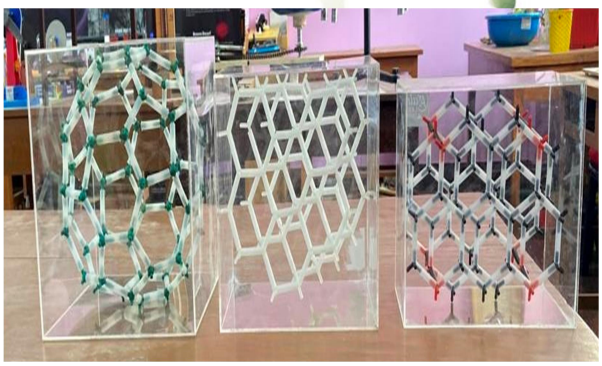


Fig.47: Model structure of fullerene, diamond, and graphite

Diamond: In diamond, each carbon atom is sp^3hybridised and linked to four other carbon atoms by sigma bonds in tetrahedral arrangement. This gives rise to 3D-arrangement of carbon atoms in diamond. The C-C bond length is 154pm. Due to absence of free electrons, diamond is bad conductor of electricity. It is lustrous owing to total internal reflection and diamonds can be synthesized in the laboratories which are almost identical to natural diamonds.

Graphite: In graphite, each carbon atom is linked to 3 carbon atoms by 3 sigma bonds and 1 pi bond. Each C-atom is sp^2hybridised.They are arranged in hexagonal rings which are forming layered (Sheet like) structure. It has 2D- arrangement. The C-C bond length is 141.5pm and the distance between the two layers is 340 pm. These layers are responsible for softness of graphite. On application of pressure, the layers slide over each other for which it is slippery in nature and used as a lubricant. In high temperature machinery two types of bonds between carbon atoms & as are present in graphite. Strong covalent bonds between three carbon atoms present within the layers but bonds between the layers are weak and easily overcome by application of pressure. The fourth valency accounts for the conductivity of graphite although it is a non-metal.

Fullerene: Fullerene is a large spherical molecule of composition C_{2n} where n $\geq$30. It is practically produced by heating graphite with a laser. The fullerene C_{60} is called 'Buckminster Fullerene'. In fullerene, the carbon atoms are sp^2 hybridized and each carbon atom form three sigma bonds with three carbon atom and one pi bond. It is an intertwined ring of aromatic framework containing twenty hexagons and twelve pentagons. The structure twists around and closes to frame a soccer ball molded particle as shown in Figure 2. Since it resembles the geodesic dome designed by Buckminster Fuller, it was named as Fullerene. It contains both single and double bonds with Carbon-Carbon distances of 142pm and 138.3pm, respectively.

Application:

a) Diamond is used in jewelry, for cutting marble, **high-precision cutting devices.**

b) Graphite **is used as lubricants**, **refractory material,** electrodes, and **lead pencils.**

c) **Fullerene** is used as **super conductor materials, tracers in cancer and AIDS therapy.**

Electrolytes and Non-Electrolytes

Solutes can be classified by their ability to conduct an electrical current. Some compounds dissociate into ions when put into solution. Compounds that dissociate completely into ions and conduct electricity are called electrolytes while those that cannot conduct electricity are called non-electrolytes. Conducting of solutions can be tested using one LED bulb in the circuit of the electrolysis model.

Activity:

1) Prepare solutions of given compounds like HCl, NaOH, NaCl, CH_3OH, $C_6H_{12}O_6$ (sucrose) for classification into electrolytes and non-electrolytes. We will also use litmus papers to see the nature of their aqueous solutions

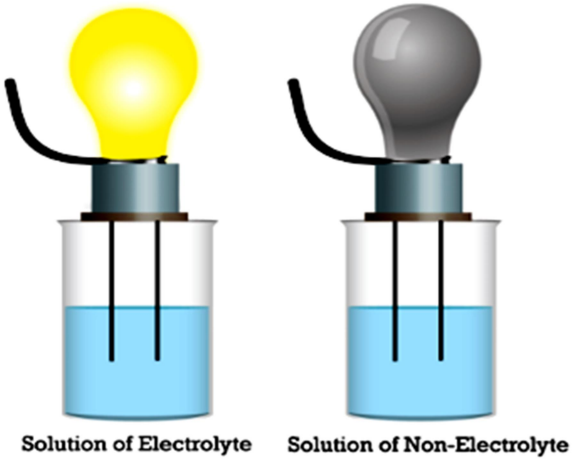


Fig.48 : Conductivity apparatus

2) When HCl solution is taken in an electrolytic cell and both electrodes are connected through an LED bulb, the blub glows showing the flow of current in the solution indicating that it is an electrolyte (migration of ions in solution). When a drop of this put-on pH paper & its color is matched with the color on the pH paper it shows that the compound is an acid (pH<7).

3) Sodium hydroxide (NaOH) is a corrosive chemical and is to be handled with care is available as solid pellets. When one small pellet is dissolved in water, its aqueous solution is called alkali. It is fully soluble in water. When this solution is taken in an electrolyte cell and completing the electrical circuit using a LED bulb, it glows showing that the compound is an electrolyte.

When a drop of this solution is put on pH paper and resulting colour is matched with the standard colour chart of the pH scale. It shows that the solution is alkaline (pH>7).

4) Similarly, NaCl shows glowing of the LED bulb, when its aqueous solution is considered and it shows neutral on pH paper
5) On taking, methanol and urea, there is no glowing of the LED bulb, showing that it is a non-electrolyte

Description:

HCl(g) is known as hydrogen chloride & covalent in nature, when it is dissolved in water, its aqueous solution HCl(aq)is called hydrochloride acid. HCl(g) is highly soluble in water and dissociates into ions. Since it gives H+ ion(proton) it is an acid. when a drop of its aqueous solution is put on a small piece of litmus paper, it turns red showing its acidic nature.

$$HCl(g)+H_2O(l) \rightarrow H^+(aq)+Cl^-(aq)$$

NaOH is sodium hydroxide and in its aqueous solution gives hydroxide and sodium ions. For NaOH solution, when a drop of this alkaline solution is put on a piece of red litmus paper, the red litmus turns blue showing that the solution is alkaline (basic).

$$NaOH\ (s) + H_2O\ (l) \rightarrow Na^+(aq)+ OH^-\ (aq)$$

For NaCl, again we see that it is a salt and an ionic compound completely dissociating into its constituent ions, Na^+ and Cl^- and on the pH scale, we see that it is neutral.

Interestingly, for methanol and sucrose, we see that they do not dissociate into ions and thereby do not conduct electricity and are non-electrolytes.

Applications:

1) Electrolytes play and important role in biochemical reactions. In human body, calcium ions help in blood clotting and muscle contraction. Sodium ions help in maintaining water balance and nerve signaling.
2) Electrolysis helps in extraction and purification of metals, electroplating, and electrode position.

Electroplating Of Copper: Chemical Effect of Electric Current

The process of depositing a layer of any desired metal on another material by means of electricity is called electroplating

Activity:

For electro plating of Cu, prepare Copper sulphate ($CuSO_4$) solution by dissolving 2-4 grams of copper sulphate in 100 ml of water (H_2O). Add a few drops of dilute sulphuric acid (H_2SO_4) to this solution to increase its conductivity. Clean a copper plate and an iron rod (which needs to be deposited) with sand paper and clean them thoroughly with water.

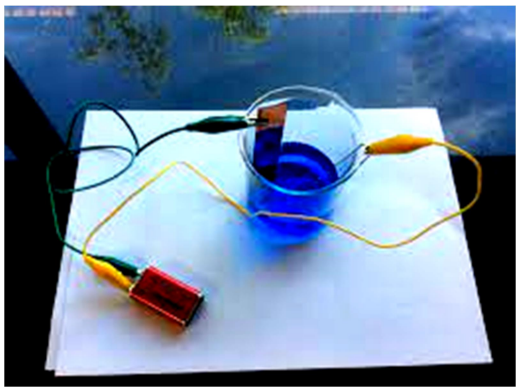


Fig.49: *Electro plating of Copper*

Connect the copper plate to the +ve terminals of a battery and iron rod to the -ve terminal of battery and immerse them in copper sulphate solution. Allow the current to pass for about 15 minutes. Now remove the electrodes from the solution and look at the colors of two electrodes carefully.

Description:

When electric current is passed through the copper sulphate solution, copper sulphate dissociates into copper (Cu^{2+}) and sulphate (SO_4^{2-}) ions. The formed Cu^{2+} ion is attracted towards the -ve electrode (iron rod) and gains deposited by gaining two electrons. In the mean while to maintain the electro neutrality of the system Cu from the Cu-plate (connected to +ve electrode) gets dissolved in the $CuSO_4$ solution. Thus there is a deposition on the -ve electrode and a corrosion from the +ve electrode. The loss of copper from the solution is restored and the process continues. This means that copper gets transferred from one electrode to the other. The overall process can be represented by the following chemical equations

At anode: $Cu(s) \rightarrow Cu^{2+} + 2e^-$ (dissolution of Cu from the Cu metal)

At cathode: $Cu^{2+} + 2e^- \rightarrow Cu\ (s)$ (deposition of Cu from the solution)

Applications:

a) Corrosion resistant plating over automobile parts
b) Ni deposition over utensils
c) Chromium plating on wheel rims and gas burners

Electricity from Lemon and Salt Water Battery

Concept and Basic principles:

Electricity in metallic conductor is the flow of electrons. Electrons can easily flow through conductors. For example, metals are very good conductors of electricity. Electrons can also flow through electrolytic solutions. When two electrodes of different metals (in this case copper and zinc) are suspended in an electrolyte, it results in producing electrons. Here copper acts as a positive electrode (anode) and zincacts as a negative electrode (cathode).

How do we get electricity from lemon or salt water battery? What is the role of lemons or salt water?

To understand chemistry behind this we need to know few terms andtheir meanings.

Electrolyte:

An electrolyte is a substance that produces ions (cations - positively charged and anions - negatively charged) when dissolved in a polar solvent, such as water and making the solution electrically conducting. Acids, bases and salts which dissociate into ions are examples of electrolytes. Take an example of common salt. When salt is added to water, it dissolves and dissociates to produce sodium and chloride ions. NaCl(s) + H20 (l) -+Na+(aq)+Cl-(aq)+1-120(l)

Nonelectrolyte:

Nonelectrolyte does not dissociate into ions in solution and therefore, their solutions do not conduct electricity. For example, sugar. It dissolves in water but does not dissociate to produce ions.

Electrochemical series:

The electrochemical series is built on the basis of standard electrode potentials of metals. The most negative value is placed at the top ofthe series whereas the most positive is at the bottom.

Potassium (K) > Calcium (Ca) > Sodium (Na) > Magnesium (Mg) >Aluminum (Al) > Zinc (Zn) > Iron (Fe) > Tin (Sn) > Lead (Pb) > Hydrogen (H) > Copper (Cu) > Silver (Ag) > Gold(Au) > Platinum (Pt) When two metal electrodes are kept in an electrolytic solution, the metal which is higher up in series gets oxidized (i.e. provides electrons) and the other metal gets reduced (i.e. accepts electrons). In our activities, we will be using zinc (Zn) and copper (Cu) metals as electrodes. Since, 'Zn' is above 'Cu' in electrochemical series it gets oxidized.

So, it is not lemon or salt water, which produces electricity but it only provides electrolytic medium for the flow of electrons.

Activity 1: Lemon Battery

1) Take 5 lemons. Roll and press them on a table or hard surface with hand. This will break some cells/tissues releasing juice inside.
2) Insert one copper strip (brownish) and one zinc strip (grayish) in each lemon. The easier way to insert metal strip into lemon is to cut the skin of lemon by using sharp corner of metal strip. Make sure that these 2 metal strips do not touch each other.
3) Connect zinc strip of first lemon to copper strip of second lemon with the help of a piece of wire. Similarly, connect zinc strip of second lemon to copper strip of third lemon and so on. In electrical terminology this type of arrangement is known as 'Series Connection'.
4) Take a wire and connect one end to the copper plate of first lemon. Connect the other end of the same wire to the long terminal (+ve terminal or anode) of LED (Light Emitting Diode).
5) In the same way, connect zinc strip of the last lemon to the short terminal (-ve terminal or cathode) of LED.

As soon as the circuit is complete the LED will glow.

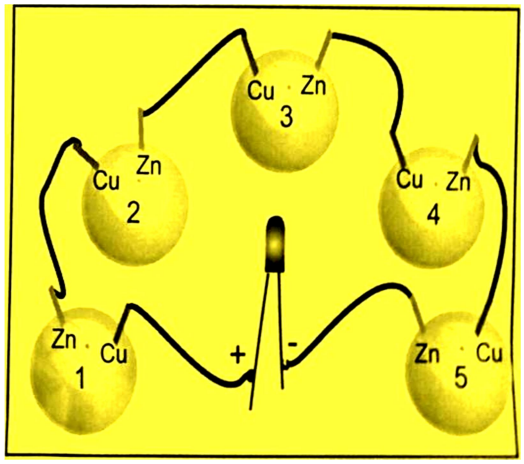


Fig.50 : Lemon battery

Working of lemon battery:

In this activity, the 'Zn' and 'Cu' electrodes are in contact with lemon juice (electrolytic solution) which contains citric acid.

Here, Zinc gets oxidized to produce electrically charged ions Zn^{2+} ions and two negatively charged electrons (e-).

$$Zn \rightarrow Zn^{2+} + 2e^-$$

These two electrons travel to copper electrode via external circuit where they combine with two positively charged hydrogen ions (H^+) from the juice to form an uncharged hydrogen molecule (H_2). The hydrogen gas produced due to this reduction reaction eventually bubbles out at the surface of copper electrode.

$$2H^+ + 2e^- \uparrow H_2$$

MATHEMATICS

Model-1 : Trundle Wheel

Description:

Trundle wheel consist of a wheel, a handle which is attached to the axle allowing the trundle wheel to be rotated freely. Revolution of the wheel measures the distance equal to the circumference of the wheel i.e. 50 cm here. Thus counting the number of revolutions measures the distance directly by multiplying number of revolutions with circumference. In comparison with the other measuring instruments like measuring tape, scale etc. it is a simple device to find rough plane distance from one place to another while walking.

Fig.51 : Trundle wheel

Application:

The purpose of the Trundle wheel is to estimate very longer distances. Now –a-days wheels are used in a similar way, but for a variety of other tasks, such as marking boundary of a land, gauging the space between buildings on a property, estimating the size of a garden and manually measuring the length of a flat in open area.

Model-2 : $(a + b)^2 = a^2 + b^2 + 2ab$

Description:

$(a + b)^2 = a^2 + b^2 + 2ab$ is a well known algebraic identity which can be proved by using this model. Model comprised of 4 geometrical figures , 2 squares and 2 rectangle, combined to from a square. Two squares are of length a and b , one rectangle is of length a and width b, another rectangle is of length b and width a, whose areas are a^2, b^2, ab and ba respectively. The square is of side length (a+b). And the area of the square is equal to the sum of the square of two squares and two rectangle.

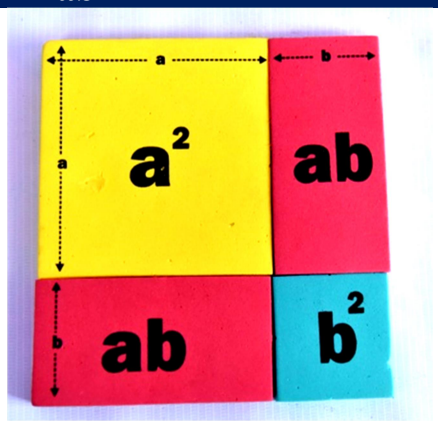


Fig.52 : Algebraic identity

$(a + b)^2 = a^2 + b^2 + 2ab$

$$(a + b)^2 = a^2 + b^2 + 2ab$$

Application:

Used to find out square of large numbers for example

$(73)^2 = (70+3)^2$

$= 4900 + 420 + 9$

$=5329$

Model-3 : Angle Sum Property

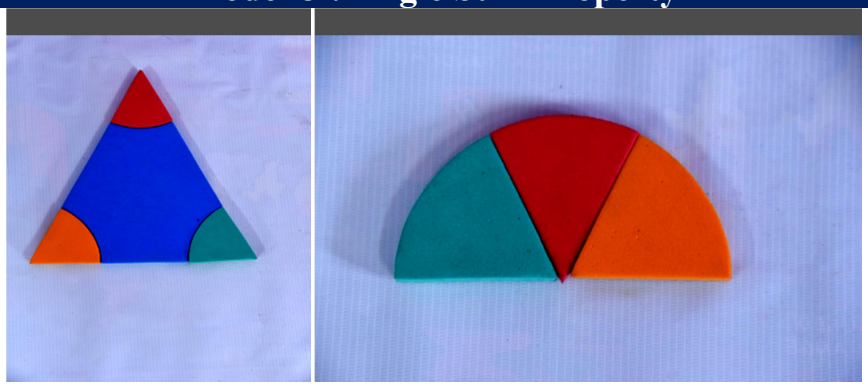


Fig.53: Sum of interior angles of a triangle is 180^0

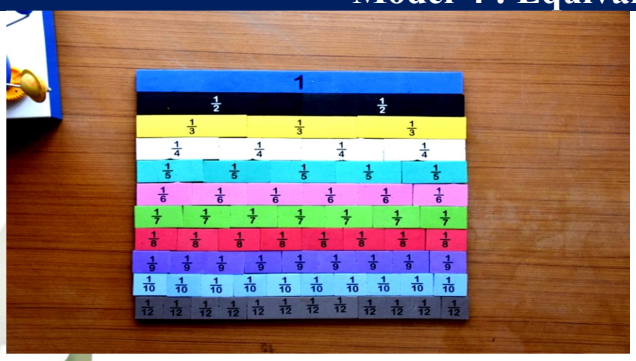
Description:

The sum of the interior angles of triangle is 180^0. In the above model we have a triangle. Cut outs are the interior angles of triangle. Take out the cut out pieces and place the angles on the straight line adjacent to each other. Observe the three interior angles of the triangle which are completely fit on the straight line. Hence the sum of the interior angles of the triangle is 180^0.

Application :

The model is used to find out the third angle of the triangle if two angles are already known.

Model-4 : Equivalent Fraction



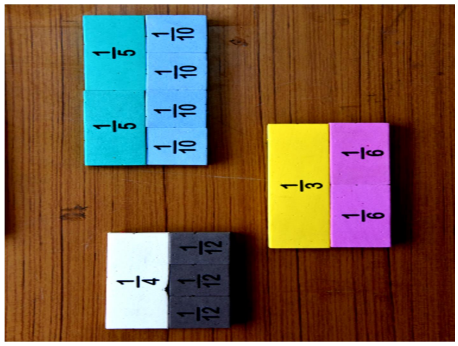


Fig.54 : Equivalent Fraction

Description:

Equivalent fraction are the fractions whose numerator and denominator value may differ but the ratio of numerator and denominator is same. In this model we have 11 rectangular strips. They are divided into equal parts i.e. 2,3,4,5,6,7,8,9, 10 and 12 equal parts, to give ½ , 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9, 1/10 and 1/12 in each part. Now take one 1/3 fraction and two 1/6 fraction and equate them we can see they both are equal i.e 2/6 = 1/3. Similarly you can check for other fractions.

Application:

- This model can help in the equal distribution of different elements.
- To understand results if they are expressed in smaller digits as opposed to larger numbers by using equivalent fractions.

Model-5 : Construction of Parabola

Figure:

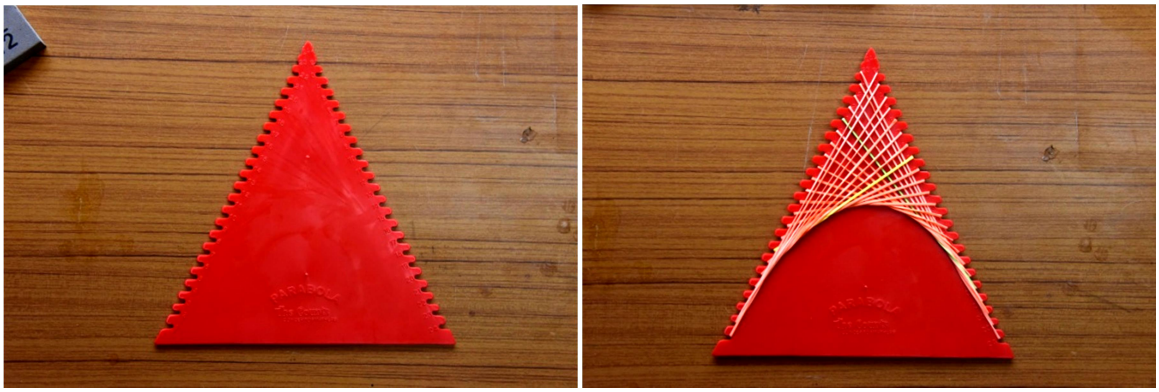


Fig.55: Constructing a parabola

Description:

Construction of parabola model consists of an isosceles triangle shape board and some rubber bands. Equal sides of the triangle is designed to hold rubber bands. Both sides are leveled equally. Attach the lower level of one side with the upper level of opposite side using rubber bands. Go on joining each level with its corresponding level in the opposite side as shown in the figure. Now a parabola is formed. Rubber bands play the role of tangents to the parabola.

Application:

Parabolic structure is used in the formation of satellite dishes, suspension bridges, concave mirror, projectile motion of objects etc.

ZOOLOGY

Museum Specimens

The living organisms on the earth has been classified into five major groups/ kingdoms namely Monera, Protista, Fungi, Plantae and Animalia. The study of the animal diversity (Kingdom- Animalia) is discussed under the zoology section. The organisms under Kingdom Animalia are eukaryotic, multicellular and exhibit a wide range of diversity. One of the salient features of the animals is their mode of nutrition which is heterotrophic. This indicates that the animals are unable to synthesize their own food. The kingdom is divided into invertebrates and vertebrates basing upon the absence and presence of notochord respectively. The animal kingdom is further divided into two various phyla basing on the fundamental features like-

1. Arrangement of cells/ grade of organization
2. Body symmetry
3. Germ layers
4. Pattern of digestive, circulatory, respiratory, excretory system etc.
5. Mode of reproduction

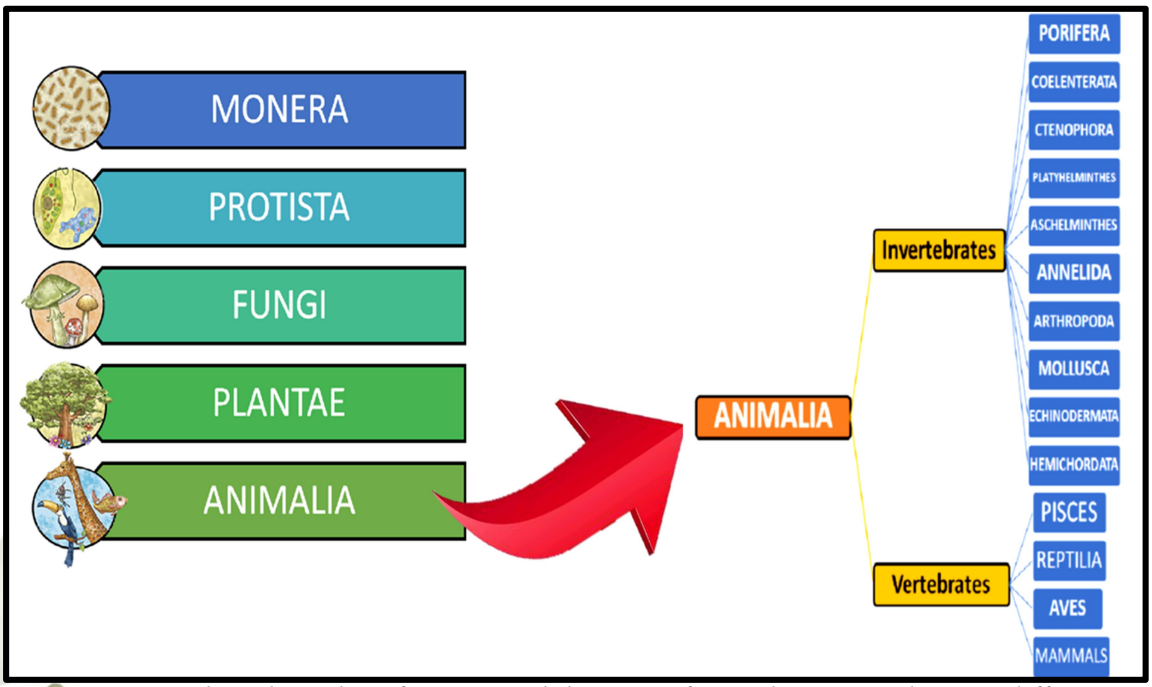


Fig.56: Five kingdom classification and division of Kingdom Animalia into different phyla and classes.

Museum specimens of Invertebrates :

The educational resource room has a diverse collection of museum specimens belonging to different phyla which are enlisted below with their salient characteristics and their significance.

➢ **Phylum –Porifera**

General Characteristics:

- Aquatic in habitat (both freshwater and marine).
- Body is radially symmetrical.
- The body wall consists of outerpinacoderm and inner choanoderm. The middle layer consists of gelatinous mesenchyme (amoeboid cells).
- These are primitive multicellular animals and have cellular level of body organization.
- They possess a well-developed water canal system.
- Body wall consists of numerous pores called ostia, through which water enters into their body. Body bears a central cavity called spongocoel, which communicates with exterior environment through osculum.
- Endoskeleton is in the form of spicules and sponging fibres.
- These are hermaphrodite i.e. both the eggs and sperms are produce by the same individual.
- Reproduce both asexually by fragmentation and sexually by the formation of gametes.

Name of the museum specimens : *Sycon, Spongilla*

Photo of the specimen:

Fig.57: Specimen - Sycon

Fig.58: Specimen - Spongilla

Application :

- The sponges are filter feeder in nature and thus help in cleaning of aquatic environment.
- They also play a pivotal role in the marine food web and providing a protective habitat for other marine organisms.
- In addition, they act as filter components to control pollution of aquatic habitat. Thus, they also serve as potential biofilters and bio-remediators and thus is co-cultured with pisciculture.
- The natural products extracted from the sponges are of great pharmacological importance.
- These are used in manufacturing of drugs that have anti-viral, anti-cancerous, anti-inflammatory, anti-helminthitic, immune suprresive and neurosuppresive mechanism.
- Moreover, the sponges are used as cleansing products such as bath sponges used to clean animals, objects, floors etc.
- Specific sponges are also used as ornamental purpose.
- Sponges are utilised in the ice-cream industry, pottery making, making of sound proof walls etc. It has a prodigious commercial value.

➢ **Phylum – Coelenterata**

General Characteristics

- These are aquatic, mostly marine in habitat.
- Body is radially symmetrical.
- Diploblastic in nature. Body wall consists of well-defined germ layers i.e. ectoderm, endoderm with gelatinous mesoglea.
- They exhibit tissue level of body organization.
- Cnidoblast or cnidocytes present on the tentacles of the body. These are used for anchorage, defense and for the capturing prey.
- They bear a central gastro-vascular cavity with a single opening called hypostome.
- They show alternation of generation (metagenesis) i.e. polyp produce medusae asexually and medusa produce polyp sexually.
- They exhibitpolymorphism, division of labour.
- Some of the cnidarians (Anthozoans) have a skeleton composed of calcium carbonate.

Name of the museum specimens: **Corals, *Gorgonia***

Photo of the specimen:

Fig.59: Specimen - Coral

Fig.60: Specimen - Gorgonia

Application:

- In India the coral reefs are mainly found in Dwarka, Gulf of mannar, Gulf of kutch, Andaman and Nicobar and Lakshadweep islands.
- These natural barriers help us by protecting from ocean storms, erosion and cyclones.
- It has potential medicinal uses and can serve as food source. Most of the coastal peoples depend on corals reefs for food, income and protection.
- It is a beautiful underwater coral which is mainly used as decoration purpose. It also used to make jewellery, having high market value.
- These are harvested in aquarium or the dry sea fan used for decoration.

➢ **Phylum – Platyhelminthes**

General Characteristics

- The body is leaf-like, dorsoventrally flattened.
- Body is biradially symmetrically.
- Organ level of body organization.
- Triploblastic animals. Body wall consists of three germ layers outer layer is called ectoderm, inner layer is called endoderm and in between ectoderm and endoderm mesoderm is present.
- The body is devoid of coelom, so called acoelomate.
- These are mostly endoparasites found in animal body. Hooks and suckers are present for parasitic adaptation.
- Osmoregulation and excretion are carried out by specialized cells called flame cells.
- Sexes are not separated. They are hermaphrodites.

Name of the museum specimens: ***Taenia*** **(tapeworm),** ***Fasciola*** **(Liver fluke)**

Photo of the specimen:

Fig.61: Specimen - Fasciola

Application: *Fasciola* is a predominant parasite which resides in sheep and cattle. Liver fluke causes the disease called fascioliasis, which is caused due to eating of raw water plants contaminated by the immature parasites. This disease causes major economic loss to the farmers depending livestock.

➢ **Phylum – Nematohelminthes**

General Characteristics

- Aquatic and terrestrial in habitat. They may be free-living or parasitic in plants and animals.
- Body is bilaterally symmetrical.
- They have organ level of body organization; tube-within- a tube body plan.
- Triploblastic animals. Body wall consists of three germ layers outer layer is called ectoderm, inner layer is called endoderm and in between ectoderm and endoderm mesoderm is present.
- There is no presence of true coelom, so called as pseudocoelomate.
- The alimentary canal is completed with well-developed muscular pharynx and the excretory product is removed through the excretory tube.
- Sexes are separate (dioecious). Male and female can be distinguished from each other (sexual dimorphism). Males are smaller in size as compare to female and the posterior end of male is curved (penial setae) but straight and blunt in case of female.

Name of the museum specimens : ***Ascaris (*Roundworm)**

Photo of the specimen:

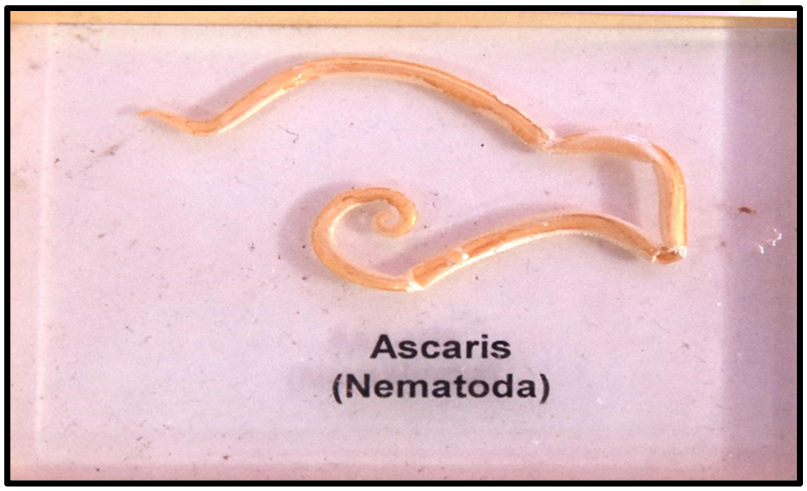


Fig.62: Specimen - Ascaris

Application*:*

- *Ascaris* causes the disease ascariasis, which occur due to various reasons some of which include dirt contaminated hands and fingers, by eating raw and unclean vegetables and fruits etc.
- It has a negative effect on the growth of undernourished children but less common in causing intestinal obstruction.

➢ **Phylum – Annelida**

General Characteristics

- Aquatic and terrestrial in habitat. Mostly free-living and sometimes parasitic in nature.
- Body is bilaterally symmetrical.
- They have organ level of body organization.
- Triploblastic animals. Body wall consists of three germ layers outer layer is called ectoderm, inner layer is called endoderm and in between ectoderm and endoderm mesoderm is present.
- The body cavity is a true coelom (schizocoel) well developed and divided by septa, except in leeches.
- The body is metamerically segmented and each segment is called as metamers.
- The body is covered by cuticle secreted by ectoderm and the body wall consists of outer circular and inner longitudinal muscle layers.
- A thick, swollen glandular portion found in epidermis called citellum used in sexual reproduction.

- Osmoregulation and excretion are carried out by metanephridia.
- Each segment of the body bears a pair of lateral parapodia, which undergo modification during sexual phase (in *Nereis* the heteronereis phase), which help in active swimming.
- Hermaphroditic or separate sexes. Reproduction both by asexually and sexually.

Name of the museum specimens: ***Nereis*, Earthworm**

Photo of the specimen:

Fig.63: Specimen - Earthworm

Fig.61: Specimen - Nereis

Application

- Earthworm is called as farmer's friend because it loosen the soil and aerated properly as they burrow deep down the soil.
- They increase the soil fertility and increases its nutritional level.
- The excretory product of earthworm is rich in nitrogenous matter which is useful for plant growth.so, earthworms are used in vermiculture to produce quality manure.
- People near to the sea used earthworm as baits for fish catching.
- *Nereis* is used as food items for foraging birds in the intertidal zone and also contributed for the colonization of the alga.

➢ **Phylum – Arthropoda**

General Characteristics

- This is the largest phylum in animal kingdom, which includes nine-tenth of all known animal species.
- They are found in almost all habitat.

- They are bilaterally symmetrical and organ- system level of body organization.
- Triploblastic animals. Body wall consists of three germ layers outer layer is called ectoderm, inner layer is called endoderm and in between ectoderm and endoderm mesoderm is present.
- The body cavity is a true coelom, called as schizocoelomate.
- The body is externally segmented and divided into tagmata consisting of head, thorax and abdomen or cephalothorax and abdomen.
- Each segment of the body consists of a pair of jointed appendages.
- The body is covered by exoskeleton of cuticle containing mainly chitin.
- Respiration by general body surface, gills, book gills, tracheae or book lungs.
- Circulatory system is open with dorsal heart, arteries and blood sinuses.
- Excretory system comprises coxal, antennal or green glands, malpighian tubules, etc.
- Sexes are separated (dioecious) with paired reproductive organs and ducts.
- Moulting or ecdysis takes place for growth.

Name of the museum specimen: ***Apis*** **(Honey bee),** ***Bombyx*** **(Silkworm)**

Photo of the specimen:

Fig. 65 : Specimen – Caterpillar Specimen – Honeybee Specimen - Silkworm

Application:

- Edible caterpillars are rich in sources of protein, lipids, carbohydrates, mineral salts and vitamins. It provide food security to a large number of people.
- It is a potential pollinator. It is also generate income in many rural areas during harvesting time.

- Honeybees collect nectar from different flowers to form honey. The honey is used to treat vomiting, diarrhoea, rheumatoid arthritis, obesity, diabetes mellitus and in preserving meat and fruits.
- It has a great importance in cosmetic treatment, used in preparing facial washes, skin moisturizers, and hair conditioner in treatment of pimples.
- Honey is used in treatment of eye diseases, throat infections, bronchial asthma, tuberculosis, hiccups, thirst, dizziness, fatigue, hepatitis, worm infestation, healing of wounds, ulcers and used as a nutritious, easily digestible food for weak people.
- Silk worms are a good source of protein, lipids, minerals and vitamins so, it is considered a good source of nutrients for humans.
- It is an economically important insect as it produces of silk.
- Silkworm pupae are a valuable insect source of substances used in healthcare products, medicines, food additives, and animal feed.
- These are having a potential use in the food and pharmaceutical industries.
- Silkworm act as a potent model organism for aging research because there are abundant mutant strains, clear genetic background, less ethical issues and low rearing cost, clear boundaries between different development stages, fasting model, and open blood circulation system.

➢ **Phylum – Mollusca**

General Characteristics

- This is the second largest phylum in animal kingdom, after arthropoda. Aquatic and terrestrial habitat.
- They exhibit organ level of body organization.
- Body is bilaterally symmetrical, unsegmented, triploblastic, coelomate (schizocoel) animals.
- The body is organized into three general regions: head, foot and visceral humps.
- Ventral body wall specialized as a muscular foot, variously modified for locomotion.
- Body covered by a soft and spongy layer of skin fold mantle which encloses mantle cavity and secretes a calcareous shell.
- Digestive system is complex with a file-like rasping organ called radula for feeding.
- Respiration by gills, lungs, mantle or body surface.
- Excretory system comprises of one or two kidneys (metanephridia, organ of bojanus) opening into pericardial cavity.
- Reproduction is sexual, usually dioecious and oviparous.

Name of the museum specimen: ***Pila, Dentalium, Unio***

Photo of the specimen:

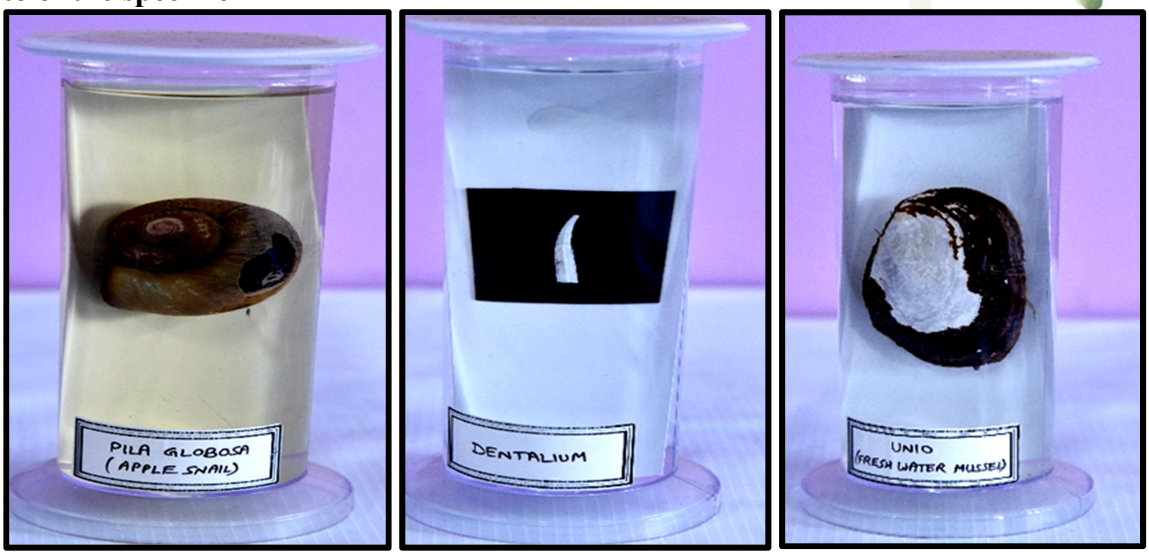


Fig.66 : Specimen – Pila *Specimen – Dentalium* *Specimen - Unio*

Application:

- *Pila globossa* is used as food in agriculture, medicine and food items of the people of our country. It is an ecological element, contributed for preserving the healthy aquatic habitat which is necessary for biodiversity preservation.
- *Dentalium* is used to make indigenous ornaments, adornment and decorating objects.
- *Unio* acts as a bioindicator for detection of water pollution.

➢ **Phylum – Echinodermata**

General Characteristics

- These are terrestrial or aquatic (marine or fresh water) in habitat.
- They are radially symmetrical (larva with bi-lateral symmetry), unsegmented and organ-system level of body organization.
- Triploblastic animals. Body wall consists of three germ layers outer layer is called ectoderm, inner layer is called endoderm and in between ectoderm and endoderm mesoderm is present.
- The body cavity is a true coelom, called as enterocoelomates.
- A calcareous endoskeleton is present in the form of ossicles bearing protective spines.
- The salient feature of phylum echinodermata is the presence of water vascular system which helps in locomotion, respiration and capture and transport of food.
- Respiration by dermal branchiae, tube feet, respiratory tree.
- Sexes are separate (few are hermaphrodite). Fertilization is external.

Name of the museum specimen: ***Asterias*** **(Star fish)**

Photo of the specimen:

Fig.67: Specimen - Asterias

Application:

- The outer body of the starfish comprises of non-sticky material, which has ability to treat inflammatory human diseases such as arthritis and hay fever.
- This non-sticky material can potentially heal human tissue damage.

Museum Specimens of Vertebrates:

The vertebrates cover a diverse species which includes from the small pieces to giant sauropods and from extincted woolly mammoth to the modern man. The vertebrates possess certain fundamental characteristics throughout the life or at a specific point of lifecycle few of which are enlisted-

- A stiff rod like structure which may be the vertebral column and/or the notochord forms the backbone. The notochord in some species is present during embryonic phases and further develops into the vertebral column in the adult stage.
- The vertebral column holds a bunch of nerve cords which help in control and coordination processes.

➢ **Class – Pisces**

General Characteristics of Bony fishes (Osteichthyes)

- The habitat of the fish comprises of marine, aquatic and brackish water.
- They possess a bony endoskeleton and therefore, called bony fishes.
- The skin is comprised of mucous gland and embedded dermal scales.
- They are characterized by paired fins, autostylic jaw suspension, mouth with many teeth (some are toothless).
- Respiration is carried out by gills supported by bony gill arches and is covered by operculum.
- They are classified into crossopterygii and actinopterygii

Fig.68: Specimen – Bony fish

General Characteristics of cartilaginous fishes (Chondrichthyes)

- The cartilaginous fish is mostly found in the marine environment.
- The exoskeleton is made up of placoid scales and the endoskeleton is cartilaginous.
- The respiratory organs are mostly gills, air bladder is not seen and the jaws are amphistylic.
- Gills are not covered by operculum.

Fig.69: Specimen – Cartilaginous fish

Name of the Model: Animal Cell

Photo of the Model:

Fig.70 : Animal cell

Description: The structural and functional unit of life is cell. The cells are of two types- eukaryotic and prokaryotic cell based upon the salient characteristics feature. The animal cell is eukaryotic in nature due to presence of certain fundamental characters which include nucleus of the cell is enclosed by a nuclear membrane, membrane bound organelles. An animal cell comprises of plasma membrane, nucleus, endoplasmic reticulum, cytoplasm, golgi apparatus, mitochondrion, ribosome, lysosome, cell membrane etc. The cytoplasm of the cell is enclosed within the plasma membrane.

- The animal cells differ from plant cells in lacking cell wall and thus are irregular in shape i.e., oval, spherical, rectangular etc.
- The animal cells are microscopic in size and can be visible under a microscope.
- Types of animal cells include: Skin cells, muscle cells, blood cells etc.

Application:

The processes in our body is carried out with help of cell which include energy production and storage, metabolic processes, transportation of molecules.

Cells are organized to form tissues to carry out a particular function. Further, group of tissues contributing to carry out a particular function form an organ such as lungs, heart, brain etc. Organs work in coordination to form a respective system.

Sickle cell disease, a condition of red blood cells in which the shape of the blood cell is affected (sickle cell/ crescent moon shape) and hence, minimizes the oxygen carrying capacity. It is inherited and most commonly seen in tribes of India. The people with sickle cell disease are *resistant to malaria* with respect to the people with normal blood cell.

Name of the Model: Skin

Photo of the Model:

Fig.71: Human Skin

Description: Skin is the largest organ of the body made up of skin cells. Skin is the covering which protects the internal organs from the outside world. The skin is made up of three layers:

- *Epidermis*- The outer layer of the skin is epidermis. It acts as a waterproof and physical barrier for the human body. It is the thinner layer of skin
- *Dermis* – The middle and thickest layer of the skin is the dermis. It consists of collagen and elastin
- *Hypodermis* – The innermost lining of the skin is hypodermis. This layer connects the skin to the muscles and bones.

Applications: The skin acts as first line of defense against all types of infections and restricts the entry of bacteria, virus, protozoa etc.

- It helps in maintaining the temperature of the body due to the presence of fatty layers which helps in insulation and sweat glands which helps in hydration to keep the body cool.
- The dermis and hypodermis is lined with nerve endings and thus, acts as one of the sense organs i.e., sense of *touch.*

- The skin facilitates the conversion of active Vitamin D from its precursor molecule in the presence of sun rays.
- The colour of the skin varies due to presence of a pigment known as *melanin*. Melanin acts as "natural umbrella". Greater pigmentation and darker skin tone (with high melanin content) in Indian tribes and different races helps protect the skin from damage by UV rays and thus, are *less prone to skin cancers*.
- Due to higher melanin index people with dark skin tone demonstrate ageing in respective persons lately and can resist fungal infections which is common in tropical or equatorial regions.

Name of the Model: Skeletal System

Photo of the Model:

Fig.72: Human Skeletal System

Description: The skeletal system is the basic structure of the body. All the rigid and solid structure of the body along with **bones** and **cartilages** form the skeletal system. The joints and different types of bones facilitates the movement and posture of the body. The skeletal system comprises of 206 bones and categorized into two types – *Axial skeleton* and *Appendicular skeleton*.

The axial skeleton consists of **skull bone**, **bones of thoracic cage** and **bones of vertebral columns** summing upto a total of 80 bones. However, the appendicular skeleton is made up of 126 bones comprising of **pelvic girdle, upper limbs, lower limbs** and **pectoral girdle**.

Application: The skeletal system performs the function of support and a solid framework to guard the delicate visceral organs inside the body. For example, the skull bones protect the brain. The bones of the thoracic cage protect the organs like lungs and heart.

- The skeletal system is provided with joints which helps in movement and tendons help in maintaining the flexibility of the body.
- The skeletal system helps in preserving and storing essential minerals like calcium which is released for repair and growth purpose.
- Sometimes there may be a growth of an extra limb or fingers or loss of digits/fingers in case of humans which is due to a phenomenon called polydactyly.
- The structure of skull bones and facial bones is aberrated in case of children's suffering from Down's Syndrome.
- **Osteoporosis** is a bone disorder in which the bone density or mineral density is reduced. The fractures associated with this disease occurs in hip, wrist or spine. This disease is most common in *Asian women* with respect to men.

Name of the Model: Models of different life processes a. Digestive System of Human, b. Circulatory System of Human, c. Respiratory System of Human

Photo of the Models:

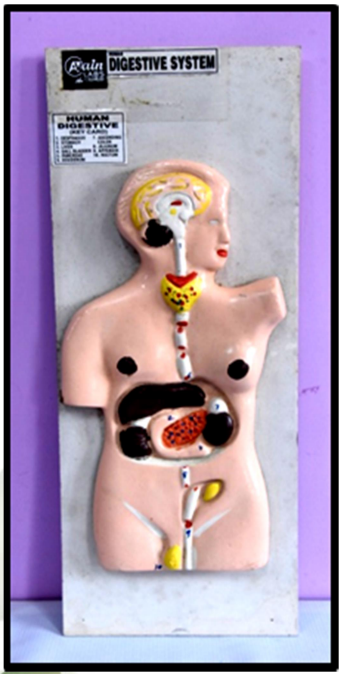


Fig.73: Digestive system of human

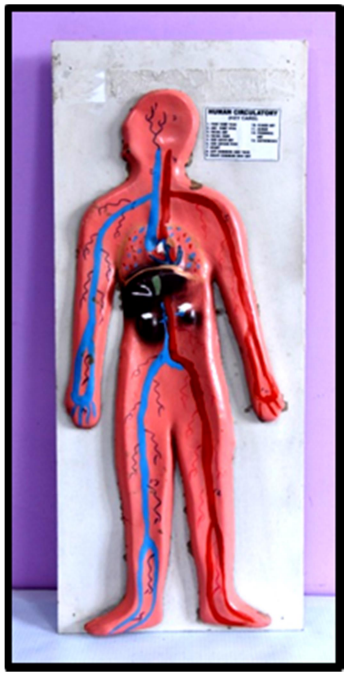
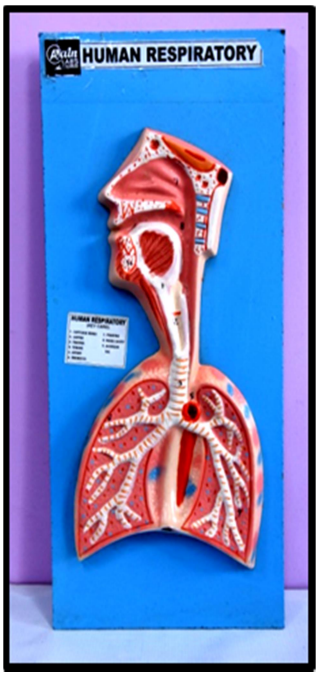


Fig.74: Circulatory system of human



Fi.g75: Respiratory system of human

Description: (a) *Digestive system of human*: The food we eat is absorbed into cells by the process of digestion and the waste is defecated. The digestive system begins with the mouth where the food is chewed with the help of teeth and mixed with saliva and then passes through the pharynx, oesophagus or food pipe, stomach, small intestine, large intestine, rectum and anus. The stomach, small intestine, liver and pancreas secrete enzymes and acids to facilitate digestion by breaking down food particle into small components. The process of absorption of minerals and nutrients takes place in small intestine.

(b) *Circulatory system of human*: The circulatory system of human consists of blood, heart, blood vessels and lymph. The blood circulation in human is done in two loops one for circulation of oxygenated blood and other for deoxygenated blood. The circulatory system is a wide network of arteries, veins and capillaries. The blood circulates twice through the heart and thus, it is known as double circulation.

(c) *Respiratory system of human*: The respiratory system of human is comprised of nose, larynx, pharynx, trachea, lungs, bronchi, bronchioles. The air which is inhaled through the nose moves through the pharynx, larynx, trachea and into the lungs. The oxygen that enter into the lungs is diffused into pulmonary capillaries through millions of microscopic sacs called alveoli. In the same manner, the carbon dioxide from the blood diffuses into the alveoli and is expelled through exhalation.

Application: (a) *Digestive system of human*: The digestive system helps in breaking down of complex food particles into simpler molecules which is further utilized as an energy source, cell repair and growth. Proper functioning of digestive system of human depends on the intake of type of food. Consumption of more processed foods and reduced fibre rich food i.e., whole grains and cereals in the diet lead to *constipation*. Consumption of junk and spicy foods causes indigestion and further leading to *heartburn* due to secretion of higher amount of acids (acidity). In contrast, the *people who reside in the rural areas* and solely depend on agriculture depend on whole cereals and fresh fruits and vegetables which help them to maintain a healthy digestive system.

(b) *Circulatory system of human*: It helps in transport of blood, oxygen, nutrients and hormones through the wide network of blood vessels. It acts as an interface for cell to cell interaction. Deaths due to the cardiovascular diseases in India attribute to 27% out of the total reported deaths in last few decades. The person who possess the risk of cardiovascular disorder (CVD) also possess obesity, hypertension and raised blood glucose levels due to unhealthy food and lifestyle habits. However, the *people belonging to the tribal communities are at less risk of CVDs* due to indigenous food habits, physical activities and non-polluted environment in contrast to the people residing in the sub-urbs and metro cities adhering to sedentary lifestyle.

(c) *Respiratory system of human*: The respiratory system helps in breaking down of glucose molecules to generate energy in living cells. The lungs help in oxygenation of deoxygenated blood which is then distributed to the body. The people who perform yoga and include exercise in their lifestyle habit demonstrate an enhanced rate of respiration and lung capacity. Thus, the persons are also risk free to any kind of respiratory ailments. Moreover, during the COVID-19 pandemic which critically affected the lungs, advisory was released based on observations to do yoga and exercises on regular mode.

Name of the Model: Models of the organs associated with Digestive system (i) Human Teeth, (ii) Human Stomach

Photo of the Model:

Fig.76: Human Teeth

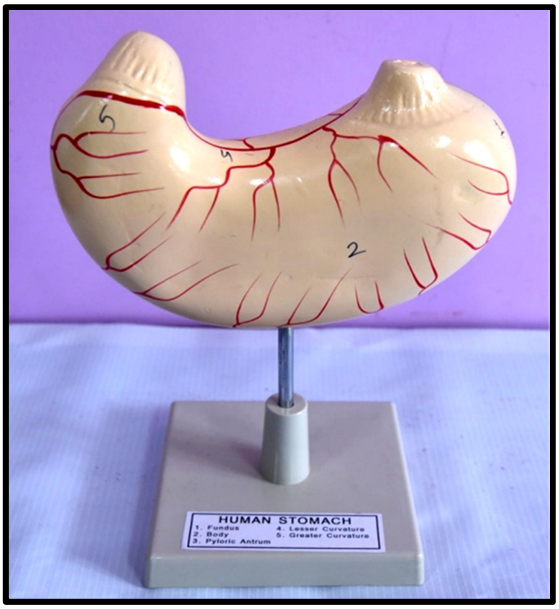


Fig.77: Human stomach

Description:(i) *Teeth* are the strongest part of the human body. Different types of teeth are modified based on different types of function such as cutting, tearing, shearing, grinding and crusing. The teeth are supported by jaw lines and composed of collagen protein and calcium. Human possess two sets of teeth in lifetime. Adults possess 32 teeth in total which includes incisors, canines, premolars and 12 molars. A kid possess 20 teeth and are devoid of premolars. The teeth present is given by a dental formula i.e., number of teeth present in one half of the upper jaw / number of teeth present in one half of the lower jaw. For e.g., the dental formula of an adult human is

$$\frac{2\ 1\ 2\ 3}{2\ 1\ 2\ 3} \times 2$$ { Upper half of the jaw contains 2 incisors, 1 canine, 2 premolars, 3 molars.

(ii) Stomach: The stomach is the J-shaped, thick-walled muscular organ of the body which is differentiated into cardiac, fundus and pyloric region. The cardiac region is the entry point of food into the stomach through oesophagus. Fundus region of the stomach is the region where all the actions of enzymes take place. The chewed food is stored in this part thus, this part is also called storehouse of the food. The pyloric part of the stomach retains the food for a longer time and then enters into the small intestine for absorption.

Application:(i) Teeth: It helps in chewing of the food and thus is hardest substance of the body which is firmly anchored to the jaw. The white part of the tooth is due to covering of enamel layer which is the body's hardest substance. Enamel has no living cells and thus, once the teeth is broken it cannot be repaired. Adults possess *wisdom teeth* (third set of molars) which appear by the age of 25. Poor alignment of wisdom teeth leads to bacteria diseases, pain and swelling.

(ii) Stomach: The major functioning of the stomach is to store the chew food and perform digestion, absorption and control of secretion. Gastric ulcer is a condition of stomach which is caused due to an erosion in the lining of the stomach, often causing pain and/or bleeding. *Gastric ulcers* are most often caused by NSAIDs or *H. pylori* infection. In addition, one of the most common stomach disorder includes inflammation of the stomach, causing nausea and/or pain. *Gastritis* can be caused by excessive consumption of alcohol, certain medications, *H. pylori* infection, etc. *Indigestion /dyspepsia* is observed more frequently due to disturbances in food timings and food quality.

BOTANY

Microscope

The microscope is a valuable instrument. There are many small objects or detail of objects which cannot be seen by the unaided human eye. The microscope magnifies the image of such objects thus making them visible to the human eye. Microscopes are used to observe the shape of bacteria, fungi, parasites and host cells in various stained and unstained preparations. Microscopes are generally made up of structural parts for holding and supporting the microscope and its components and the optical parts which are used for magnification and viewing of the specimen images. This description defines the parts of a microscope and the functions they perform to enable the visualization of specimens.

Types of Microscopy :

Microscopes used in clinical practice are light microscopes. They are called light microscopes because they use a beam of light to view specimens.

(A). Simple Microscope :

1. A simple microscope is a convex lens of short focal length.
2. They are called light microscopes because they use a beam of light to view specimens.
3. It is used to form a virtual image of an object placed just inside its principal focus.
4. It is made up of a single convex lens or a combination of lenses which functions as a convex lens.
5. Under simple microscope the enlarged image of the object is formed on the retina of the eye of the viewer.
6. A simple lens can magnify an object only three times OX).
7. For getting a magnification of more than 3X, a combination of several lenses is used. Such a combination of several lenses (called elements) functions as a single convex lens, and a magnification of about 20X can be obtained.
8. Improved simple microscopes, used by the biologists during field work, may magnify an object even up to 100 times.

A dissecting microscope (Fig-78) is an example of a simple microscope used either for dissecting the material or for viewing the magnified image of the material. It consists of only one lens unit.

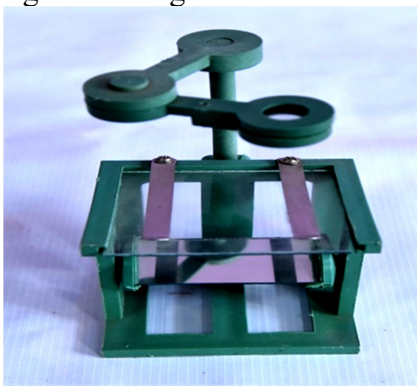


Fig.78: Dissecting simple microscope

B). Compound Microscope:

A compound microscope is the most common microscope used in microbiology. It consists of two lens systems (Combination of lenses) to magnify the image. Each lens has a different magnifying power. A compound light microscope with a single eye-piece is called molecular one with two eye-pieces is said to be binocular.

1. A compound microscope (Fig.79) comprises either two (objectives and eyepiece) or three (condenser, objectives and eyepiece or ocular) kinds of lenses.
2. The condenser, located above the mirror and below the stage, collects and focuses the light rays into the plane of the object.
3. The objectives (10X, 40X, 100X) are mounted on a revolving nosepiece.
4. Each objective consists of a set of elements fused together to work as a single lens.

The objectives collect light rays from the object and form a magnified real image at some distance above them.

Fig.79: Compound microscope

Application of Microscope :

i. **Microscopes in Botanical Field-**Botanists do multiple researches in various plants and fungi for research purposes to find many new features.

ii. **Microscopes in Biological Field-** This device is used to study bacteria, cells and many more**.**

iii. **Microscopes in Crime Detection-** Use of microscopes in crime fields helps to simplify complex evidences and helps in studying them to solve cases.

iv. **Microscopes in Education-** In various institutions, colleges, schools and universities students use this device to learn new things and understand the world around them.

v. **Microscopes in Medical Science-**Scientists and lab professionals use this device to study various viruses and bacteria and find out cure for various diseases.

Leaf Anatomy

Description

The leaf is a flattened green outgrowth that is carried on the node of the stem of the plant. Based on anatomy leaves are of 2 types Dorsiventral and Isobilateral. Leaf tissues are composed of layers of cells. Different cell types form three main tissues found in leaves. These tissues include a mesophyll tissue layer that is sandwiched between two layers of epidermis. Leaf vascular tissue is located within the mesophyll layer. Followings explain different cell types of the internal structure of a leaf.

- **Epidermis-**The outer leaf layer is known as the epidermis. The epidermis secretes a waxy coating called the **cuticle** that helps the plant retain water. The epidermis in plant leaves also contains special cells called **guard cells.** Guard cells control the size of pores called **stomata** (singular stoma) in the epidermis.

Fig.80: Leaf anatomy

- **Mesophyll-**The middle mesophyll leaf layer is composed of a palisade mesophyll region and a spongy mesophyll region. **Palisade mesophyll** contains columnar cells with spaces between the cells. Most plant chloroplasts are found in palisade mesophyll. Chloroplasts are organelles that contain chlorophyll, a green pigment that absorbs energy from sunlight for photosynthesis. **Spongy mesophyll** is located below palisade mesophyll and is composed of irregularly shaped cells. Leaf vascular tissue is found in the spongy mesophyll.

- **Vascular Tissue -**Leaf veins are composed of vascular tissue. Vascular tissue consists of tube-shaped structures called **xylem and phloem** that provide pathways for water and nutrients to flow throughout the leaves and plant.

Functions and Applications

- Green leaves prepare food for the plant through the process of the photosynthesis so the leaves are called food factory of the plants.
- Leaves help in the interchange of water vapor, oxygen and carbon dioxide for various physiological functions of the plants. The gases enter and exit through stomata. G**uard cells** regulate gas exchange between the plant and the environment.
- Plants get rid of excess water by transpiration through stomata present in the leaves.
- Transpiration by leaves helps in the ascent of sap by creating suction force in the vascular column that extends up to the root. It helps in transport of water and minerals through root.
- Leaf apex, lamina, petioles, stipules etc. undergo modification to provide support to the plant.
- Leaves are often modified into spines for defensive purpose.
- Leaves break down quickly and will make great fertilizer for your garden or yard in the spring. They should be used as mulch around plants. As leaves break down, they add to the nutrition of the soil. Composting or mulching services are offered by some municipalities.

Ecological Adaptation

Any physiological, behavioral or morphological attribute of an organism that enables it to survive and reproduce in its respective habitat is called as an **Ecological Adaptation**. Adaptations help the organisms to exist under the prevailing ecological habitat.

Plants have special traits that help them to enlarge their tolerance limits to =>

i. Light regimes
ii. Dry conditions
iii. High temperature
iv. Water saturated condition
v. Saline environments

On basis of light intensities, plants are grouped into **Sciophytes (Shade loving plants)** and **Heliophytes (Adapted to high intensity of light).**

On the basis of habitats plants are classified into five groups:-

- Hydrophytes
- Mesophytes
- Epiphytes
- Halophytes
- Xerophytes

Hydrophytes

Hydrophytes are the plants that grow on extremely wet soil where water is available in abundance. Hydrophytes are the plants which live completely or partially submerged in freshwater. Such plants do not face the problem of water shortage.

Hydrophytes are divided into different types on the basis of the way, they develop in water:-

1. **Free floating hydrophytes**=> Float freely on water surface.
   Example- *Wolffia, Lemna, Azolla, Eichornia, Pistia, Vallisneria*
2. **Rooted hydrophytes with floating leaves=>** Roots are fixed in mud but leaves have long petioles which keep them floating on water surface. Example- *Trapa, Nelumbo, Nymphaea*
3. **Submerged floating hydrophytes=>** completely submerged in water and not rooted in water.
   Example- *Ceratophyllum, Utricularia, Najas.*
4. **Rooted submerged hydrophytes=>** completely submerged in water and are rooted in soil.
   Example- *Hydrilla, Isoetes, Potamogeton, Vallisneria, Chara*
5. **Rooted emergent hydrophytes=>** Grow in shallow water. Rooted in soil and the shoot are partially or completely exposed to air.
   Example- *Ranunculus, Sagittaria, Scircpus, Cyperus,Typha*
6. **Rooted Amphibious=>** Grow in shallow water and the shoot extended above water surface. These plants develop root hairs in their adventitious roots, when water is low. So they have capability to grow as mesophytes. Example- *Polygonum, Marsilea*

Morphological Adaptation in Hydrophytes

ROOTS

- In hydrophytes roots do not play an important role in water absorption.
- Roots are either completely absent (*Ceratophyllum)* or poorly developed (*Hydrilla*).
- Root pockets are present instead of root caps (*Eichhornia, Lemna, Pistia*).
- Floating roots present in addition to normal adventitious roots (*Jussiaea repens*).
- Root hairs absent (*wolffia*) or poorly developed (*Hyrilla*)
- Roots are fibrous, reduced, unbranched.

STEMS

- The stem is long, slender, spongy and flexible (*Hydrilla*, *Potamogeton*)
- The stem may float horizontally on water surface (*Azolla)* or may be thick, short and stoloniferous(*Eichhornia*).
- May be attached to the bottom of the pond by a rhizome (*Nymphaea*).

PETIOLE

- The petioles have special modifications to suit the aquatic environment.
- Long, slender and delicate petioles are present in hydrophytes with their leaves floating on water surface (*Nymphaea*).
- In some plants petiole is swollen to form a bulb like structure to help the plants to float on water (*Eichhornia).*

LEAVES

- In submerged hydrophytes the leaves are thin, long and in the shape of a ribbon, (*Vallisneria*) or finely dissected (*Ceratophyllum).*
- Floating leaves are large, entire and flat (*Nymphaea).*
- Floating leaves have a coat of wax.
- The leaves may also have hairs (Salvinia).
- The leaves of emergent and amphibious hydrophytes are heterophyllous, i.e., the leaves below the water are long, narrow and dissected while those outside the water are entire and broad. This is also termed as dimorphism of leaves(*Ranunculus, Limnophila heterophylla, Sagittaria, Sagitifolia*).

Hydrilla Verticillata

Family-Hydrocharitaceae

- A completely submerged plant with roots, stem and leaves. Roots are reduced, fixed to the substratum.
- Stem is long , spongy and with long internodes.
- Leaves are whorled, reduced, linear and fleshy. Soft and spongy character is due to the presence of air storage tissue for floating purpose.

Fig.81 : Hydrilla

Eichhornia Crassipes

Family- *Ponteriadaceae*

- A free floating plant with poorly developed root system. Roots are without root caps and root hairs.
- Stem modified to offset for vegetative propagation. Offset has soft, thick short internodes. Internodes bear the tuft of leaves and cluster of adventitious roots at tip.

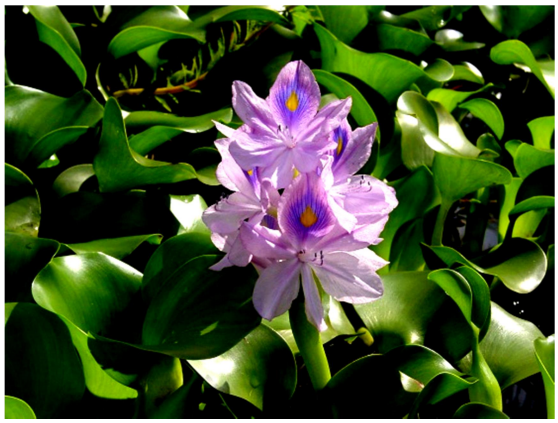


Fig.82 : Eichornia crassipes

Vallisnaria Natans (Lour.) Hara.

Family-Hydrocharitaceae

- *Vallisnaria* is commonly known as Tape grass, eelgrass, wild celery, water celery, eel weed and duck celery.
- Submerged, tufted, acquiescent, glabrous, dioecious, freshwater herbs with fibrous roots .
- Leaves radical, linear, ribbon shaped, sheathing at base, with longitudinal air chambers, margin dentate.

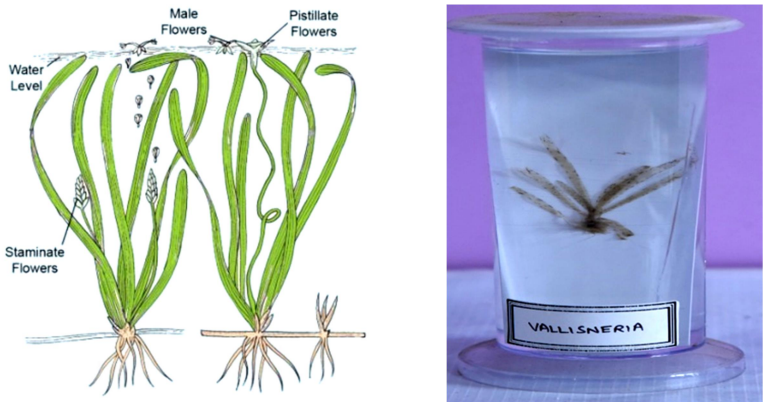


Fig.83 : Vallisneria

Lemna Minor L.

Family: Araceae

Common Name: Duckweed, water lens or bay root

Fig.84 : Lemna minor

- These are freshwater aquatic plants.
- They float in still or slow-moving fresh water and wetlands.
- The common duckweed, also known as ‘water lentil’, is smaller in size than the giant duckweed.

- These plants are very simple lacking an obvious stem or leaves.
- The light green, oval, leaf-like structure having air pockets that floats on the water surface is a thalloid.
- In polluted or nutrient-rich water bodies, it grows to form dense colonies and covers the water surface completely.

Xerophytes

Xerophytes are the plants that grow in desert or in dry situation. The plants growing in xeric habitat is greatly modified in form and develop some special features to absorbs more and more water from surroundings, to retain more and more water in their organs for long time and to reduce consumption of water.

Xerophytic habitat can be of two different types:

a. Physical dryness: In these habitats, soil has a little amount of water.

b. Physiological dryness: In these habitats, water is sufficiently present but plants are unable to absorb it.

Xerophytes are classified into three categories :

- Ephemerals
- Succulents
- Non succulent plants.

Fig.85: Xerophyte

Ephemerals:

- Called drought escapers or drought evaders.
- Grow in arid places.
- Complete their life cycle within a short period during rainy season.
- Pass dry season in seeds and fruits which have hard and resistant seed coats.

Succulents

- Called drought enduring plants.
- Some organs become smaller and fleshy.
- Store water in their plant parts during the dry period.
- Develop certain adaptive characters to resist extreme drought conditions. Examples: Opuntia, Aloe, Euphorbia, Bryophyllum and Begonia.

Large straggling fleshy shrub with often drooping branches and large flat limbs mostly thick, oblanceolate, articulated with a ring of spines or bristles. Spiny shrub growing in xeric condition, it is a succulent xerophyte.

Stem is modified into green, flat, fleshy, and jointed structure called phylloclade. Phylloclade bears succession of nodes and internodes, performing the function of leaf as well as stores water. Leaves are reduced to spines to check transpiration. Root system is well developed and profusely branched and deeply seated.

Non succulents:

- Called drought resistant plants (true xerophytes).
- They face both external and internal dryness.
- Have many adaptations to resist dry condition.
- Examples: Casuarina, Nerium, Zizyphus, Calotropis procera, Saccharum, Salvadora and Morphological Adaptation in Xerophytes

Fig.86 : Zizyphus

Fig.87 : Acacia

ROOTS

- Roots are well developed (cactus).
- Roots are strongly developed and of greater size (Calotropis).
- Root hairs extend up to root tip (Opuntia).
- Root become fleshy and store water (Asparagus).
- Roots go deep into the soil in search of water.

SHOOTS

- The shoot is generally hard and woody.
- It is mostly covered with hairs, wax and silica.
- Prominent bark is present in some woody xerophytes to check transpiration.
- The stem form leaf like structure called phylloclade (Cactus) and leaf like structure formed by the leaf is called as cladode (Asparagus and Ruscus)

Physiological Adaptation in Xerophytes

- Rate of transpiration is greatly reduced.
- Ratio between starch and sugar is low.
- Osmotic pressure is higher.
- Protoplasm is less viscous and more permeable.
- Resistant to wilting.
- Bear flowers and fruits earlier.

Plants Root System

1. Plants are divided into two main components: the root system (present underground) and the shoot system (present above the ground or Ariel)

Roots have the major function of nutrient and water absorption from soil and anchorage or mechanical support.

It comprises of cells that have the following features:

1. Non-green due to absence of chlorophyll
2. Not divided into nodes and internodes
3. Absence of leaves and buds
4. Positively geotropic (grow towards gravity)
5. Positively hydrotropic (grow towards water)
6. Negatively phototropic (grow away from light)

   Root system are of major two types: tap root system and fibrous root system

Another root system that appears from the other parts of the plant other than radicle called as adventitious roots. Prop root of banyan and pneumatophores of mangroves.

Tap Root System - It is the root system that develops from the radicle and continues as the primary root (tap root) which gives off lateral roots and remains underground. These provide very strong anchorage as they are able to reach very deep into the soil. It is usually found in dicots e.g. sunflower, mustard, carrot, mango.

Along with the major function of absorption and anchorage roots sometime undergoes modifications for storage and gaseous exchange.

Fig.88: Tap root

Fig.89: Fibrous root

Fibrous root system: Usually formed by the seminal roots arise from the embryo along with radicle. These are thin, moderately branching roots growing from the stem. A fibrous root system is universal in monocotyledonous plants and ferns. The fibrous root systems look like a mat made out of roots when the tree has reached full maturity.

Functions :

- They absorb water and dissolved mineral from the soil.
- They can store food in the form of reserve material as tuberous, fasciculate and annulated
- They can also synthesise growth regulators.
- They keep the plant attached to the soil firmly, that is, provide anchorage as in stilt roots

2. Turnip:

Botanical name: Brassica rapa

Family: Brassicaceae

Common Name: Turnip, White Turnip, Swede

- The turnip or white turnip is a root vegetable.
- It is commonly grown in temperate climates worldwide for its white, fleshy taproot.
- The root is roughly globular, from 5 to 20 centimetres (2 to 8 in) in diameter, and lacks side roots. Commonly known as napiform root (Spherical at base tapering sharply towards the tip) system.

Uses:

Turnip is an ideal weight loss product. 100 grams of this root vegetable contains only 30 kilocalories, but it contains more than enough vitamins, a lot of calcium, an indispensable tool for strengthening the bones of peasant children. The turnip has diuretic and anti-inflammatory properties. A mixture of turnip juice with honey is very good for colds. Rinsing the mouth with turnip juice saved our ancestors from toothache.

Fig.90: Turnip

Turnip leaves are sometimes eaten as "turnip greens" and they resemble mustard greens in flavour. Young turnip roots are eaten raw in salads or pickled, they are also cooked and served whole or mashed and are used in stews. Turnip roots are excellent source of dietary fibre, vitamin C and vitamin B6, folate, calcium, potassium, and copper.

3. Carrot:

Botanical name: Daucus carota subsp. Sativus

Family: Apiaceae

Common Name: Carrot, Gajar

The carrot (*Daucus carota* subsp. *sativus*) is typically orange in color, though purple, black, red, white, and yellow cultivars exist. The wild carrot, *Daucus carota*, is a native to Europe and South western Asia. It is a conical root modification (Base is broad and tapers gradually towards apex), a vegetable plant. The most commonly eaten part of the plant is the taproot, although the stems and leaves are also eaten. Cultivars mature within 90 days or 120 days.

Fig.91: Conical root

The roots contain high quantities of alpha- and beta-carotene, and are a good source of vitamin A, vitamin K, and vitamin B6. The carrot gets its characteristic, bright orange colour from β-carotene, and lesser amounts of α-carotene, γ-carotene, lutein, and zeaxanthin. α- and β-carotenes are partly metabolized into vitamin A.

Raw carrots are 88% water, 9% carbohydrates, 0.9% protein, 2.8% dietary fiber, 1% ash and 0.2% fat Carrot dietary fiber comprises mostly cellulose, with smaller proportions of hemicellulose, lignin and starch. Free sugars in carrot include sucrose, glucose, and fructose.

Uses:

Carrots can be eaten in a variety of ways. Only 3 percent of the β-carotene in raw carrots is released during digestion: this can be improved to 39% by pulping, cooking and adding cooking oil. Alternatively they may be chopped and boiled, fried or steamed, and cooked in soups and stews, as well as baby and pet foods.

The greens are edible as a leaf vegetable, but are rarely eaten by humans; some sources suggest that the greens contain toxic alkaloids.

In India carrots are used in a variety of ways, as salads or as vegetables added to spicy rice or dal dishes. A popular variation in India is the Gajar ka Halwa carrot dessert. Carrots can also be cut in thin strips and added to rice, can form part of a dish of mixed roast vegetables or can be blended with tamarind to make chutney.

Carrots are puréed and used as baby food, dehydrated to make chips, flakes, and powder, and thinly sliced and deep-fried, like potato chips. The sweetness of carrots allows the vegetable to be used in some fruit-like roles. Carrots can also be used alone or blended with fruits in jams and preserves. Carrot juice is also widely marketed, especially as a health drink.

Highly excessive consumption over a period of time can result in carotenemia, a yellow-orange discoloration of the skin caused by a build-up of carotenoids.

4. Radish

Botanical name: Raphanus sativus

Family: Brassicaceae

Radishes are annual or biennial crops grown for their swollen tap roots which can be globular, tapering, or cylindrical usually fusiform type (Swollen in middle, tapering towards both ends) modification of root. The root skin colour ranges from white through pink, red, purple, yellow, and green to black, but the flesh is usually white. A longer root form, including oriental radishes, daikon or mooli, and winter radishes

Fig.92: Fusiform root

Leaves are arranged in a rosette. They have a lyrate shape, meaning they are divided pinnately with an enlarged terminal lobe and smaller lateral lobes. The white flowers are borne on a racemose inflorescence.

The flesh of radishes harvested timely is crisp and sweet, but becomes bitter and tough if the vegetable is left in the ground too long. The raw flesh has a crisp texture and a pungent, peppery flavor, caused by glucosinolates and the enzyme myrosinase, which combine when chewed to form allyl isothiocyanates, also present in mustard, horseradish, and wasabi.

The most commonly eaten portion is the napiform or fusiform taproot, although the entire plant is edible and the tops can be used as a leaf vegetable. The seed can also be sprouted and eaten raw in a similar way to a mung bean. The root of the radish is usually eaten raw, although tougher specimens can be steamed. Radishes are mostly used in salads, as garnish for traditional dishes such as tostadas, sopes, enchiladas and Posole stew.

Radish greens are usually discarded, but are edible and nutritious, and can be prepared in a variety of ways. The leaves are sometimes used in recipes, like potato soup or as a sauteed side dish. They are also found blended with fruit juices in some recipes.

In Indian cuisine the seed pods are called "moongra" or "mogri" and can be used in many dishes. The seeds of radishes can be pressed to extract radish seed oil.

Wild radish seeds contain up to 48% oil, and while not suitable for human consumption, this oil is a potential source of biofuel.

The daikon grows well in cool climates and, apart from its industrial use, can be used as a cover crop, grown to increase soil fertility, to scavenge nutrients, suppress weeds, help alleviate soil compaction, and prevent winter erosion of the soil.

"Radi", a spiral-cut radish that is sprinkled with salt and occasionally chives, and eaten with the fingers, is traditionally served with beer at the Bavarian Oktoberfest

Pinecone Science

Scientific Name: Pinus Spp.

Family: Pinaceace

Common Name: Pine Plant, Chir ka ped

Description

Fig.93: Pinus

- Pine plants evergreen, perennial lofty trees with spirally growing branches which give pyramidal or conical appearance.
- Distributed throughout the world but native primarily to northern temperate mountainous areas between 600-2300 m elevation over Bhutan, North India, Kashmir, Nepal, Pakistan, Sikkim, and southern part of Tibet.
- Unlike other deciduous trees which reproduce seeds that are surrounded by fruit, pine seeds are located on scales of structures called pine cones.
- Cone is typically a seed-bearing structure in a gymnosperm.
- The male cones develop in clusters. Each male cone is ovoid in shape. A male cone consists of a large number of microsporophylls arranged spirally on the cone axis.
- The female cone is often larger than the male cone. Female cone develops either solitary or in groups of 2 to 4. Each female cone is an ovoid structure when young but becomes elongated or cylindrical at maturity. Many megasprophylls arranged spirally on the cone axis. Female pine cones open and close as per weather condition.
- The male cone produces pollen and female cone produces ovule.

Applications

- **Pine cones used to** feed the birds over the winter.
- **Pine cone can be used for art and decorative purposes like pine flower, garland, pine cone bonsai, card holders etc.**
- Pine Cones used as a natural aromatherapy diffuser because it is rich in exclusive phenolic compounds.
- Especially pine cones make perfect base for a thriving succulent garden.
- As the cones of chir pine is used for decoration, which can be a flourishing business for indigenous communities.

- In ancient times, pine cones were a symbol of fertility. Celtic women who wanted to have a baby put a pine cone under their pillow. Ancient Romans associated pine cones with Venus, Goddess of love and fertility.
- Pine cone improves immune response and stimulates the body to produce antibodies. Research shows it is very potent against influenza viruses and even HIV.
- Pine cone extract has been shown to reduce levels of immunoglobulin E (IgE), the antibodies involved in an allergic reaction.
- Pine cone extract and other conifer extracts have anti-inflammatory properties. These are mostly attributed to the high levels of polyphenol antioxidants in the cones.
- Essential oils from pine cones have antibacterial properties, help to heal wounds.
- Conifer cones contain many powerful antioxidants. Some of these antioxidants include glycosides, anthocyanin and carotenoids.

Name of the Model- Ornamental Plants

Ornamental plants are those plants grown for decorative purposes in garden and landscape design projects. They enhance the beauty of surroundings of home and grab attention of all due to their attractive colour, beautiful design and mesmerizing look.. They are used as decorative materials in constructing a lawn, plaza and various kinds of gardens which can be displayed both indoor and outdoor for decoration. They have vibrant colours and add life to the settings . These plants are also used by florists for decoration in weddings and parties.

Classification of Ornamental Plants

a. **Flowering**- Roses, Sampaguita, Ilang-ilang, Orchids, Chrysanthemums, Callallies etc.
b. **Non Flowering**- Ferns, Palms, Japanese bamboo, Sam Fransico etc.

On the basis of physical properties ornamental plants are of different kinds :

a. **Herbaceous Plants**- These are plants with soft stems and grow relatively short in height with a short life span. E.g. Orchids, Dahila, Sunflower, Zinnia and Camia.
b. **Shrubs and Bushes**-A woody plants with two or more stems that grow form the ground is identified as a shrub. This kind of plant is similar than the trees. E.g, Sampaguita, Rose, Santan and Gumamela.

Importance of Ornamental Plants

- Ornamental plants give a cooling effect in the house.
- They make the house and its surrounds clean, beautiful, comfortable and relaxing-a nice place to live in.

- They provide interest to the landscape of parks, big buildings and others in making these places beautiful.
- They are used to make perfumes, medicines and dyes.
- They can source of income for the family. The growing of flowering and non flowering ornamental plants is a thriving business in the cities and urban areas.

Some of important indoor ornamental plants listed below:

Fig.94: Cordyline firebrand

A. **Botanical Name**- *Cordyline fruticosa* Comm.ex.Br.
Family- Asparagaceae
Common Name- Cordyline firebrand, Dracena
Traditional knowledge- Native to New Zealand & Australia.
Ornamental plant having many species used for food stuff and medicine. This plant is used for treatment of various disorders such fever, headache, diarrhea, cough etc.

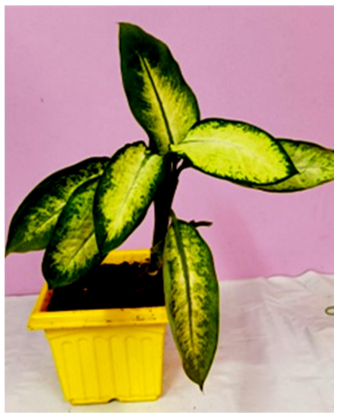


Fig.95: Dumb cane

B. **Botanical Name**- *Dieffenbachia seguine* (Jacq.) Schott.
Family- Araceae
Common Name- Dumb cane
Traditional knowledge- NASA identified this plant as top 10 indoor plants. Native to tropical America. Ornamental plant cultivated as indoor houseplant. Sap is causes irritation and toxic in nature.
The plants have also been used as food, medicine, stimulants, and to inflict punishment.

Fig.96: Rhoeo

C. **Botanical Name**- *Tradescantia spathacea* Sw.
Family- Commelinaceae
Common Name-Rhoeo, Boat lily
Traditional knowledge- Native to Southern Mexico. Widely cultivated as ornamental houseplant. The Boat Lily to treat cough, bronchitis and sprains. Other traditional uses include treating fever, amenorrhea, headache and rheumatism.

D. Botanical Name - *Licula grandis* (Hort.ex.W.Bull.) H.Wendl.

Family- Arecaceae

Common Name-Ruffled fan palm.

Traditional knowledge- Ornamental plant native to Vanuatu, an Island nation in the pacific. One of the most interesting and elegant small palms, when matured drooping cluster of red fruits are very attractive. The large umbrella-size leaves of *Licuala grandis* are used for thatching. Generally, it's free of serious diseases and pests protect against mealy bugs on matured fruits. Protect from frost.

Fig.97: Ruffled fan palm

E. Botanical Name- *Dracaena sanderiana* Mast.

Family- Asparagaceae

Common Name- Belgian evergreen, Lucky Bamboo

Traditional knowledge- Native to Central Africa.

The plant is commonly marketed as "Lucky bamboo". It's a traditional symbol of happiness, wealth and health. The lucky bamboo plant is one of the most popular Feng Shui cures said to bring good luck and prosperity to the place where it is grown. It is also known to enhance the flow of positive energy in the home and office when placed in the right direction.

Fig.98: Belgian everygreen

F. Botanical Name- *Livistonia chinensis* (Jacq.) R.Br.ex.Mart.

Family- Arecaceae

Common Name- Chinese fan palm /Fountain palm

Traditional knowledge-Native to East Asia. Ornamental plant cultivated as indoor houseplant. *Livistona chinensis* is used in traditional Chinese medicine as an anticancer agent. The extracts of *L. chinensis* fruits and seeds show the antiproliferative and antiangiogenic properties.

Fig.99: Chinese fan palm

G. Botanical Name- *Dracaena trifascicata* (Prain)Mabb.
Family- Asparagaceae
Common Name- Snake plant /Mother-in-law's tongue.
Traditional knowledge- Native to Tropical West Africa also called Saint George's Sword. An evergreen perennial plant most commonly grown ornamental plant which can be easily propagated by cuttings. The plant sap is poisonous. The lant is used to treat ringworm and fungal diseases. Snake plants are also known for their ability to help remove toxic cancer causing air pollutants like CO_2, benzene, formaldehyde, xylene, toluene.

Fig.100: Snake plant

H. Botanical Name- *Zamioculcas zamifolia* (Lodd.)Engl.
Family- Araceae
Common Name- Jade plant/Z plant/Zuzu plant/Zangiber gem
Traditional knowledge-Native to Eastern Africa.Grown as ornamental plant for attractive glossy foliage and easy care. All plant parts are toxic. ZZ plant or *Zamioculcas zamiifolia* is easy to maintain ornamental houseplants, which are considered to bring luck and prosperity as per Vastu Shastra and Feng Shui.

Fig.101: Jade plant

I. Botanical Name- *Epimermnum aureum* (Linden & Andre) G.S.Bunting
Family- Araceae
Common Name-Money plant
Traditional knowledge- Native to Mo'orea & French Polynesia. Popular houseplant can grow up to 20mtrs. It is often used in decorative displays at home, office and public places. Plant is toxic to pets. Each part of this plant possesses antibacterial, anti-termite and antioxidant properties. The plant is also used against anti-malarial, anti- cancerous, anti-tuberculosis, anti-arthritis and wound healing etc which are a severe international problem.

Fig.102: Money plant

J. **Botanical Name**- *Dieffenbachia amoena* hort.ex Gentil
Family- Araceae
Common Name- Dumbcane
Traditional knowledge- Native to West Africa also.
An evergreen perennial plant most commonly grown ornamental plant which can be easily propagated by tip and nodal cuttings. The plant sap is poisonous.The sap is used used to treat tumours and warts. The seed oil is applied on wounds, burns and inflammations. In tropical America it is also as an antidote (counter-irritant) against snakebites, and to treat rheumatism and gout externally.

Fig.103: Dumbcane

Name of the Model: White Rust of Crucifers

Host Plant- Brassica campestris
Family - Brassicaceae
Causal Organism- Albugo candida / Cystopus candidus (Fungus)

Introduction:
It appears on a number of cruciferous plants (Brassicaeae) throughout the world. This disease occurs in Capparidaceae, Convolvulaceae and Amaranthaceae other than Brassicaceae.
Symptoms:

Fig.104: White rust of crucifers

Symptoms can be seen almost on all parts of the plant except on roots. Mainly the young stems and inflorescence are infected. White creamy pustules appear on surface of leaves, stem and inflorescence .Pustules appear on the lower surface of the leaves. The pustules appear in

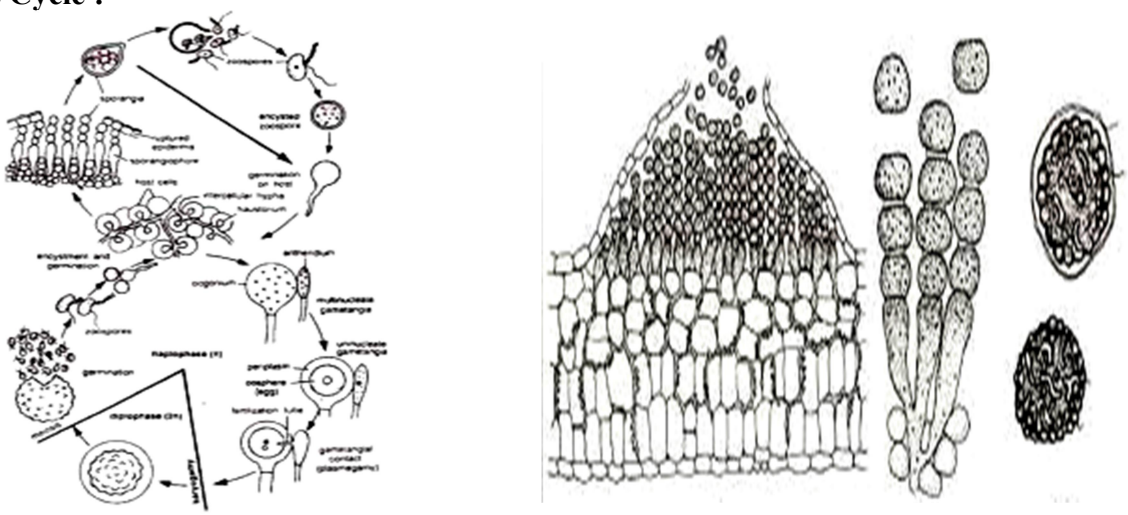
variable shape and sizes to form large irregular patches. When the floral axis infected, the floral pats become swollen, fleshy, green or violet in colour. The parasite stimulates the cell activity which results in hypertrophy and hyperplasia.

Causal Organism:

The disease caused by ***Albugo candida*** and also known as ***Cystopus candidus.*** The fungus is an endophytic, obligate, aseptate parasite which survives in soil as oospore in crop debris.

The hyphae penetrate the host cell walls and send knob like haustoria inside the host cells to obtain nutrients from the host. Continuous sporangia formation and the growth of the fungus in a constant space pressurize epidermis to rupture or brust resulting in the release of sporangia, which generally form a white crust on the surface of the host.

Disease Cycle :



A. B.

Fig.105: (A) Disease cycle of white rust caused by Albugo candida and (B) conidiophores producing conidia.

White rust is spread through oospore contaminated seeds, wind and rain borne zoosporangia and possibly perennial mycelium in infected plants. Non cruciferous weeds are not the source of infection. The disease is a soil borne disease. The parasite infects through oospore lying in the soil. Perennial weed hosts also serve as a source of primary inoculums. By means of air, the sporangia and zoospores also helpful in spreading of the disease. Moist temperature (5^0 C to 12^0C) is the favourable temp for spread of the disease.

Control Measures

- Sanitation of the crop field by cleaning or burning of the infected debris or infected parts helpful for destroying the oospores which is helpful for disease control.
- Spraying of copper fungicides such as Boredeaux mixture (4:4:50) has been recommended to control the disease.
- Treatment of seeds with Metalaxyl (Apron 35SD) @ 6gm/kg is recommended for infection free plant growth.
- Crop rotation is the traditional method for inhibition of infection of the host plant.

PHYSICAL CONTROL Ploughing or disking diseased plants and plant parts results in rapid decomposition of infected tissues and helps to significantly reduce future white rust infection. Crop rotation with non-cruciferous host plants is also effective. Weed control and other• sanitary methods are necessary too. BIOLOGICAL CONTROL THROUGH RESISTANT VARIETIES Resistance has been successfully deployed with mustard and rutabaga, however, with Asian vegetables such as Chinese mustard, Chinese cabbage, pak choi, and diakon, resistant varieties have not yet been identified. CHEMICAL CONTROL. The development of the acyl alanine fungicide metalaxyl (Ridomil; Subdue) greatly improved the ability to control while rust with fungicide application. Metalaxyl provides limited curative activity and some control of systemic infection. With the possibility of developing fungicide tolerant pathogen strains associated with metalaxyl, growers should consider using Ridomil MZ58 formulations with foliar fungicide applications. This formulation adds a second fungicide to the tank mix. Older fungicides used, but less effective, for white rust control include: Dithane Z-78, Blitox, wettable sulphur, fixed copper compounds, Bordeaux mixture, chlorothalonil, captofol, captan, dodine, mancozeb, metiram, maneb, and zineb.

Name of the Model - Citrus Canker

Host Plant - Citrus medica L.
Family - Rutaceae
Causal Organism - Xanthomonas citri (Bacterial)

The disease was originated in China. It causes disease in Citrus, Orange, lemon fruits. It is a common disease in India, China, Japan etc. it causes large destruction in orchards.

Symptoms:

Fig.106 : (A) Xanthomonas citri causing Citurs canker disease on leaf and fruits of Citrus

The disease affects the leaves, thorns and fruits. All green parts and maturing fruits become more or less covered with brown scabby spots surrounded by dark brown glossy margins. The lessons appear as small yellowish spot become raised and rough or spongy and turn brown. The market value of the fruits reduced, because of the appearance of the scabby lesions.

Causal Organism:

It caused by a gram negative monotrichous capsulated rod shaped bacteria *Xanthomonas citri.* The bacterium doesn't produce endospores and cannot reduce nitrates.

Disease Cycle

The bacterium enters through stomata and wounds. The bacteria multiply in the intercellular space of the cortical region. The disease is favored by mild temperature and humid water. The bacteria cannot survive in soil and dead plant parts. From the cankers, disease spreads by rain splash and insects. Sometimes human being becomes an important agent of dissemination.

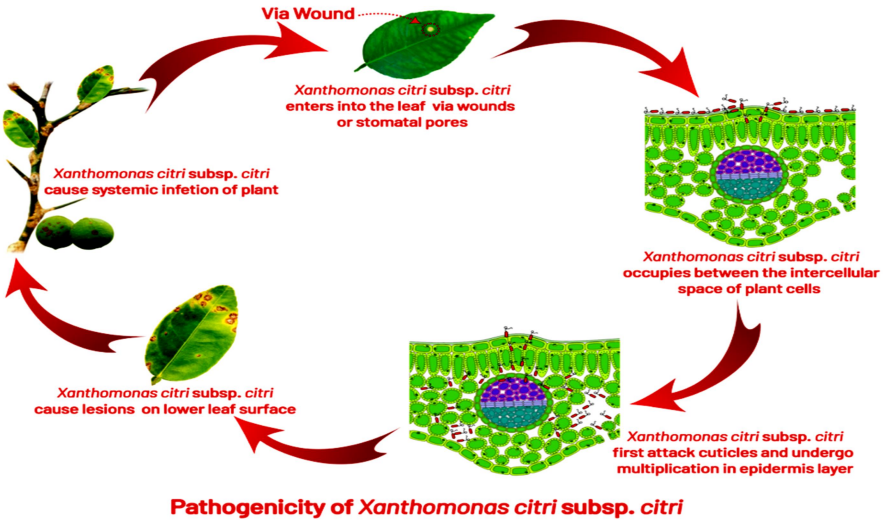


Fig.107: (B) Disease cycle of Citrus canker

Control Measures

- Complete destruction of diseased plant by burning them.
- Use of disease free nursery stock for planting.
- Burning of infected part/parts also prevent from spreading.
- Use of disease free and resistant varieties can reduce the chance of infection.
- Spraying the plants with 1% Bordeaux mixture is effective.
- Proper irrigation and manuring helps the health of the plant.
- Spraying of antibiotics
- Traditionally spraying of antibiotics like streptomycin and phytomycin with neem cake helps in control of the disease.

The Biogas plant:

Most organic materials undergo a natural anaerobic digestion in the presence of moisture and absence of oxygen and produce biogas. The biogas so obtained is a mixture of methane (CH_4): 55-65% and Carbon dioxide (CO_2): 30-40%. The biogas contains traces of H_2, H_2S and N_2. The calorific value of biogas ranges from 5000 to 5500 Kcal/Kg (18.8 to 26.4 MJ /m^3). The biogas can be upgraded to synthetic natural gas (SNG) by removing CO_2 and H_2S. The production of biogas is of particular significance in India because of its large scale cattle production. The biogas is used for cooking, domestic lighting and heating, run I.C. Engines and generation of electricity for use in agriculture and rural industry. Family biogas plants usually of 2-3 m^3 capacity.

Steps of Biogas production:

Anaerobic digestion:

The treatment of any slurry or sludge containing a large amount of organic matter utilizing bacteria and other organisms under anaerobic condition is commonly referred as anaerobic digestion or digestion. Anaerobic digestion consists of the following three stages. The three stages are (i) the enzymatic hydrolysis, (ii) acid formation and (iii) methane formation.

Enzymatic Hydrolysis: In this stage, a group of facultative microorganisms acts upon the organic matter and convert insoluble, complex, high molecular compounds of biomass into simple, soluble, low molecular compounds. The organic substances such as polysaccharide, protein and lipid are converted into mono-saccharide, peptide, amino acids, and fatty acids. Then they are further converted into acetate, propionate and butyrate.

Acid Formation:

The microorganisms of facultative and anaerobic group collectively called as acid formers, hydrolyse and ferment the productions of first phase i.e., water soluble substances into volatile acid. The major component of the volatile acid is the acetic acid. In addition to acetate or hydrogen and carbon dioxide, some other acids like butyric acid and propionic acid are also produced.

Methane Formation:

Finally, acetate or hydrogen plus carbon dioxide are converted into gas mixture of methane (CH_4) and CO_2 by the bacteria, which are strictly anaerobes. These bacteria are called methane fermentators. For efficient digestion, these acid formers and methane fermentators must remain in a state of dynamic equilibrium.

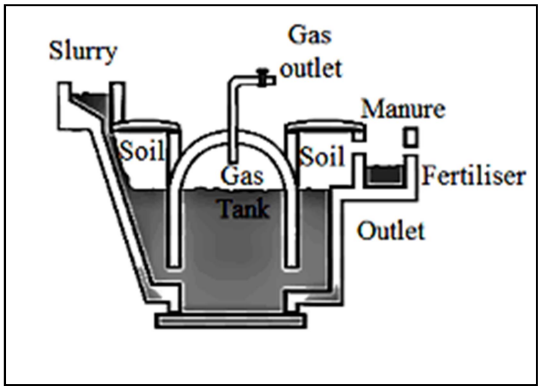
The remaining indigestible matter is referred as "slurry". Typical retention time of slurry in a biogas plant is 40 days.

The efficiency of Biogas generation depends upon the following factors:

- Acid formers and methane fomenters must remain in a state of dynamic equilibrium, which can be achieved by proper design of digester.
- Anaerobic fermentation of raw cow dung can takes place at any temperature between 8 and 55°C. Methane bacteria work best in the temperature range of 35 and 38°C.
- A pH value between 6.8 and 7.8 must be maintained for best fermentation and normal gas production.
- A specific ratio of carbon to nitrogen (C/N ration) must be of 30:1 is taken as optimum.
- The water content should be around 90% of the weight of the total contents. Anaerobic fermentation of cow dung proceeds well if the slurry contains 8 to 9% solid organic matter.
- The slurry should be agitated to improve the gas yield.
- Loading rate should be optimum. If digester is loaded with too much raw material, acids will accumulate and fermentation will be affected.

There are two types of biogas plant:

1. Floating dome type (KVIC-type (KVIC- Khadi Village Industries Commission)
2. Fixed dome type (Deenabandu model)



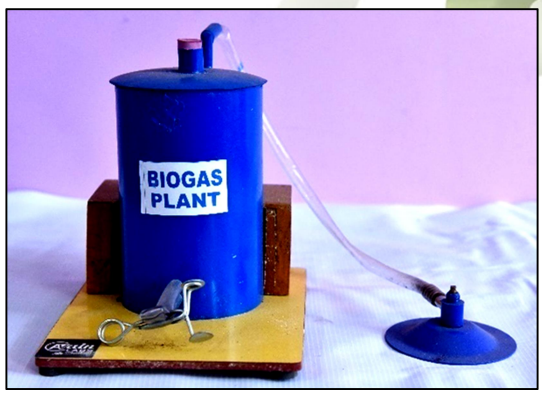


Fig.107: Bioggas plant

The model is a floating Dome type which is mainly consists of a digester or pit for fermentation and a floating drum for the collection of gas. Digester is 3.5-6.5 m in depth and 1.2 to 1.6 m in diameter. There is a partition wall in the centre, which divides the digester vertically and submerges in the slurry when it is full. The digester is connected to the inlet and outlet by two pipes. Through the inlet, the dung is mixed with water (4:5) and loaded into the digester. The fermented material will flow out through outlet pipe. The outlet is generally connected to a compost pit. The gas generation takes place slowly and in two stages. In the first stage, the complex, organic substances contained in the waste are acted upon by a certain kind of bacteria, called acid formers and broken up into small-chain simple acids. In the second stage, these acids are acted upon by another kind of bacteria, called methane formers and produce methane and carbon dioxide.

Advantages:

- The technology is very suitable for rural areas.
- The initial investment is low for the construction of biogas plant.
- Biogas is locally generated and can be easily distributed for domestic use.
- Biogas reduces the rural poor from dependence on traditional fuel sources, which lead to deforestation.
- The use of biogas in village helps in improving the sanitary condition and checks environmental pollution.
- The digested slurry undergoes composting producing nitrogen rich manure.
- Biogas reduces the drudgery of women and lowers incidence of eye and lung diseases.

GEOGRAPHY

Name of the Model : Fluvial Landforms

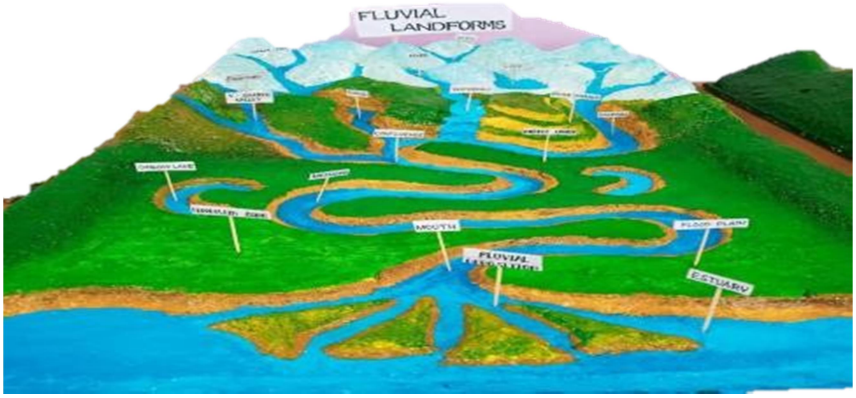


Fig.108: Fluvial Landform

The landforms formed by river by erosional, depositional and transportation work of river are known as Fluvial Landforms or Fluvial Topography. On the basis of above-mentioned acts of river, the landforms are further categorised as Depositional landforms and Erosional landforms. Stream with high velocity will form erosional landform and lower velocity will for Depositional Landforms.

Fluvial Erosional Landforms: Gorges, canyons waterfalls, rapids and river capture etc.
Fluvial Depositional Landforms: Floodplains, oxbow lakes, natural levees and Delta etc.
Indian River systems like Ganga, Brahmaputra, Indus has all certain kinds of erosional and depositional landforms in it. Such as V- Shapped valley of Panchmari, Jawalpur. Gorge of Kotain, Rajastan, Sunderban Delta, Kanwar Lake of Bagusrai, Bihar.

Application of the model
The Model is helpful to explain different fluvial landforms. The three stages of river, erosional cycles of W M Davis, L C King, W Penk can be easily explained with the help of it.

Name of the Model : Interior of The Earth

Fig.109: Interior of Earth

The interior structure of the earth is composed of three main layers: Crust, Mantle and Core. Crust is the outer most solid part of the earth, about 8-40 km thick. Nearly 1% of the earth's volume and 0.5% of earth's mass are made of the crust. Constituent elements of crust are slice and aluminum(SIAL).Mantle is about 2900 km in thickness. Nearly 84% of the earth's volume 67% of the earth's mass is occupied by the mantle. Constituent elements of the mantle are silicon and magnesium (SIMA). Asthenosphere is situated in the upper mantle. Core is the inner most layer of the earth composed mainly of iron and Nickle (NIFE). Core constitutes nearly 15% of the earth's volume and 32.5% of earth's mass. The inner core is in solid state and the outer core is in the liquid state or semi liquid. Barysphere is sometimes used to refer the core of the earth or sometimes the whole interior.

Indian knowledge about the study of earth can be dated back to 500CE. In the book, Surya Sidhanta written by Varaha during 500CE mentioned about the diameter of the earth calculated as 8000 miles which is very close to modern calculation i.e., 7917.5 miles. It also says about the spherical shape of the Earth.

How to use the Model:

This is the 3D model of the structure of the earth. The physical and chemical properties of each layer and discontinuities be explained and demonstrated. The tectonic events can be explained with the help of properties of these layers.

Name of the Model : Water Cycle

Fig.110: Water cycle

Description:

This model is a 3D model of water cycle made up of paper by the students. The theory of water cycle deals with the understanding of movement of water between the earth and atmosphere in the solid, liquid and gaseous form due to the changes in the pressure and temperature on earth. It is also known as hydrologic cycle or hydrological cycle.

Indian knowledge about hydrological cycle can be dated back to 800BC. India's first poet Mahakavi Valmaki mentioned about the water cycle in his Mahakavya Ramayan on 28th sarga of 4th Kanda of Kishkindha Kanda. To make lay man believe and understand the complex phenomena of nature easily, ancient literatures used to be poetic and metamorphic in nature. In Kishkindha Kanda of Ramayan Rishi Valmiki explains that atmosphere conceives a pregnancy of 9 months by the rays of Sun and rain comes as a child of them between the month of Kaartiika to AaSaaDha, which is roughly from November to July.

Stages of Water Cycle According to Modern Science:

Stage 1: Evaporation- water at the surface turns into water vapors. Waterborne(oceans, seas, lakes) are the main source of evaporation.

Stage2: condensation-At high altitudes water vapour change into very tiny particles of ice/water droplets, known as cloud.

Stage 3: Precipitation – water droplets fall down at the earth in the form of rain due to wind or temperature change.

Stage 4: Runoff-After raining, It flows down towards the oceans and collects in rivers, lakes and streams as well as underground.

How to use the Model:

It can be used to explain the Water Cycle and different stages of the cycle through the demonstration method.

Name of the Model : Structure of Volcano

Fig.111: Structure of volcano

Description:

The study of the Structure of the volcano plays an important role in understanding how the phenomena of volcanism occurs, how it changes the shape of the earth, what is the structure and composition of the interior of the earth, what are the minerals and chemicals it provides and with the help of modern science how its thermal energy can be used to produce energy.

Volcanic eruption is a process in which the molten magma present inside the earth erupts to the surface of the earth by explosive or gentle manner through the vents of volcanoes due to endogenetic pressure like plate tectonics.

The first recorded eruption of the volcano in India dates back to 1787 and it as on Barren Island Since then, the volcano has erupted multiple times. But the knowledge about the eruption of fire from the belly of the earth can be dated back to 400BCE. The author of Mahabharata Krishna Dvaipayana, better known as Vyasa or Vedavyasa mentioned about the characteristics of ocean where he mentioned about **Vadavanal, '**Vadav' means mare and 'anal' means fire in Sanskrit**.** Vadavanala is a mare which breathes fire and stands on the ocean floor or it is fire found in the shape of a mare under the ocean. This submarine fire causes the sea water to evaporate and turn into mist, thus preventing the sea from overflowing on to the land. Just before Pralaya, Vadavagni will burst forth as volcanoes from under the sea and escape. Subsequently the seas will consume the land which will finally consume the current cycle of creation and prepare the

universe for the next cycle of creation. The Ring of Fire, also referred to as the Circum-Pacific Belt, is a path along the Pacific Ocean characterized by most active volcanoes and frequent earthquakes. The majority of Earth's volcanoes and earthquakes take place along the Ring of Fire.

Application of the Model:

The 3D model of the volcano is helpful to understands about the process of Volcanic eruption as well as to develop an understanding about the various important parts of volcano. It will also help the students visualize how an actual volcano looks like and develop a complete understanding about Volcanic eruption.

Name of the Model: Rocks and Minerals

Fig.112: Different types of rocks and minerals

Rocks and minerals are important for learning about earth materials, structure, and systems. Studying these natural objects incorporates an understanding of earth science, chemistry and physics. A Rock is a mineral which is inorganic, solid and natural substance without any specific atomic structure or chemical composition. It is simple to remember that rocks are made up of two or more minerals. Examples of rocks involve limestone, granite, marble, slate and sandstone. Each of these rocks consists of different minerals that can be mixed up with the rock through different geologic processes. Rocks are generally classified based upon the process of its formation. There are three main types of rocks: sedimentary, igneous, and metamorphic. Minerals can be classified as ferrous, non-ferrous, precious stones and metals.

Indian Knowledge about rocks and minerals can be dated back to Indus valley civilization, the Navaratnam and all astrological scripture the most extensive information about Gemstones and their uses have been documented in ancient Hindu Scriptures like the **Garuda Purana and the Agni Purana** which was written by Vedavyas around 800CE.

During the times of the Roman Empire, the author Pliny the Elder noted major stones, which included amethyst, beryl, rock crystal, diamonds and onyx, had been exported from South India. Muziris on the western or Malabar coast became a major South Indian port for the export of gems. In AD 23-79, Pliny wrote, "The rivers that produced the gems are the Chenab and the Ganges, and of the lands that produce them, India is the most prolific." In fact, neither the Ganges or the Chenab produces precious stones, and instead Pliny's references should have alluded to India as a whole.

Application of the Model:

The 3-D Model of the rocks and minerals is helpful to visualize different types of the rocks and minerals with the chemical and physical properties.

Name of the Model: Constellation

Fig.113: Constellation

Description:

A constellation is a group of stars that form a shape or pattern in the sky. In ancient times it was named after God, animals and heroes. There are 88 constellations that are recognized by the International Astronomical Union. Out of which, 42 depict animals, 29 depict inanimate objects and 17 depict humans or mythological characters. Saptarshi or Ursa Major is famous constellation. There are seven stars in this constellation. According to ancient Indian mythology, Saptarshi has been associated with seven well known ancient Indian sages, or rishis. These seven sages who form the Saptarshi, preserve the eternal knowledge of Vedas and explain it to people in every new age.

According to early astrologers, it takes 12 lunar cycles for the sun to return to its original position. Hence twelve constellations were identified that correlated with the progression of the seasons and named them after certain animals or people. These are the twelve Zodiac signs. The Zodiac signs are divided into four groups: Fire, Water, Air and Earth. Fire signs include Sagittarius, Aries and Leo. Water signs include Scorpio, Cancer and Pisces. Air signs include Aquarius, Libra and Gemini. Earth signs include Taurus, Capricorn and Virgo.

Applications:

1. It will help in identifying different constellations in the night sky.
2. It will also help in locating the positions of important constellations in different hemispheres.

Name of the Model: Seasonal Apparatus

Fig.114 : Seasonal apparatus

Description:

In Indian Puranic literatures, there are descriptions of six seasons or ritu in India- Vasant (Spring), Grishma (Summer), Varsha (Monsoon), Sharad (Autumn), Hemant (Pre-winter) and Shishir (Winter) Ritu. Shree Vishnu Puran, Valmiki's Ramayan and Shreemmad Bhagvatam have described the beauty of different seasons in India. Earth rotates on its axis as it orbits the Sun. The axis always points in the same direction. The tilt of the Earth's axis causes change in seasons. There is summer season in the hemisphere tilted towards the Sun and winters in the hemisphere tilted away from the Sun. This is because the hemisphere that is tilted towards the sun receives more insolation than the other. In the month of December, the Sun shines directly on the Southern Hemisphere. Therefore, there is summer in the southern hemisphere and winter in northern hemisphere. In March, the position of the Sun is such that it shines equally in both

the hemispheres. Thus, there is fall in the southern hemisphere and spring in the northern hemisphere. In the month of June, the sun is positioned in the northern hemisphere. This causes summer in the northern hemisphere and winter in the southern hemisphere. In September, the sun shines equally in both the hemisphere. Therefore, there is spring in southern hemisphere and fall in the north of equator.

Applications:

1. It helps in understanding the causes of four seasons: summer, winter, fall (autumn) and spring.
2. It helps in developing concepts about the longest and shortest day in both the hemispheres.

Name of the Model: Phases of the Moon

Fig.115: Different phases of the moon

Description:

Surya Siddhanta, a treatise in Indian astronomy written in 4th or 5thcentury, discusses about the movement of different celestial bodies in the universe. The moon completes its orbit around the earth once in a month. We see moon in its different phases depending upon its position with respect to the Sun. When the moon is positioned between the Earth and the Sun, we face the dark side. Therefore, we are unable to see the moon at all. This is called **new moon**. With the passage of each day, the Earth moves out from its mid position between the Earth and the Sun. This causes appearance of more lighted portion and by the fourth day, it is known as **waxing crescent**. On the seventh day, the moon has moved 90º from the Earth and the Sun. This phase is known as **first quarter**. On tenth day, we are able to see three quarters of the moon which is known as **waxing gibbous** phase. After two weeks, the moon is positioned such that the Earth comes between it and the Sun. This is called as **full moon** as we are now able to see the fully lit side of the moon. Further, in its revolution around the Earth, the moon begins to move into shadow as the **waning gibbous moon** by day eighteen, then the **third quarter half-moon** at the twenty second day, then **waning crescent** at the twenty sixth day and finally the **invisible new moon** again on twenty ninth day.

Application:

1. It develops an understanding about the rotation and revolution of different celestial bodies around its axis and the Sun.
2. It helps to illustrate the different positions of moon in its orbit with respect to the Earth and the Sun.
3. It also helps in illustrating the difference between the planets and stars. Stars have their own light but planets reflects the light received from the Sun.

Name of the Model: Solar and Lunar Eclipse

Fig.116 : Solar and Lunar Eclipse

Description:

In Indian astronomy, the earliest description of eclipse was found in Rig Veda dated between 1700 – 1400 BC. The eclipses are explained as the body less head of Rahu who tried to eat the moon and the Sun because of the enmity. Later in 1499 AD, Aryabhata explained the theory of eclipse based on the transit of moon between Earth and the Sun. An eclipse occurs when the light coming from one object is blocked by other. A solar eclipse occurs when the moon comes between the Earth and the Sun. During this, the moon casts a shadow over the Earth. A solar eclipse happens in the phase of new moon. There are three types of solar eclipse: Annular, Partial and Total solar eclipse. Annular solar eclipse occurs when the moon covers the Sun's center, leaving the outer edges of Sun to form a ring of fire. It happens when the moon is farthest from the Earth. Total solar eclipse happens when the moon completely blocks the face of the Sun. During partial solar eclipse, the moon covers only a part of Sun. When the earth comes in between the Sun and the moon, there is lunar eclipse. It can occur during full moon. There can be three types of lunar eclipse – total lunar eclipse, partial lunar eclipse and penumbral lunar eclipse. Total lunar eclipse occurs when the moon is completely into the umbra, total shadow of the Earth. Partial lunar eclipse happens when the moon is not completely moved into the umbra. Penumbral lunar eclipse occurs when the moon passes through the penumbra of the Earth.

Applications:

It helps in demonstrating the relative positions of moon, earth and the Sun during an eclipse.

Name of the Model: Solar System

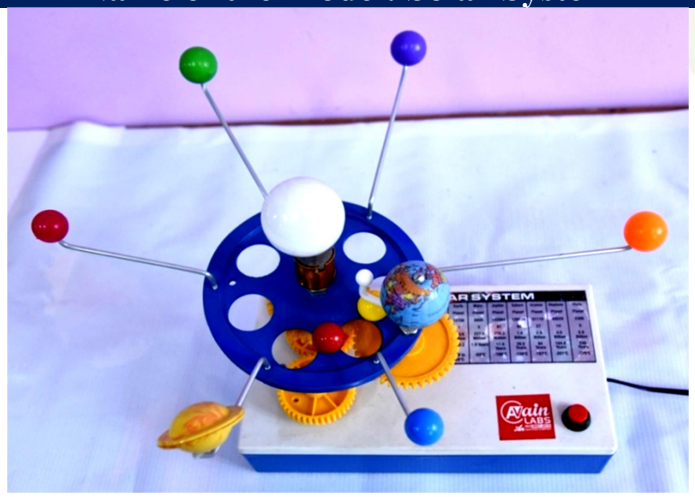


Fig.117: Solar System

Description:

The Indian astronomer, Aryabhatta, in his magnum opus Aryabhatiya has propounded about the heliocentric model of the solar system. It states that all other planets revolves around the Sun. It is opposite of the Geocentric model of the Solar System. The congregation of stars and planets is known as Solar System. The Sun, largest body, is in the center of the solar system. It consists of eight planets, namely, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Besides, there are moons, dwarf planets, asteroids, meteorites and comets. All these bodies revolve around the Sun almost in the same plane and same direction along elliptical orbits. The Earth is about 149600000 km away from the Sun. The planets in the solar system are classified into two groups – planets of the inner circle (Terrestrial Planets) and planets of the outer circle (Giant Planets). The inner circle have smaller and denser bodies while the outer circle have large size and less dense materials. Mercury, Venus, Earth and Mars constitute the inner circle. Outer circle is comprised of Jupiter, Saturn, Uranus and Neptune. Our solar system is a small part of the system of stars collectively known as Milky Way Galaxy.

Applications:

1. It helps understand the difference between the heliocentric and geocentric models of the Solar System.:
2. It helps in visualizing the relative sizes of planets and the Sun
3. It also demonstrates the planets' relative positions and motions in the Solar System.

Resource Centre, RIE (NCERT), Bhubaneswar

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Theme Park

Model Name - Angular Momentum

Any object in motion is associated with its momentum. As the moving object has a certain direction along with its magnitude, momentum is a vector entity. Momentum is classified into two types such as linear momentum and angular momentum.

(Demonstration of Angular Momentum)

The linear momentum of an object is equal to the mass of the object multiplied by its velocity (p=mv). It is described by Newton's Second Law of Motion which states that the rate of change of momentum is equal to the net force acting on the object.

Angular momentum (rotational momentum) is the rotational analog of linear momentum. Angular momentum is represented by $L = r \times p$, where r is the object's position relative to its origin and p is the linear momentum. Unlike linear momentum, angular momentum depends on where this origin is chosen since the particle's position is measured from it.

Angular momentum also represents the product of a body's rotational inertia (moment of inertia) and rotational velocity (angular velocity) about a particular axis (L = Iw). The moment of inertia depends on the body's mass distribution and the axis chosen, with larger moments requiring more torque to change the body's rotation rate. One can explain angular momentum by a simple example considering pedalling a bicycle. We will fall off if we try to get on a bicycle and balance without a kickstand. But once we start pedalling, these wheels pick up angular momentum, thereby making balancing will be easier.

Difference between Linear and Angular Momentum :

	Linear momentum	Angular momentum
Definition	Product of mass and its velocity	Rotational analog of linear momentum. Product of moment of inertia and angular speed
Application	An object moving in a direct path	An object moving in an angular motion
Equation	$p = mv$	$L = r \times p$, $L = Iw$
Units	Kg m/s	Kg m^2 rad/s
Changing momentum	Force is required to change the linear momentum	Torque is required to change the angular momentum

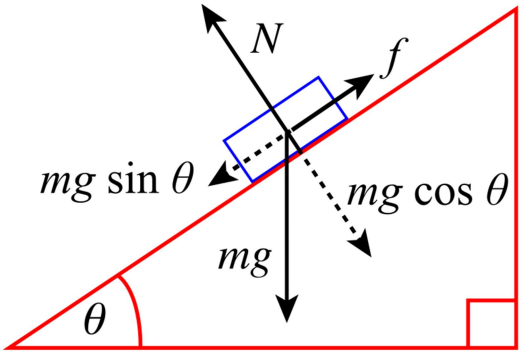
Model Name – Inclined Plane

An inclined plane is a simple arrangement (ramp) that consists of a flat supporting surface tilted at an angle, with one end higher than the other. They are used to raise and lower a load over a vertical obstacle. One significant advantage is an inclined plane requires less force to move an object than lifting it straight up, at the cost of an increased distance. The mechanical advantage of an inclined plane, the factor by which the force is reduced, is equal to the ratio of the length of the sloped surface to the height it spans.

(Demonstration of pulling bodies at different inclined plane)

Inclined planes are widely used as loading ramps to load and unload goods on trucks, ships and planes. Wheelchair ramps allow people in wheelchairs to get over vertical obstacles without exceeding their strength. Escalators and slanted conveyor belts are also forms of an inclined plane.

When an object rests on a horizontal surface, a normal force supports it equal in magnitude to its weight. Until now, we dealt only with normal force in one dimension, with gravity and normal force acting perpendicular to the surface in opposing directions (gravity downward and normal force upward).



When an object rests on an inclined plane that makes an angle θ with the horizontal, the force of gravity acting on the object is divided into two components: A force acting perpendicular to the plane and a force acting parallel to the plane. The perpendicular force is equal to the normal force but in the opposite direction. The force parallel to the plane causes the object to accelerate down the inclined surface.

Model Name -Friction and Speed

When a body is in motion, it has resistance as it interacts with its surroundings. Therefore, friction is a resisting force that opposes relative motion between systems in contact. Friction always opposes the motion and reduces the speed at which the object moves on the surface. It will turn some of the kinetic energy of an object into heat energy, thereby reducing the speed. Friction is not itself a fundamental force. It arises from inter-surface adhesion, surface roughness, contamination, and surface deformation. Friction is also a non-conservative force, i.e. work done is path-dependent. In friction, some kinetic energy is always transformed into thermal energy, so mechanical energy is not conserved.

There are several forms of friction. One of the simpler characteristics of sliding friction is that it is parallel to the contact surfaces and is always in a direction that opposes the motion of the systems relative to each other. If two systems are in contact and moving relative to one another, then the friction between them is called kinetic friction. When objects are stationary, static friction can act between them. Static friction is usually greater than the kinetic friction between two objects.

(Demonstration of effect of friction on speed of a ball)

Static friction keeps the box from moving without being pushed, and it must be overcome with a sufficient opposing force before the box will move. Kinetic friction (also known as dynamic friction) is the force that resists the relative movement of the surfaces once they're in motion.

For example, if the tire rolls along so that the surface touching the ground never slides, then static friction slows the car. If the wheels are locked and sliding, kinetic friction slows the car.

Friction has many applications in day-to-day life. Friction is used to heat and ignite matchsticks. It has many applications in household usage and transportation.

Model Name - Revolving Periscope

A periscope is an instrument for observation over, around or through an object, obstacle or condition that prevents direct line-of-sight observation from an observer's current position. It is used in land and sea warfare, submarine navigation, and elsewhere to enable an observer to see his surroundings while remaining under cover, behind amours.

(Demonstration of Periscope)

In its simplest form, the periscope consists of an outer case with mirrors at each end set parallel at a 45° angle. This form of periscope, with the addition of two simple lenses, served for observation purposes in the trenches during World War I. Military personnel also use periscopes in some gun turrets and armoured vehicles.

More complex periscopes using prisms or advanced fibre optics instead of mirrors and providing magnification operate on submarines and in various fields of science. The overall design of the classical submarine periscope is very simple: two telescopes pointed at each other. If the two telescopes have different individual magnifications, their difference causes an overall magnification or reduction. The arc of vision is limited by the simple geometry of the tube: the longer or narrower the tube, the smaller the field of view.

Periscopes have been extensively used in many fields for observation purposes. Tanks and armoured vehicles used periscopes as observation devices for the drivers, commanders, and other vehicle occupants. It has also been used for naval purposes. Periscopes allow a submarine to search visually for nearby targets and threats on the water's surface and in the air.

Crystal Structure

Most solids are made of crystals. The three-dimensional arrangement of atoms, molecules or ions inside a crystal is known as a crystal lattice. A unit cell is the building block of a crystal lattice, the smallest repeating unit of the crystal lattice.

There are three types of the unit cell:

a) Primitive or Simple Cubic Unit cell:

The simplest repeating Unit in SCC (Simple Cubic Unit Cell) is shown in the Figure. Each corner of the unit cell is defined by a lattice point at which an atom, ion or molecule can be found in the crystal. Every atom in the corner is shared among 8 adjacent unit cells. It is an open structure.

(Demonstration of simple cubic crystal structure)

There are 8 atoms at the corners. The total number of atoms in one unit cell is $8 \times 1/8 = 1$ atom. An example of an SCC unit cell is Polonium.

b) Body-Centred cubic unit cell:

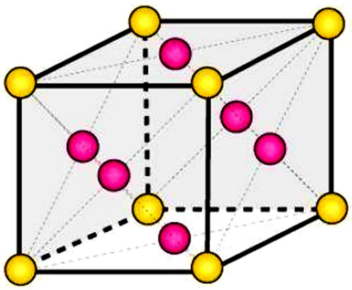
The simplest repeating unit in BCC (Body- centred cubic unit cell) is shown in Figure. In this structure, there are eight identical particles on the eight corners of the unit cell and one at the centre of the body of the unit cell. It is an open structure.

(Demonstration of body centred cubic crystal structure)

The total number of atoms in one unit cell is $8 \times 1/8 + 1 = 2$ atoms. An example of BCC unit cell is Iron, Chromium and Tungsten.

c) Face-Cantered Cubic Unit Cell:

As shown in the Figure, the simplest repeating unit in FCC (Face-centred Cubic Unit Cell) is a closest-packed structure. It contains atoms at all the corners of the crystal lattice and the centre of all the faces of the cube. The atom presented at the face- centered is shared between 2 adjacent unit cells, and only ½ of each atom belongs to a cell.



(Demonstration of face-centred cubic crystal structure)

The total number of atoms in one unit cell:

$8 \times 1/8 + 6 \times 1/2 = 1+3 = 4$ atoms.

An example of FCC unit cell is Copper, Gold and Aluminum.

DNA

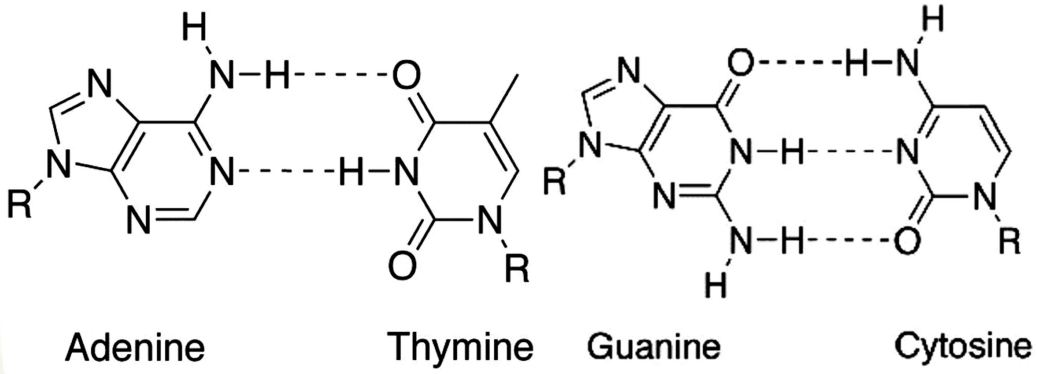
Nucleic acids are the organic material in all organisms in the form of DNA or RNA. These nucleic acids are formed by combining nitrogenous bases, sugar molecules, and the phosphate group linked by different bonds in a sequence. DNA, deoxyribonucleic acid, is an organic chemical of complex molecular structure found in cells and viruses.

(Demonstration of DNA)

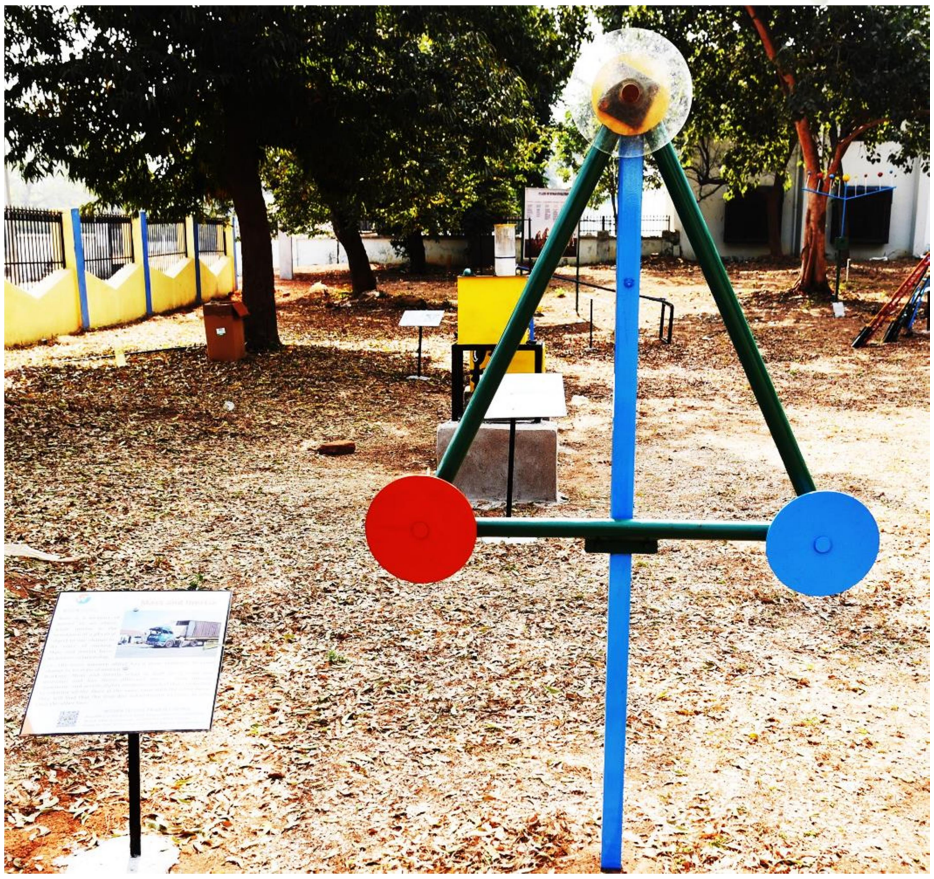
DNA is made up of molecules called nucleotides. Each nucleotide contains a phosphate group, a sugar group and a nitrogen base. The four types of nitrogen bases are Adenine (A), thymine (T), guanine (G) and cytosine (C).

Nucleotides are attached together to form two long strands that spiral to create a structure called a double helix.

If you consider a double helix as a ladder, the phosphate and sugar molecules would be the sides, while the bases would be the rungs



MASS & INERTIA



(Demonstration of Mass and Inertia)

Newton's first law of motion states that "An object at rest stays at rest, and an object in motion stays in motion with the same speed and the same direction unless acted upon by an unbalanced force." The tendency to resist change in their state of motion is described as inertia.

All objects resist changes in their state of motion. All objects have this tendency- they have inertia. But do some objects have more of a tendency to resist changes other than others? If yes, the tendency of an object to resist changes in its state of motion varies with mass. Mass is that quantity solely dependent upon an object's inertia. A more object has a greater tendency to resist changes in its state of motion

PYTHAGORAS THEOREM

Pythagoras' theorem states, "In a right-angled triangle, the square of the hypotenuse side is equal to the sum of squares of the other two sides".

The sides of this triangle have been named Prep. (Perpendicular), Base and Hypotenuse. The hypotenuse is the longest side, and it's always opposite to the right angle.

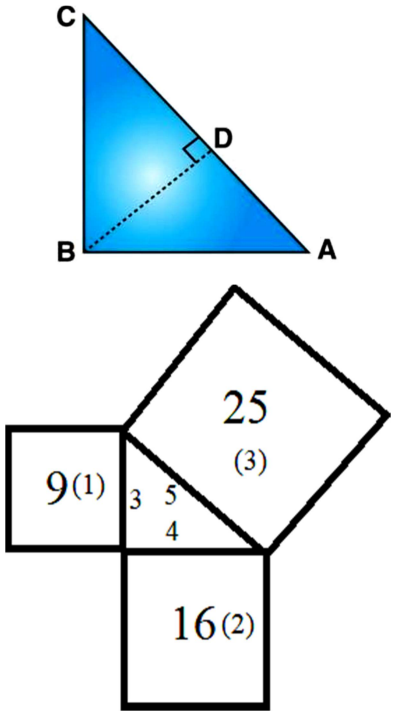
$h^2 = p^2 + b^2$

$AB^2 + BC^2 = CA^2$

We can determine whether the triangle shown is a right triangle.

Area of square (1) + Area of square (2)
= Area of square (3)

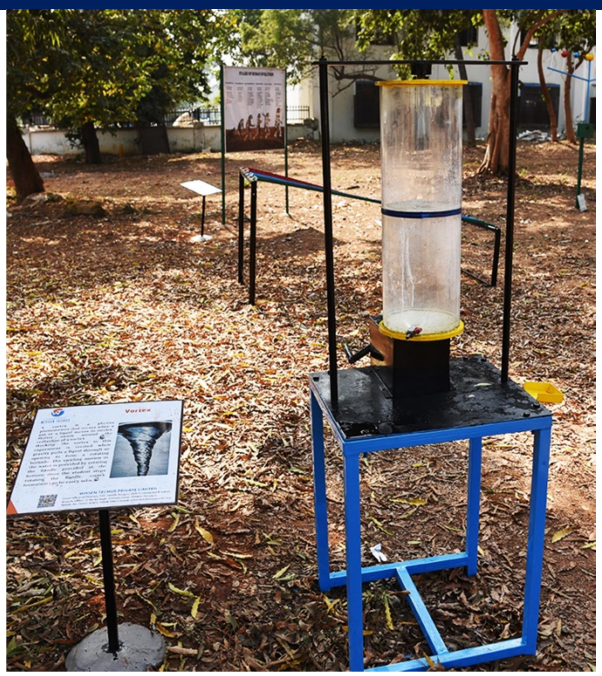
If it is true, the triangle formed by the sides of these squares will be a right-angle triangle.



(Demonstration of Pythagoras theorem)

VORTEX

A vortex is a physical phenomenon that occurs when a gas or a liquid move in circles. At the centre is a vortex line that the matter swirls around. They are formed when there is a difference in the velocity of what surrounds the line. Hurricanes, tornadoes and air moving over a plane wing are an example of vortices.



(Demonstration of Vortex Formation)

In short, A vortex is a fluid that revolves around the axis line. This fluid might be curved or straight. Vortices form from stirred fluids: they might be observed in smoke rings, whirlpools, in the wake of a boat or in the winds around a tornado or dust devil.

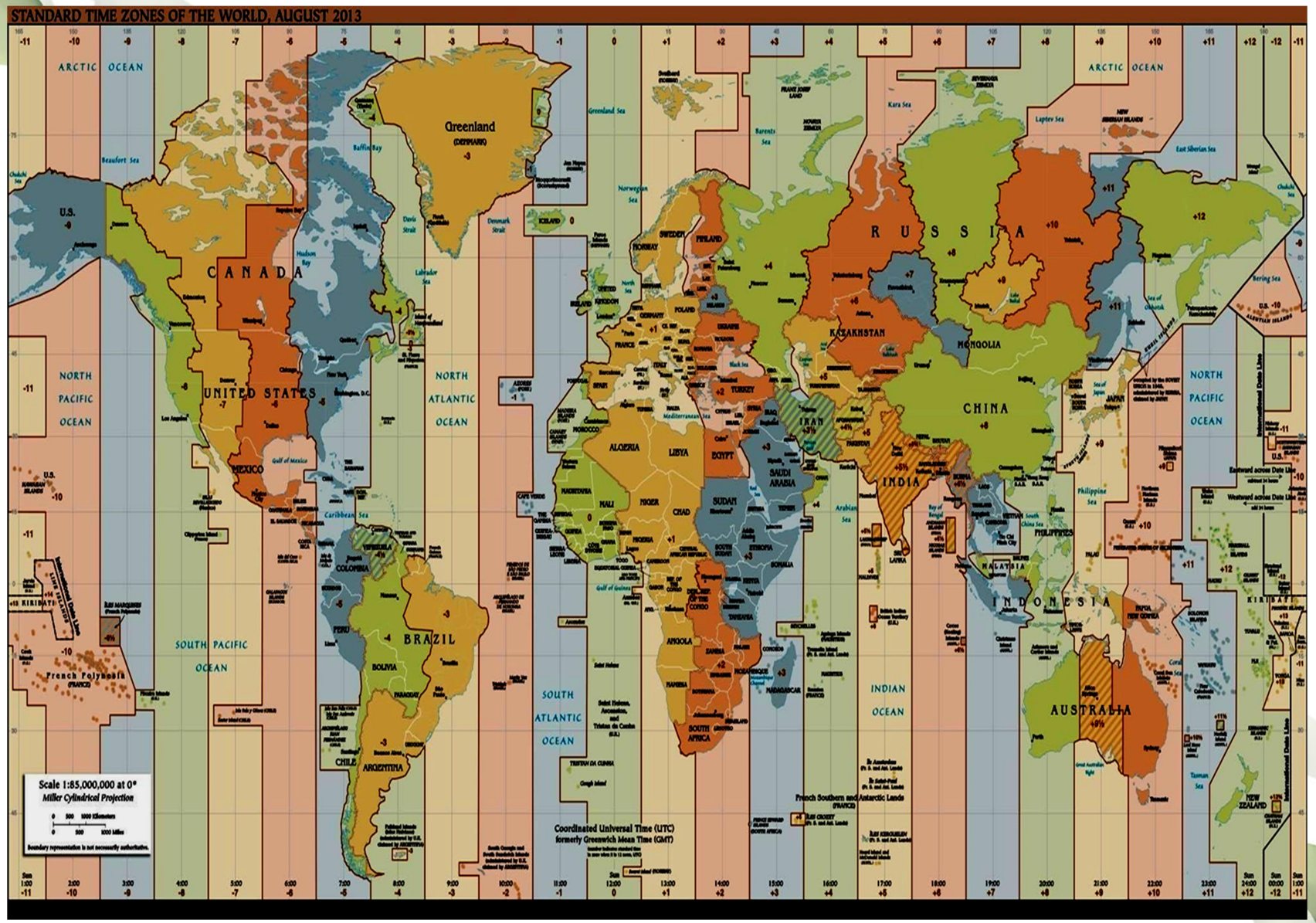
WORLD GLOBE TIME

Time zones give specific Areas on the Earth a time of day that is earlier or later than the neighbouring time zones. This is because when it is daytime on one side of the Earth, it is night-time on the other side. A time zone is a region where the same standard time is used. The local time within a time zone is defined by its offset from Coordinated Universal time (UTC), the world's time standard. Time zone is a geographical world globe division of 15^0 each, starting at Greenwich, in England, created to help people know what time it is now in another part of the world. The Earth has been divided into 24 time zones of one hour each. Each zone thus covers 15^0 of longitude. GMT began in 1675.

(Demonstration of Geographical World Globe)

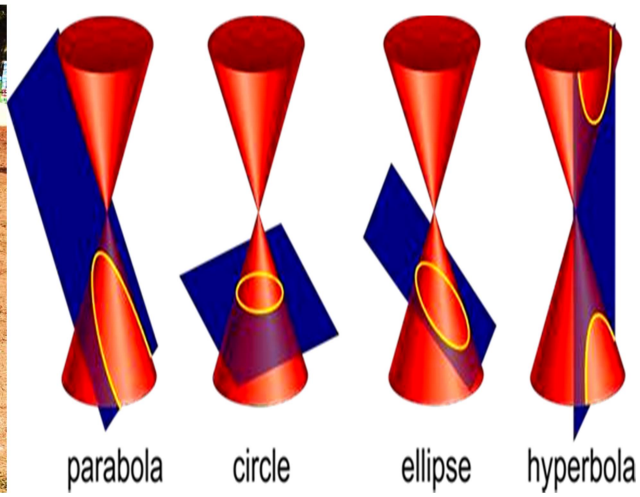
How to Calculate?

The Earth rotates 360^0 in about 24 hours, which means 15^0 an hour or 1^0 in four minutes. Thus, when it is noon at Greenwich, the time at 15^0 east of Greenwich will be 15×4 = 60 minutes, i.e., 1 hour ahead of Greenwich Time, but at 15^0 west of Greenwich, the time will be behind Greenwich Time by one hour.


STANDARD TIME ZONES OF THE WORLD, AUGUST 2013
ARCTIC OCEAN
Greenland
(DENMARK)
U.S.
CANADA
UNITED STATES
MEXICO
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
RUSSIA
KAZAKHSTAN
MONGOLIA
CHINA
IRAN
INDIA
SAUDI ARABIA
ALGERIA
LIBYA
EGYPT
SUDAN
NIGERIA
ETHIOPIA
SOMALIA
BRAZIL
COLOMBIA
PERU
BOLIVIA
CHILE
ARGENTINA
AUSTRALIA
INDONESIA
PHILIPPINES
MALAYSIA
NEW ZEALAND
JAPAN
Scale 1:85,000,000 at 0°
Miller Cylindrical Projection
Coordinated Universal Time (UTC)
formerly Greenwich Mean Time (GMT)

STRAIGHT BAR PASSING PARABOLA

A curve generated by intersecting a right circular cone with a plane is termed a 'conic'. These conic sections are one of the important topics in geometry. Different types of conic sections in math can be defined based on the angle formed between the plane and the intersection of the right circular cone with it.

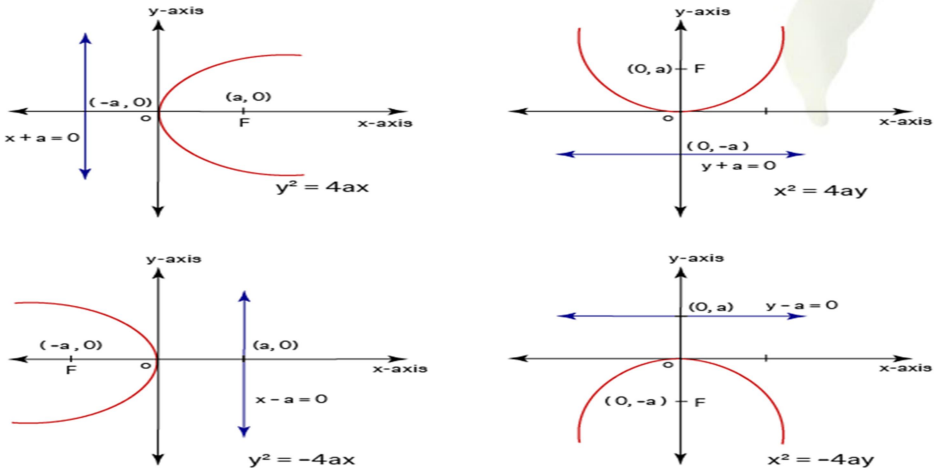


(Demonstration of generation of parabola, circle ellpse and hyperbola)

In the above Figure, we can see how the different conic sections are formed. The formulation of a different kind of geometry depends upon the angle of the intersection plane. A plane perpendicular to the cone's axis cuts out a circle; a plane parallel to a side of the cone produces a parabola; a plane at an arbitrary angle to the cone's axis forms an ellipse, and a plane parallel to the axis cuts out a hyperbola. If we extend the cone through its vertex and create a second cone, you find the second branch of the hyperbola. All these curves can be described as graphs of second-degree equations in two variables.

A conic section can also be described as the locus of a point P moving in the plane of a fixed point known as focus and a fixed line known as directrix in such a way that the ratio of the distance of a point from focus to its distance is a constant is known as eccentricity. Now,

- If eccentricity, e = 0, the conic is a circle
- If $0<e<1$, the conic is an ellipse
- If $e=1$, the conic is a parabola
- And if $e>1$, it is a hyperbola



PLANCK'S LAW

Heat is transferred from one place to another by three modes – Conduction, Convection and radiation. Heat transfer through radiation occurs in electromagnetic waves, mainly in the infrared region. Radiation emitted by a body results from the thermal agitation of its composing molecules.

(Demonstration of Planck's Law)

In radiation, bodies are categorised based on the absorption and reflection of radiation. Three types of bodies are known: Black, grey, and White. These names of bodies do not indicate colours. However, it indicates complete, partial and no absorption, respectively.

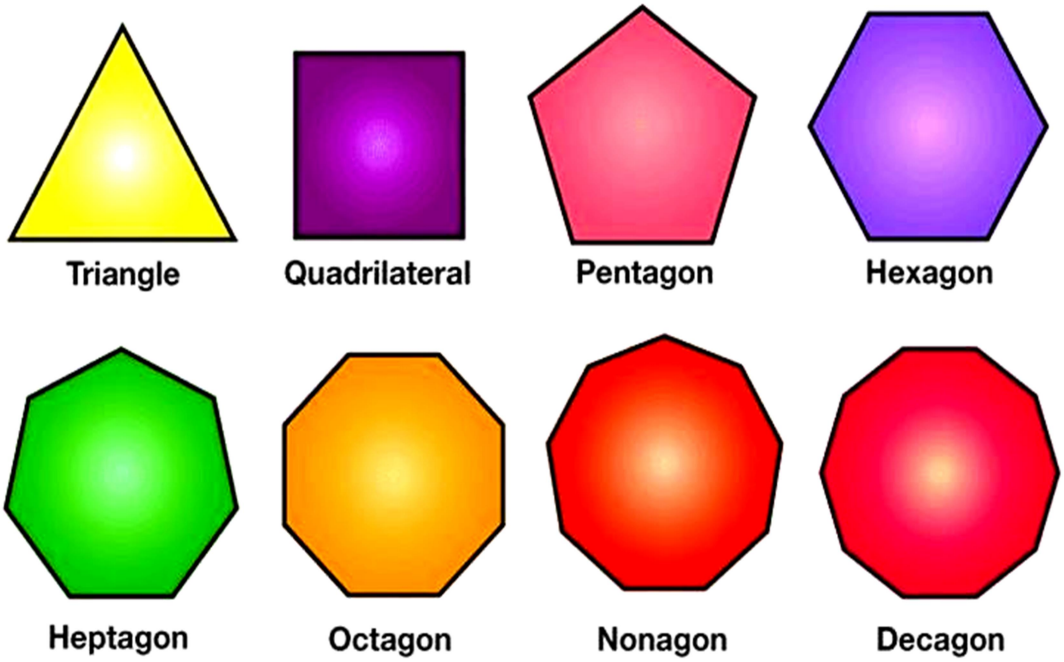
The black body absorbs all radiation that falls on its surface. Actual black bodies don't exist in nature. The emission spectrum of such a black body was first fully described by Max Planck. A black body is a hypothetical body that completely absorbs all wavelengths of thermal radiation incident on it.

Planck's radiation law, a mathematical relationship formulated in 1900 by German physicist Max Planck to explain the spectral-energy distribution of radiation emitted by a blackbody (a hypothetical body that completely absorbs all radiant energy falling upon it, reaches some equilibrium temperature, and then reemits that energy as quickly as it absorbs it).

POLYGON FAMILY TREE

A polygon is a closed shape with straight sides. Rectangles, triangles, hexagons, and octagons are all examples of polygons. The segments of a polygonal circuit are called its edges or sides. The points where twoedges meet are the polygon's vertices (singular: vertex) or corners.

Examples of some polygons are



(Demonstration of different polygons)

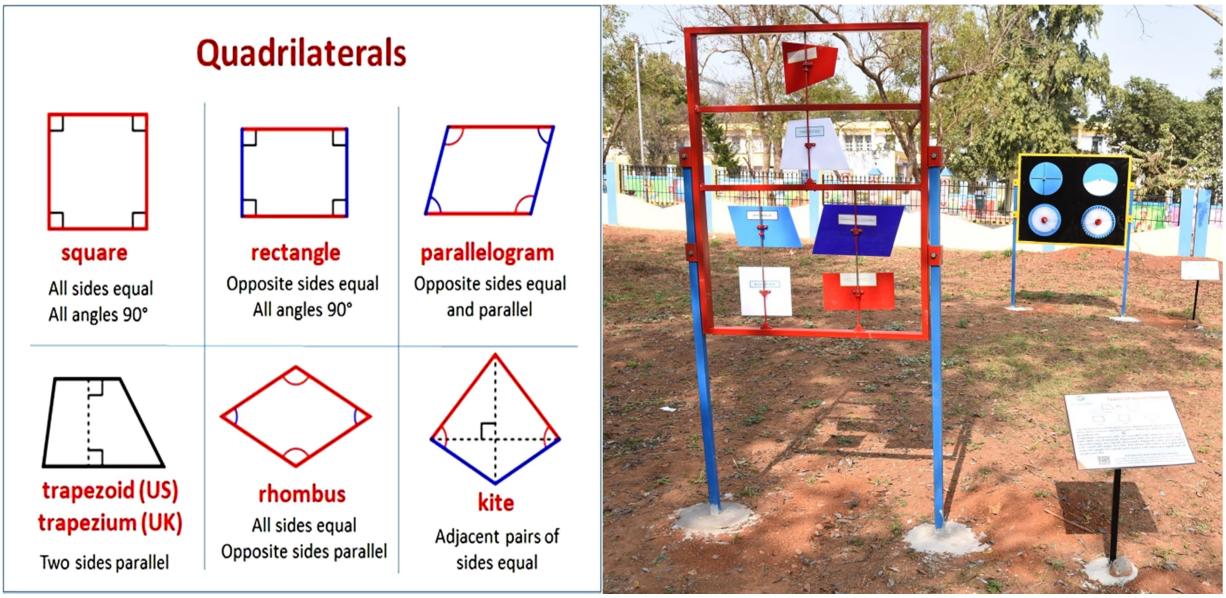
Quadrilaterals and triangles are very common figures that we can easily find. All polygons can be further classified based on their orientation, angles and side lengths. So, here we study a bit more about the quadrilateral.

Types of Quadrilaterals

A quadrilateral is a closed shape and polygon with four sides, four vertices and four angles. It is formed by joining four non-collinear points. The sum of the interior angles of quadrilaterals is always equal to 360 degrees.

The list of types of quadrilaterals are:

1. Trapezium
2. Parallelogram
3. Square
4. Rectangle
5. Rhombus
6. Kite



(Demonstration of types of quadrilaterals)

HYDROELECTRIC PLANT

(Demonstration of hydroelectric planet)

There are two major categories of energy: renewable and non-renewable.

Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The advantage of these non-renewable resources is that power plants can produce more power on demand. The non-renewable energy resources are:

- Coal
- Nuclear
- Oil
- Natural gas

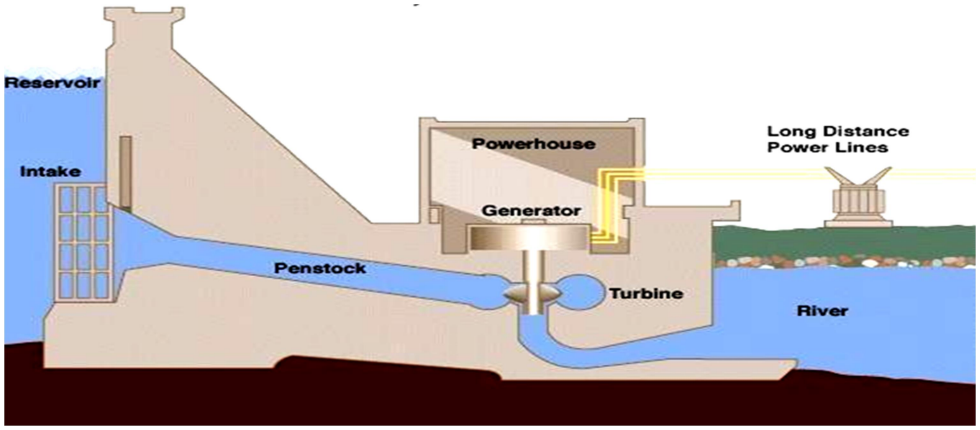
Renewable resources, on the other hand, replenish themselves. The five major renewable energy resources are:

- Solar
- Wind
- Water, also called hydro
- Biomass, or organic material from plants and animals
- Geothermal, which is naturally occurring heat from the Earth

Hydroelectric power is one of the most common renewable sources of energy. In 2020 hydropower generated one-sixth of the world's electricity, almost 4500 KWh, which was more than all other renewables combined. There are four different methods to generate electricity from water:

1. Conventional method (Dams)
2. Pumped-Storage
3. Run-of-the-river
4. Tide

In the conventional method, water is collected or stored at a higher elevation and led downward through large pipes or tunnels (penstocks) to a lower elevation; the difference in these two elevations is known as the head. At the end of its passage down the pipes, the falling water causes turbines to rotate. The turbines, in turn, drive generators, which convert the turbines' mechanical energy into electricity. Transformers are then used to convert the alternating voltage suitable for the generators to a higher voltage suitable for long-distance transmission. The structure that houses the turbines and generators, and into which the pipes or penstocks feed, is called the powerhouse.



(Hydroelectric Dam)

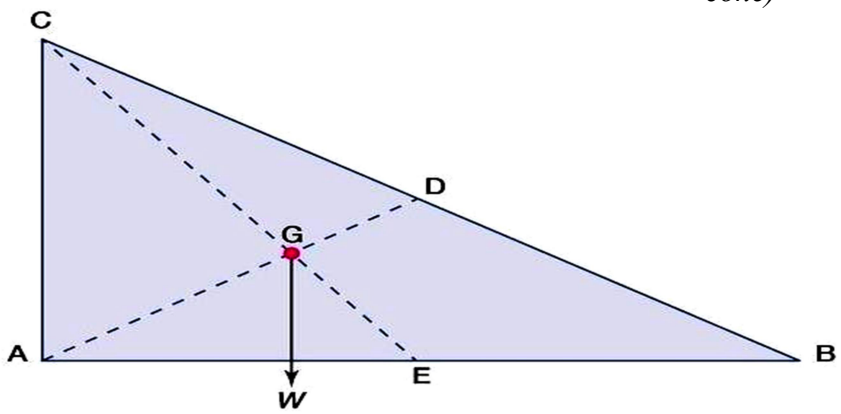
Advantages of hydroelectric power :

- Fuel is not burned, so there is minimal pollution
- Water is a natural, renewable resource
- Reduced greenhouse gas emissions
- Relatively low operations and maintenance costs
- Technology is reliable and proven

DOUBLE ENDED CONE

The centre of gravity is a geometric property of any object. The centre of gravity is the average location of the weight of an object. We can completely describe the motion of any object through space in terms of the translation of the centre of gravity of the object from one place to another and the rotation of the object about its centre of gravity if it is free to rotate

(Demonstration of rolling of a double ended cone)



GEAR, BELT AND CHAIN DRIVE

A Gear is a machine component used to transmit mechanical power from one shaft to another by successfully engaging its teeth. Gears are one of the most used methods of mechanical power transmission in machines. Power transmission by the gears has almost 100% efficiency. Different types of Gears are Spur gear, Helical gear, Bevel gear, Worm gear, Rack and pinion gear

(Demonstration of gear system)

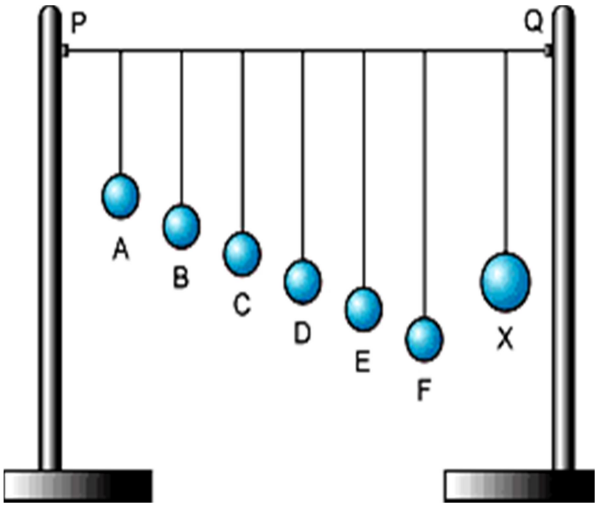
BARTON PENDULUM

A pendulum is a body suspended from a fixed point so it can swing back and forth under gravity. Pendulums regulate movement because the interval of time for each complete oscillation, called the period, is constant. The formula for the period T of a pendulum is T = 2π Square root of√L/g, where L is the length of the pendulum and g is the acceleration due to gravity.

(Demonstration of Barton pendulum)

Different types of pendulums have different applications. Examples of simple pendulums are found in clocks, swing sets, and even the natural mechanics of swinging legs. Tetherballs are examples of spherical pendulums. Schuler pendulums are used in some inertial guidance systems, while certain compound pendulums have applications in measuring the acceleration of gravity.

A simple pendulum consists of a bob suspended at the end of a thread that is so light as to be considered massless. The period of such a device can be made longer by increasing its length, as measured from the point of suspension to the middle of the bob. However, a change in the bob's mass does not affect the period, provided the length is not thereby affected.



Prof. Edwin Henry Barton (1858-1925), a professor of Physics, who had a particular interest in the movement and behaviour of spherical bodies, first demonstrated Barton's pendulums which show the physical phenomenon of resonance and the response of pendulums to vibration at, below and above their resonant frequencies. In its most straightforward construction,

approximately 4-10 pendulums are hung from one standard string. This system vibrates at the resonance frequency of a driver pendulum (X), causing the target pendulum to swing with the maximum amplitude. The other pendulums to the side do not move as well, thus demonstrating how torquing a pendulum at its resonance frequency is most efficient.

Human Evolution

Anthropology is the study of human evolution and culture. It deals with fossils, prehistoric and living man.

Dryopithecus :

- Dryopithecus or proconsul was a fossil ape from Miocene (Asia and Africa).
- It is believed to be the ancestor of today's hominoids, i.e. apes and humans.
- Age – 25 million years ago (Miocene)
- Brain and skull- large and muzzle skull, front coming jaws
- Teeth –large and strong canines incisors, molar is square
- Diet – soft fruits and leaves.
- Posture -knuckle walker, small body, small head, low developed eyebrows
- Significance-earliest fossil ape persisted until 10 million years ago.

Ramapithecus :

- G.E. Lewis discovered from Shivalik hills of India. These are ape-like on the tree tops.
- Age – 1,00,00,000 years ago (Pliocene)
- Brain and skull- having deep jaws
- Teeth – small canines, flattened molars
- Diet- seed and nuts
- posture- partially upright
- Significance-earliest hominid ground dwelling

Australopithecus :

- Commonly called a southern ape. They became extinct about 1 million years ago.
- It resembles a chimpanzee in many cases.
- Age – 40,00,000 years ago (Pleistocene)
- Brain and skull- larger jaws and having brain capacity near about 450/cm2
- Teeth –small canines and incisors
- Diet and posture-herbivorous in nature hand having fully erect posture, height about 4 feet tall and weight of about 60-90 pounds
- Significance- still at home in trees but savannah dwellers.

Homohabilis :

- Also called a skilful human or handyman. They are the first probable fossil man that makes tools. (tool makers)
- Age – 20,00,000 years ago
- Brain –having lighter jaws and bearing brain capacity near about 700 /cm2
- Teeth –small canines
- Diet-omnivorous
- Posture-fully erect and height about feet tall
- Significance-earliest stone tools, begin hunting for meat

Homo Erectus :

- Age –15,00,000 years ago
- Brain and skull- having thick, low forehead and brain capacity neat about 900/cm2
- Teeth –small canines
- Diet and posture- carnivorous and height about 5-6 feet tall
- Significance-beginning of cultural evolution, making and using stone tools, prominent speech, rudimentary language, use of fire

Homo Sapiens :

- Age - 1,50,000 years ago
- Brain skull- shorter skull, reduced jaws, and brain is large than moderate man and has capacity near about 1360/cm2
- Teeth – teeth closer together, bears wisdom teeth
- Diet- omnivorous
- posture- 5-6 feet tall
- Significance- powerful and muscular body, hunter, cave dweller, cave paintings.

(Demonstration of Stages of Human Evolution)

ANGLE DEMONSTRATOR

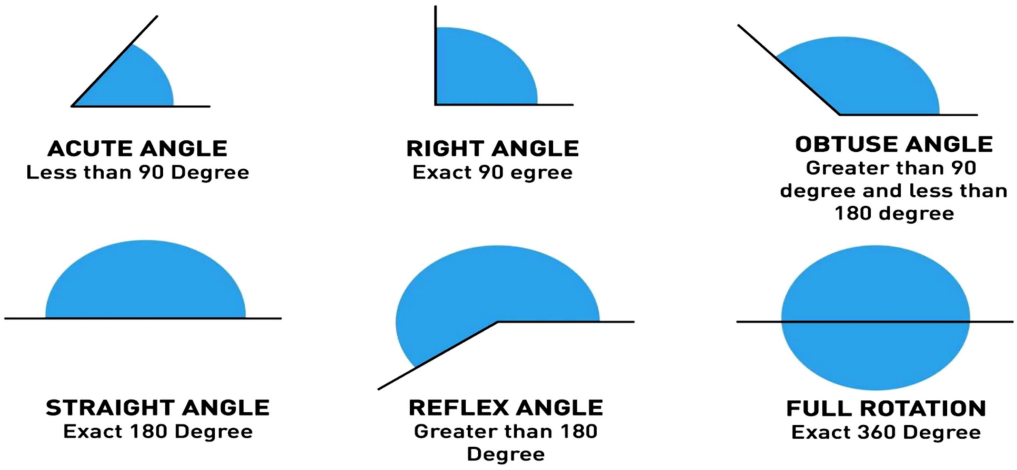
An angle is formed when two straight lines or rays meet at a common endpoint. The common point of contact is called the vertex of an angle.

The angles are classified under the following types:

- Acute Angle – an angle measure less than 90 degrees
- Right Angle – an angle is exactly at 90 degrees
- Obtuse Angle – an angle whose measure is greater than 90 degrees and less than 180 degrees
- Straight Angle – an angle which is exactly at 180 degrees

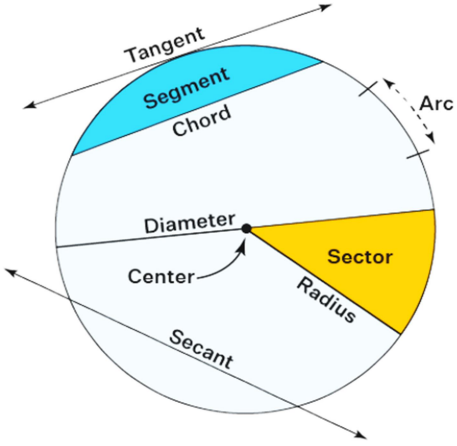
(Demonstration of Plane)

- Reflex Angle – an angle whose measure is greater than 180 degrees and less than 360 degrees
- Full Angle – an angle whose measure is exactly at 360 degrees



PARTS OF CIRCLE

A circle can be defined as a 2D figure formed by a set of points that are adjacent to each other and are equidistant from a fixed point.



(Demonstration Parts of Circle)

The radius of a circle is the length of the line segment joining the center of the circle to any point on the circumference of the circle. A circle can have many radii (the plural form of radius) and they measure the same.

The diameter of a circle is a line segment that passes through the center of the circle and with endpoints that lie on the circumference of a circle. The diameter is also known as the longest chord of the circle and is twice the length of the radius.

A chord of a circle is a line segment that joins two points on the circumference of the circle. A chord divides the circle into two regions known as the segment of the circle which can be referred to as minor segment and major segment depending on the area covered by the chord.

The tangent of a circle is defined as a straight line that touches the curve of the circle at only one point and does not enter the circle's interior. The arc of a circle is the curved part or a part of the circumference of a circle.

A segment of a circle is the region that is bounded by an arc and a chord of the circle. There are two types of segments - minor segment and major segment. A minor segment is made by a minor arc and a major segment is made by a major arc of the circle.

A sector of a circle is a pie-shaped part of a circle made of the arc along with its two radii dividing the circle into a minor sector and a major sector. The larger portion of the circle is called the major sector whereas the smaller portion of the circle is called the minor sector.

TRIGNO TOWER

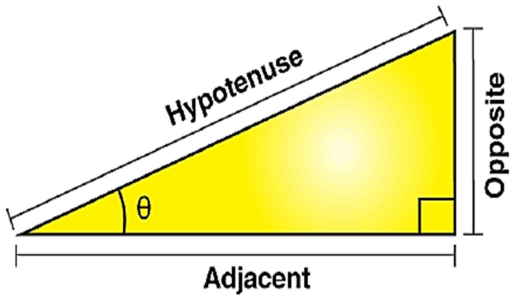
Trigonometry is one of the important branches in the history of mathematics that deals with the study of the relationship between the sides and angles of a right-angled triangle. This concept is given by the Greek mathematician Hipparchus. The branch called "Trigonometry" basically deals with the study of the relationship between the sides and angles of the right-angle triangle. Hence, it helps to find the missing or unknown angles or sides of a right triangle using the trigonometric formulas, functions or trigonometric identities.

(Demonstration of Trigno Tower)

The trigonometric ratios of a triangle are also called the trigonometric functions. Sine, cosine, and tangent are 3 important trigonometric functions and are abbreviated as sin, cos and tan. Consider a right-angled triangle, where the longest side is called the hypotenuse, and the sides opposite to the hypotenuse are referred to as the adjacent and opposite sides.

The six important trigonometric functions (trigonometric ratios) are calculated using the below formulas and considering the above figure.

Functions	Abbreviation	Relationship to sides of a right triangle
Sine Function	sin	Opposite side/ Hypotenuse
Tangent Function	tan	Opposite side / Adjacent side
Cosine Function	cos	Adjacent side / Hypotenuse
Cosecant Function	cosec	Hypotenuse / Opposite side
Secant Function	sec	Hypotenuse / Adjacent side
Cotangent Function	cot	Adjacent side / Opposite side



TYPES OF QUADRILATERALS

A quadrilateral is a closed shape and a type of polygon that has four sides, four vertices and four angles. It is formed by joining four non-collinear points. The sum of interior angles of quadrilaterals is always equal to 360 degrees.

The types of quadrilaterals are defined based on the measure of the angles and lengths of their sides. The list of types of quadrilaterals are:

Properties of Trapezium

- Only one pair of the opposite side of a trapezium is parallel to each other
- The two adjacent sides of a trapezium are supplementary (180 degrees)
- The diagonals of a trapezium bisect each other in the same ratio

Parallelogram Properties

- The opposite side of the parallelogram are of the same length
- The opposite sides are parallel to each other
- The diagonals of a parallelogram bisect each other

- The opposite angles are of equal measure
- The sum of two adjacent angles of a parallelogram is equal to 180 degrees

Rhombus Properties

- All the four sides of a rhombus are of the same measure
- The opposite sides of the rhombus are parallel to each other
- The opposite angles are of the same measure
- The sum of any two adjacent angles of a rhombus is equal to 180 degrees
- The diagonals perpendicularly bisect each other

Rectangle Properties

- The opposite sides of a rectangle are of equal length
- The opposite sides are parallel to each other
- All the interior angles of a rectangle are 90 degrees.
- The diagonals of a rectangle bisect each other

Square Properties

- All the sides of the square are of equal measure
- The sides are parallel to each other
- All the interior angles of a square are at 90 degrees (i.e., right angle)
- The diagonals of a square perpendicular bisect each other

Quadrilateral	Properties
Rectangle	4 right angles and opposite sides equal
Square	4 right angles and 4 equal sides
Parallelogram	Two pairs of parallel sides and opposite sides equal
Rhombus	Parallelogram with 4 equal sides
Trapezoid	Two sides are parallel

(Demonstration of ypes of Quadrilaterals)

TIME DEMONSTRATOR

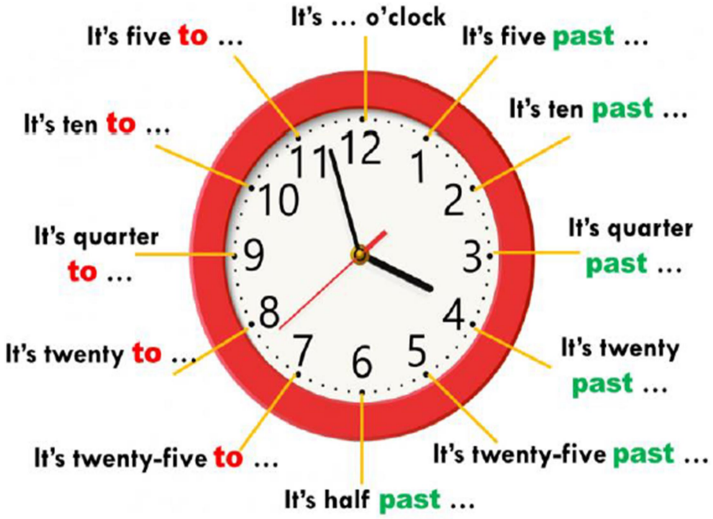
In our day-to-day life, we use watch/clock to see the time. We can see there are 12 numbers starting from 1 to 12. We can see there are 5 short divisions between any two consecutive numbers. So, in total we have 60 short divisions. Each short division corresponds to one minute. Every clock has two hands as shown in above figure. The shorthand is known has hour hand and the long hand is known as minute hand. The minute hand takes 1 hour to complete one complete rotation. In other word, we can say that minute hand takes 60 minutes to complete one rotation.

So, 60 minutes = 1 hour
Hour hand takes 12 hours to complete one full rotation. Since there are 24 hours in a day, the hour hand completes 2 rotations in a day.

There are some clocks which have additional hand, it is called seconds' hand. It completes one round in 1 minute.

- So, 60seconds = 1 minutes

(Demonstration of on a Clock)



In this figure, the hour hand is between 1 and 2. The minute hand is at 3. The time is 15 minutes past 1 or one-fifteen. We write it as 1:15. In this figure, the hour hand is between 5 and 6. The minute hand is at 9. The time is 45 minutes past 5 or five forty-five. It is written as 5:45, also called as quarter to 6.

In this figure, the hour hand is between 4 and 5. The minute hand is at 8. The time is 40 minutes past 4. We say it four forty and we write 4.40.

VELOCITY OF SOUND

A sound wave is fundamentally a pressure disturbance that propagates through a medium by particle interaction. In other words, sound waves move through a physical medium by alternately contracting and expanding the section of the medium in which it propagates. The rate at which the sound waves propagate through the medium is known as the speed of sound.

Some factors like density and temperature of the medium in which the sound wave travels affect the speed of sound.

Density of medium: When the medium is dense, the molecules in the medium are closely packed, which means that the sound travels faster. Therefore, the speed of sound increases as the density of the medium increases.

Temperature of Medium: The speed of sound is directly proportional to the temperature. Therefore, as the temperature increases, the speed of sound increases.

The table below lists the speed of sound in various media. The proportional variation of speed with density is visible here.

Material	Density (g/cm^3)	Speed (m/s)
Copper	8.90	6420
Steel	7.86	5940
Beryllium	1.93	12890
Aluminium	2.58	6420
Water	1.00	1496
Ethanol	0.79	1207
Air	0.00139	331.45
Helium	0.000178	965
Fat	0.95	1450
Muscle	1.07	1580
Skull bone	1.91	4080

(Demonstration of Velocity Of Sound)

Theme Park, , R.I.E. (NCERT), Bhubaneswar

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EDUCATIONAL RESOURCES

Prof. P. C. Agarwal
Prof. S. K. Dash

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