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THE SCIENCE OF WOW



# **SCIENCE CITY: A Centre For Environmental And Sustainable Development Education**



Dr. B S Bhalla  
Scientist D





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# SUSTAINABLE DEVELOPMENT

"Sustainable development is development that meets the needs of the present generation, without compromising the ability of future generations to meet their own needs."

- **World Commission on Environment and Development (WECD)**





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# SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD

**1** NO POVERTY



**2** ZERO HUNGER



**3** GOOD HEALTH AND WELL-BEING



**4** QUALITY EDUCATION



**5** GENDER EQUALITY



**6** CLEAN WATER AND SANITATION



**7** AFFORDABLE AND CLEAN ENERGY



**8** DECENT WORK AND ECONOMIC GROWTH



**9** INDUSTRY, INNOVATION AND INFRASTRUCTURE



**10** REDUCED INEQUALITIES



**11** SUSTAINABLE CITIES AND COMMUNITIES



**12** RESPONSIBLE CONSUMPTION AND PRODUCTION



**13** CLIMATE ACTION



**14** LIFE BELOW WATER



**15** LIFE ON LAND



**16** PEACE, JUSTICE AND STRONG INSTITUTIONS



**17** PARTNERSHIPS FOR THE GOALS



**SUSTAINABLE DEVELOPMENT GOALS**





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# ENVIRONMENTAL EDUCATION

Various facilities available at Science City, make it an ideal place for conducting environmental education activities. Visit to Science City campus will enhance your understanding about the relationship between human beings and the environment and develop capabilities/skills to protect the environment and promote sustainable development.





- ❑ Supreme Court directs universities to include Environment Studies in UG curriculum as a compulsory subject (1991).
- ❑ It makes us aware of our need to adopt sustainable development.



  
 ज्ञान-विज्ञान विभूक्तये  
 प्रो. रजनीश जैन  
 सचिव  
 Prof. Rajnish Jain  
 Secretary



सत्यमेव जयते

विश्वविद्यालय अनुदान आयोग  
**University Grants Commission**  
 (मानव संसाधन विकास मंत्रालय, भारत सरकार)  
 (Ministry of Human Resource Development, Govt. of India)  
 बहादुरशाह जफर मार्ग, नई दिल्ली-110002  
 Bahadur Shah Zafar Marg, New Delhi-110002  
 Ph : 011-23236288/23239337  
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 E-mail : secy.ugc@nic.in

D.O.No.F.13-1/2000(EA/ENV/COS-I)

22<sup>nd</sup> May, 2019

Dear Sir/Madam,


This issues in supersession of earlier letter of even number dated 14<sup>th</sup> May, 2019.

As per directives of Hon'ble Supreme Court of India, a course on Environment should be implemented at all branches of Higher Education in India. The University Grants Commission had earlier passed instructions through numerous letters to all the universities/institutions to compulsorily implement Six Months Core Module Syllabus on Environmental Studies for under-graduate courses in all branches of higher education and also to create awareness among the students for preservation of environment which will go a long way for providing safe and healthy atmosphere for future generations.

You are once again requested to kindly ensure the implementation of Six Month Core Module Syllabus for Environmental Studies for under-graduate course (available on UGC website [www.ugc.ac.in](http://www.ugc.ac.in)) in your University and affiliated colleges/institutes in case not implemented so far. The task of teaching the Module on Environmental Studies be entrusted with the teachers who fulfil the qualifications laid down by the UGC.

With kind regards,

Yours sincerely,

  
(Rajnish Jain)

The Vice Chancellor of all the Universities.

Copy to:

Publication Officer, UGC for uploading on UGC website.





# UGC COURSE CURRICULUM ON ENVIRONMENTAL STUDIES

## Ability Enhancement Compulsory Courses (AECC – Environmental Studies)

### Unit 1: Introduction to environmental studies

- Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.
- Scope and importance; Concept of sustainability and sustainable development. (2 Lectures)

### Unit 2: Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem; food chain, food web and ecological succession. Case studies of the following ecosystems:
  - a) Forest ecosystem
  - b) Grassland ecosystem
  - c) Desert ecosystem
  - d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
 (6 Lectures)

### Unit 3: Natural Resources: Renewable and Non-renewable Resources

- Land Resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Heating of earth and circulation of air; air mass formation and precipitation.
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 Lectures)

### Unit 4: Biodiversity and Conservation

- Levels of biological diversity :genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. (8 Lectures)

### Unit 5: Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies. (8 Lectures)

### Unit 6: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
- Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).
- Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context (7 Lectures)

### Unit 7: Human Communities and the Environment

- Human population and growth: Impacts on environment, human health and welfares.
- Carbon foot-print.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquakes, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi). (6 Lectures)

## UNIT 8: Mandatory Field Visit PGSC : One stop shop for maximum field information

### Unit 8: Field work

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc. (Equal to 5 Lectures)





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# Environmental Issues covered

## Climate Change & Air Pollution

### Water Conservation

- ❖ Rainwater Harvesting System
- ❖ Sprinkler System
- ❖ Drip Irrigation
- ❖ Karnal Technology

### Wastewater Treatment

- ❖ Sewage Treatment Plant (STP)

### Solid Waste management

### Non- Conventional Energy

- ❖ Solar, Hydro, Biomass & Wind Power
- ❖ Nuclear Energy
- ❖ Battery Power

### Ecosystems and Biodiversity

### Disaster management







# CLIMATE CHANGE

Simply said 'Climate change is a long-term change in the average weather patterns that define Earth's local, regional and global climates.'

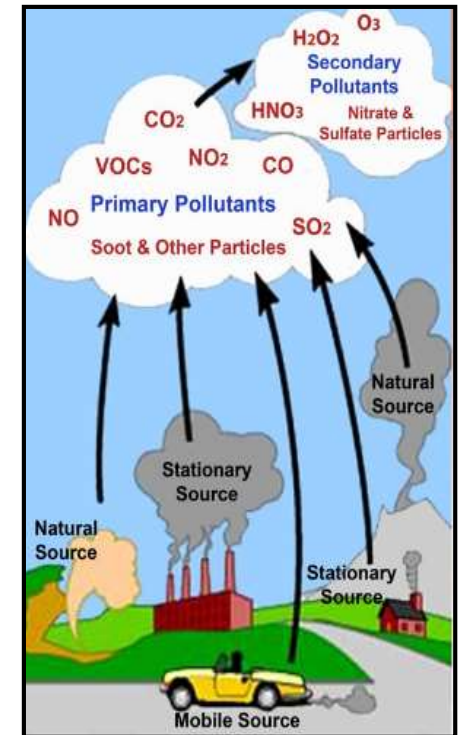
Technically, **Climate Change** refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period. The major cause of this change is CO<sub>2</sub> or other Green house gases due to **Air Pollution**.

# AIR POLLUTION

**The Principal Sources of Air Pollution are:**

**Primary Pollutants** are emitted directly from various sources and cause harm in their emitted state. For example: NO, SO<sub>2</sub>, CO, CO<sub>2</sub> etc.

**Secondary Pollutants** result from chemical transformations in the atmosphere. For example: O<sub>3</sub>, H<sub>2</sub>O<sub>2</sub>, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, Nitrate and Sulfate etc.



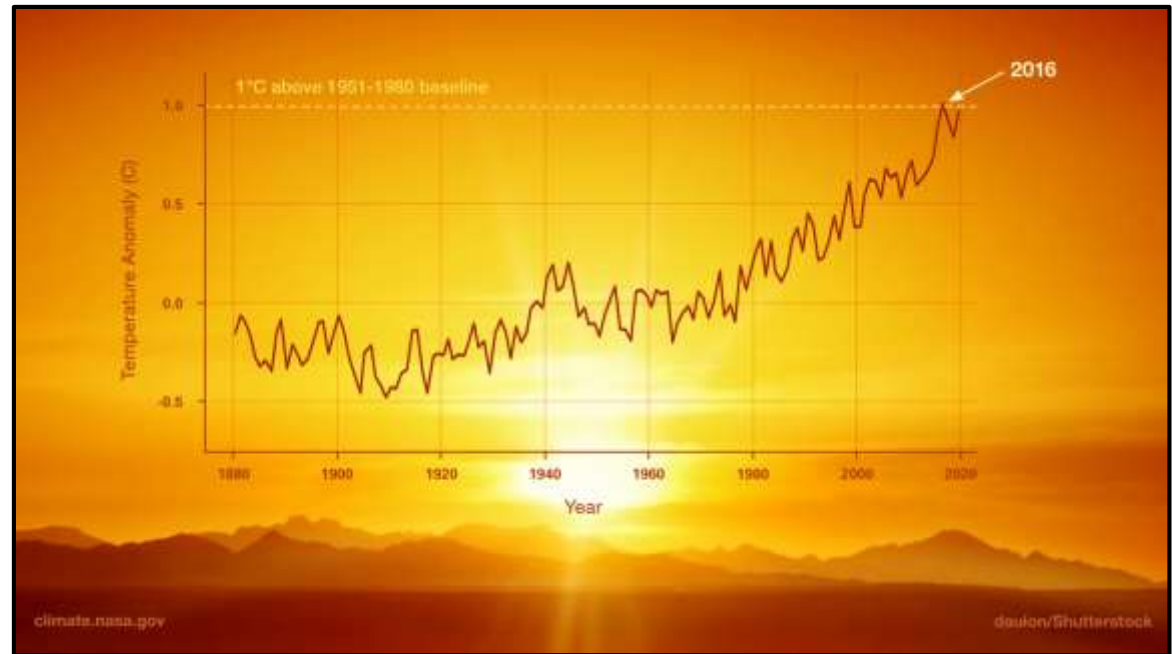


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# What is Global Warming?

Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.



Since the pre-industrial period, human activities are estimated to have increased Earth's global average temperature by about 1 ° Celsius (1.8 ° Fahrenheit), a number that is currently increasing by 0.2 ° C (0.36 ° F) per decade. This is affecting our ecosystems & productivity





# Weather vs. Climate

**Weather** refers to atmospheric conditions that occur locally over short periods of time—from minutes to hours or days. Familiar examples include rain, snow, clouds, winds, floods or thunderstorms.

**Climate** refers to the long-term regional or global average of temperature, humidity and rainfall patterns over seasons, years or decades.





# Is climate changing ?

## Glaciers- Natural thermometers

Glaciers expand when climate cools and they shrink when it warms. Most glaciers around the world are shrinking, proof that climate is warming.



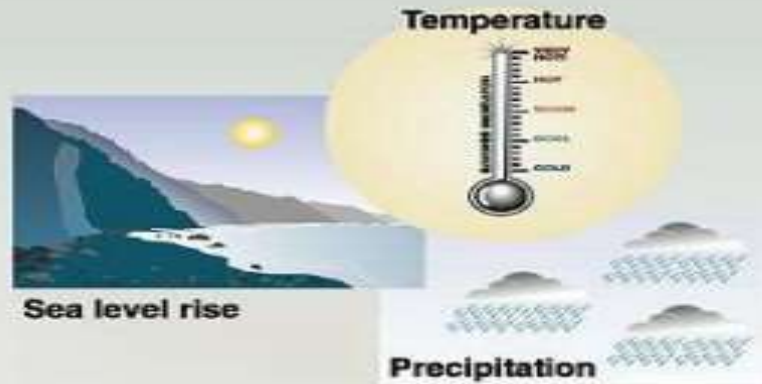
"Glaciers in the Himalayan are receding faster, if the present rate continues, the likelihood of them disappearing by the year 2035 is very high," says the International Commission for Snow and Ice (ICSI) in its recent study on Asian glaciers.

The great Himalayan glaciers are retreating at the alarming rate of 30-50 feet per year (10-15 meters).





## Potential climate changes impact



## Impacts on...

### Health



Weather-related mortality  
Infectious diseases  
Air-quality respiratory illnesses

### Agriculture



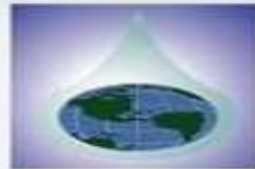
Crop yields  
Irrigation demands

### Forest



Forest composition  
Geographic range of forest  
Forest health and productivity

### Water resources



Water supply  
Water quality  
Competition for water

### coastal areas



Erosion of beaches  
Inundation of coastal lands  
additional costs to protect coastal communities

### Species and natural areas



Loss of habitat and species  
Cryosphere; diminishing glaciers





## Climate Change Theatre

A unique theatre to promote sustainable development, the theatre sensitizes the masses on Climate Change and global warming issues. This 18 meter diameter dome shaped building with seating capacity of 125 persons. The theatre takes visitors around the globe through a film, to explore the implications of a warming planet, specifically from the Indian perspective, and provides opportunity to understand and appreciate the latest climate issues and the human role in mitigating and adapting to climate change. This show also educates visitors on renewable energy and Sustainable Development issues via multi-screen projections.





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# RAIN WATER HARVESTING

**Science City harvests 100% of rain water.**

- ❑ **Rain water harvesting** is a technique of collection and storage of **rainwater** into artificially constructed tanks ( for later use) or in natural reservoirs, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).
- ❑ One method of **rainwater harvesting** is rooftop harvesting. All buildings of PGSC are connected through pipes to an underground system which takes water harvested from the roof tops to a large pond (14,000 m<sup>3</sup> capacity) specifically constructed for the purpose. This water is later used for irrigation.





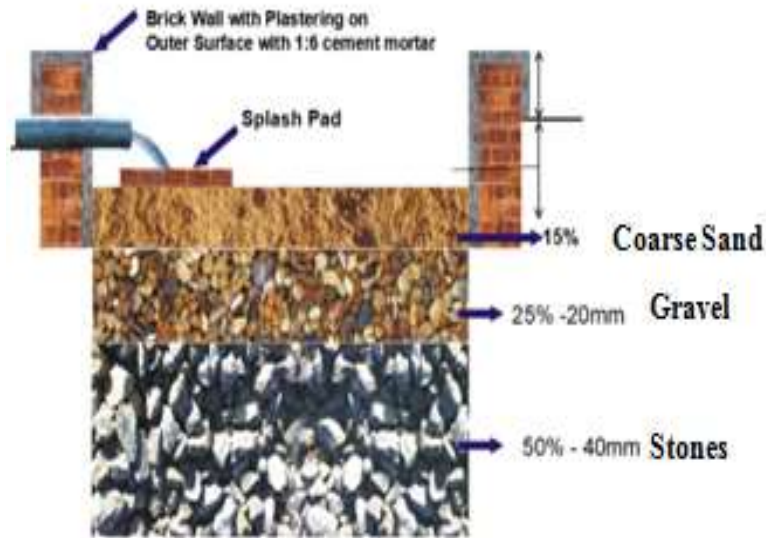
# RAIN WATER HARVESTING – Layout Design of Pipes throughout the campus







# RAIN WATER HARVESTING - RETENTION POND



**Cross section**



**Volume: 14,000 m<sup>3</sup>**





## SPRINKLER SYSTEM

PGSC conserves water by use of sprinkler system in place of flood irrigation.

**Sprinkler** is a device used to irrigate lawns, landscapes, crops, etc. by applying water in a controlled manner in way similar to rainfall. They are also used for cooling and for the control of airborne dust.





# DRIP IRRIGATION

**Drip irrigation** is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation.

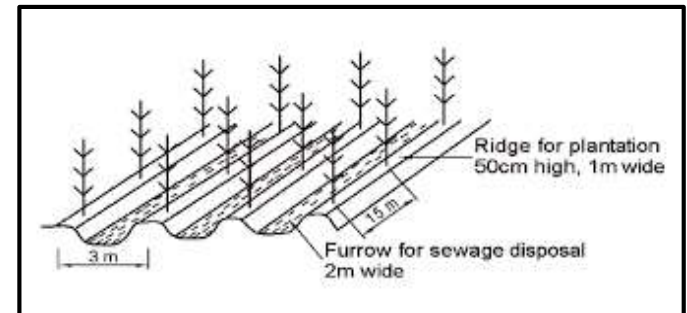


# KARNAL TECHNOLOGY

100% treated water generation through STP is used for irrigation.

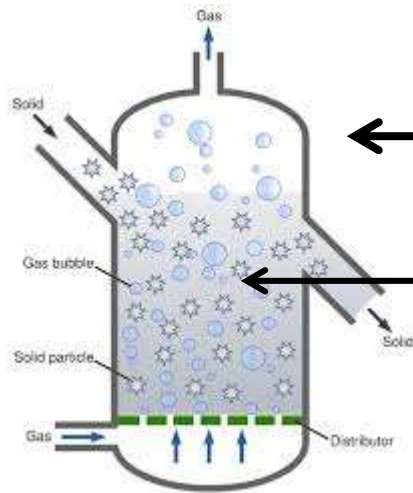


**Karnal Technology** involves growing tree on ridges 1m wide and 50 cm high and disposing of treated/untreated sewage water in furrows. The amount of effluents to be disposed off depends upon the age, type of plants, climatic conditions, soil texture and quality of effluents.





# SEWAGE TREATMENT PLANT BASED ON FAB TECHNOLOGY



**Bioreactor**

**Ring pack media**

**Aerator**

**Screening &  
Grit  
removal**

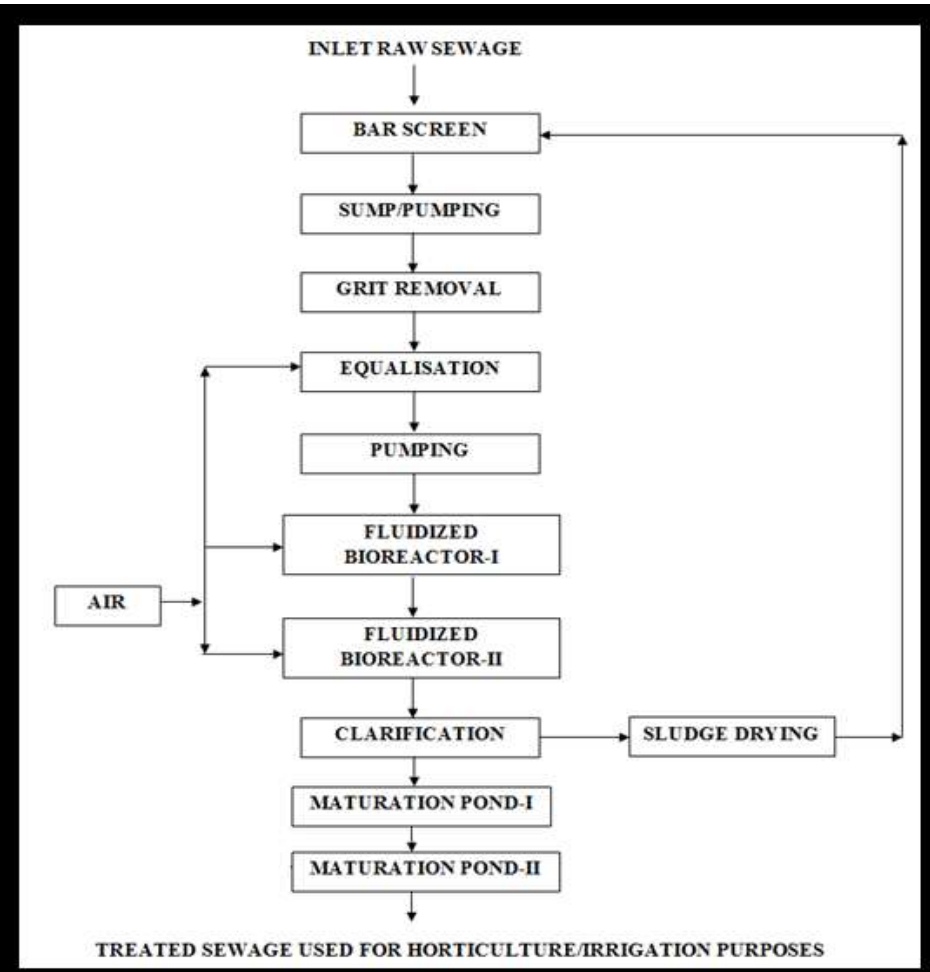




# SEWAGE TREATMENT PLANT BASED ON FAB TECHNOLOGY

**FAB(Fluidized Aerobic Bioreactor)**, a waste water treatment **technology**, is a better alternative to conventional waste water treatment. A thin film on the media enables the bacteria to act upon the biodegradable matter in the effluent and reduce BOD<sub>5</sub>/COD content in presence of oxygen from the air used for fluidization.

- **Nature of discharge: Domestic**
- **Quantity: 150 KL/D**
- **Designed Capacity: 225 KL/D**
- **Mode of final Disposal: Use in Horticulture/ Irrigation**





# SANITATION MANAGEMENT

## Bio Toilet Demonstration and Use in PGSC

- Bio toilet** is a decomposition mechanized toilet system which decomposes human excretory waste in the digester tank using specific high graded bacteria (aerobic or anaerobic) further converting it into methane gas and water.
- Hydrolytic, acidogenic, acetogenic and methanogenic group of bacteria are used.
- Indian Railways is installing Biotoilets to make railways free of the stink in bathrooms
- The Bio-digester technology has been developed by Gwalior based Defence Research and Development Establishment (DRDE) and Tezpur based Defence Research Laboratory (DRL).



# WASTE SEGREGATION

## Municipal Solid Waste

According to **Municipal Solid Wastes (Management and Handling) Rules, 2000** municipal solid waste includes commercial and residential wastes generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.







## Solid Waste Management

- ❑ It is the collecting, treating, and disposing of solid material that is discarded and no longer useful.
- ❑ Its sources are households; educational institutions; hotels; agricultural fields; industries, roads and railways; hospitals; places of recreation and tourism, etc.
- ❑ Improper disposal can create unsanitary conditions and lead to pollution and outbreak of vector-borne disease.
- ❑ Solid waste management involves technical, economic, administrative, and social challenges.
- ❑ **It is important to segregate waste at source and dispose it properly.**
- ❑ **It is our responsibility to reduce waste and to recycle & reuse it, where possible, to protect the environment and conserve our resources.**

### Classification of Solid Wastes

- Municipal Waste
- Hospital Waste
- Hazardous Waste





# SOLID WASTE MANAGEMENT

## COMPOST PRODUCTION AT SCIENCE CITY

- 100% Garden Waste is Composted
- No Manure is Purchased

PGSC harbours about 5500 trees, fallen leaves are collected & used to generate compost.

**Composting** of organic waste, like food waste , paper, garden and Agricultural waste.

### Simple Compost Pit

- Garden waste placed in pit & covered with soil
- Kept moist and shovelled as required.
- Compost ready in 3-6 months





# SOLID WASTE MANAGEMENT

## Vermicomposting

## THE GARDEN GOLD



Vermicomposting (composting with worms) is one of the best sustainable options for recycling organic materials like garden waste into a valuable vermicompost



### Vermicompost Characteristics

#### Physical

- Granulated
- High Nutrient Holding Capacity
- High Water Holding Capacity

#### Biological

- High Microbial Population
- Active Bacteria and Fungi Population

#### Chemical

- pH Near Neutral
- Rich in Plant Growth Hormones, Humic Acids & Nutrients

### Nutrient Profile of Vermicomposting

- Organic Carbon: 9.0-18.0 %
- Total Nitrogen: 1.5% - 2.0 %
- Total Phosphorus: 1.0%- 1.5%
- Potassium: 0.6%
- Other Nutrients: Calcium, Magnesium, Manganese, Zinc, Sulphur, etc



### WINDROW COMPOSTING

Windrow composting is the production of compost by piling organic matter or biodegradable waste in long rows (windrows). This method is suited to produce large volumes of compost.





## Vermicomposting Demonstration and Use in PGSC



A vermicomposting shed



Segregation of earthworms from ready compost



On-going training





# RENEWABLE ENERGY

## State level Renewable Energy Park

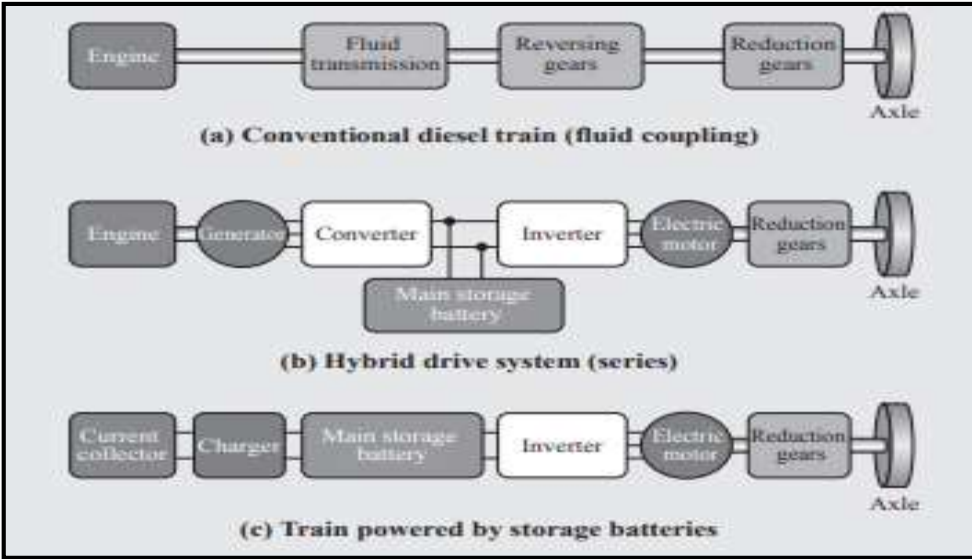
The park is set up in 3.25 acre area with the assistance of the Ministry of Non-Conventional Energy Sources (MNES) and Punjab Energy Development Agency (PEDA) to create awareness among the masses on use of various renewable energy sources (Solar, Wind, Hydel, Tide, Wave, Geo Thermal etc), information on new technologies developed in the area of renewable energy and to educate the masses on energy conservation measures. Students can also see live example of Solar Energy use (as PGSC meets its partial energy demand through SPV).





# Battery Operated Trains

The use of battery operated vehicles helps to save energy and reduce carbon dioxide (CO<sub>2</sub>) emissions.





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## Evolution of Life

- Evolution is the change in characteristics of a species over several generations .
- As per Darwin's '**Theory of Evolution**' all species gradually change over time.
- This happens by natural selection. Individuals in a species have differences in their genes. Hence, they show variation in physical characteristics.
- Individuals which are best suited to their environment are more likely to survive, finding food, avoiding predators and resisting disease. These individuals are more likely to reproduce and pass their genes on to their children.
- Individuals that are poorly adapted to their environment are less likely to survive and reproduce. Therefore their genes are less likely to be passed on to the next generation.
- As a result those individuals most suited to their environment survive and gradually evolve.

**To see how life evolved on the earth visit the 'Panorama of Life through Ages' at PGSC**



## Panorma on 'Life through the Ages' at PGSC

At “Life through the Ages Panorama” students can trace the origin of Earth (Big Bang) and life and their evolution and explore progression of human species, is set up in 80-foot diameter dome structure through 2D and 3D models, huge background paintings (along with landscaping), providing a wide-angle view of the entire occurrence. It helps one embark on a million years journey, from the first hominines to the last surviving human species i.e. *Homo sapiens*. Some original fossils are also placed at Science City.







## Dinosaur Park

The Panorama is associated with a 2.5 acres open Dinosaur Park with more than 44 life size dinosaurs and several robotic dinosaurs on the island at the Science City. The students walk through Cretaceous, Jurassic and Triassic eras when Dinosaurs ruled the Earth.

**You can also see moving dinosaurs at Science City.**





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## Evolution, Ecology and Ecosystems

- Ecology is the interaction between organisms and their environment.
- It plays a significant role in forming new species
- An ecosystem includes all living things (plants/animals/organisms) in a given area that interact with each other and the non-living environment (weather, earth, soil, atmosphere) that surrounds them
- Major ecosystems are forests, grasslands, deserts, tundra, freshwater and marine.



Pic Source: <https://www.yourgenome.org/facts/what-is-evolution>





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## Birds Gallery and Wetland Ecosystem

A gallery on Avian biodiversity showcasing avian wealth of the country.

Punjab is rich in aquatic resources which provide home to a large number of resident and migratory birds. It is, therefore, especially rich in Avian biodiversity. A gallery on Bird biodiversity showcasing wetland ecosystem along with various birds of each State of India has been set up. It provides information on avian wealth of the country and conservation issues.





# BIODIVERSITY

Biodiversity is the variety and variability of life on Earth. Biodiversity is typically a measure of variation at the genetic, species, and ecosystem level. Science City harbours rich floral and faunal biodiversity



## FLORAL BIODIVERSITY IN PGSC

PGSC harbours rich floral biodiversity with Cactus Garden, herbal garden and avenue of rare, endangered and threatened species. In all, there are more than 168 plant species covering 144 genera and 58 families of plants. Cactus garden has been developed in an area of approximately 4.25 acres. An herbal garden has also been set up with a collection of medicinal and aromatic plants. Besides, Science City has beautiful collection of trees of Punjab having rich cultural and heritage value and Ashok Vatika.

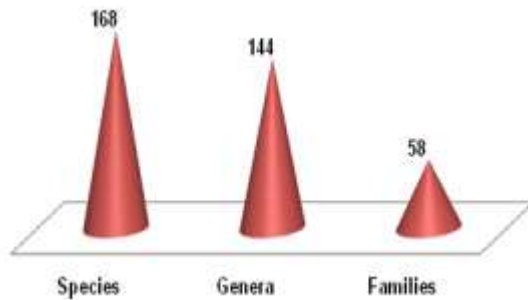




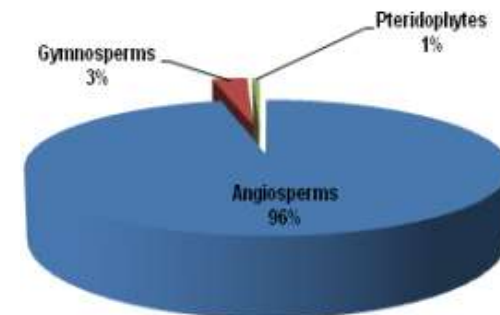
- ❑ About 168 plant species from 144 genera.
- ❑ More than 5,500 trees in the campus.



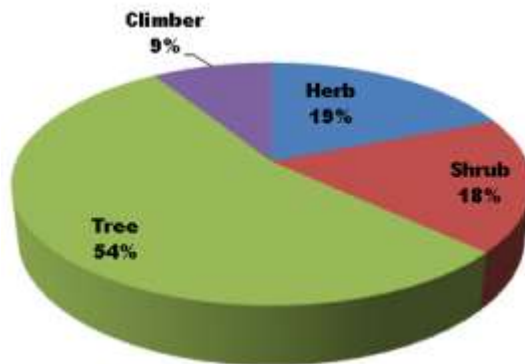
# FLORAL BIODIVERSITY IN PGSC



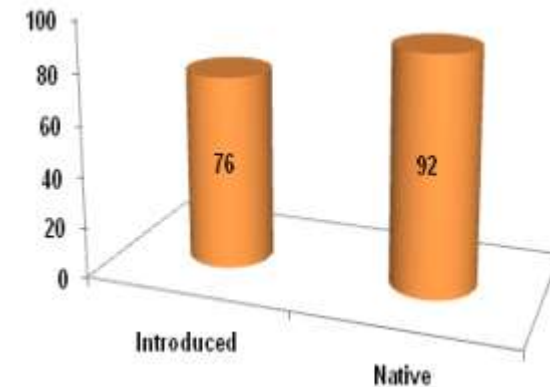
**Number of Species, Genera and Families**



**Distribution of higher plants**



**Habit-wise distribution of plants**



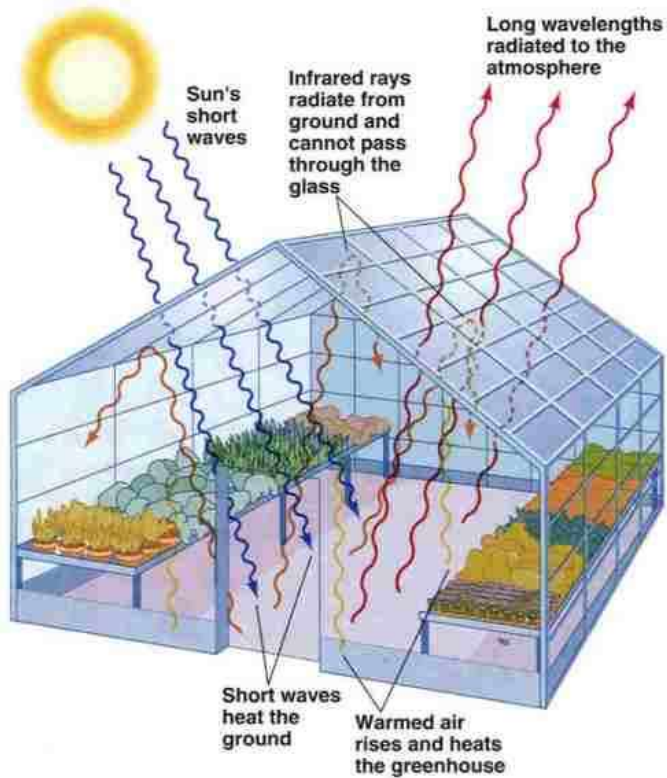
**Status of Native/Introduced Species**

Reference: Jerath et al. 2017



# Greenhouses

A greenhouse works by converting light energy into heat energy. Light rays from the sun enter the greenhouse, where they are absorbed and converted to heat.





# FAUNAL BIODIVERSITY IN PGSC

- ❑ PGSC is endowed with a rich faunal biodiversity.
- ❑ Bird watchers will find it interesting.



**Indian Pea fowl (*Pavo cristatus*)**



**Spotted Owl (*Strix occidentalis*)**



**Cormorant (*Phalacrocorax fuscicollis*)**



**Egret (*Egretta garzetta*)**







# DISASTER MANAGEMENT

## Earthquake Simulator

This theatre-style ride simulator comes equipped with 30 chairs on a shake table which enables you to watch a computer-generated film projected on the LED TV with an objective to prepare you to face the disaster while you undergo a vigorous and shaky feeling of immersion in real action.

The Earthquake simulator provides simultaneous and self-regulating programmable motion in horizontal and vertical direction and reproduces up to Richter Scale 6.5 magnitude programmable earthquake.



## Earthquake Simulator





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## Seismic Zones in India

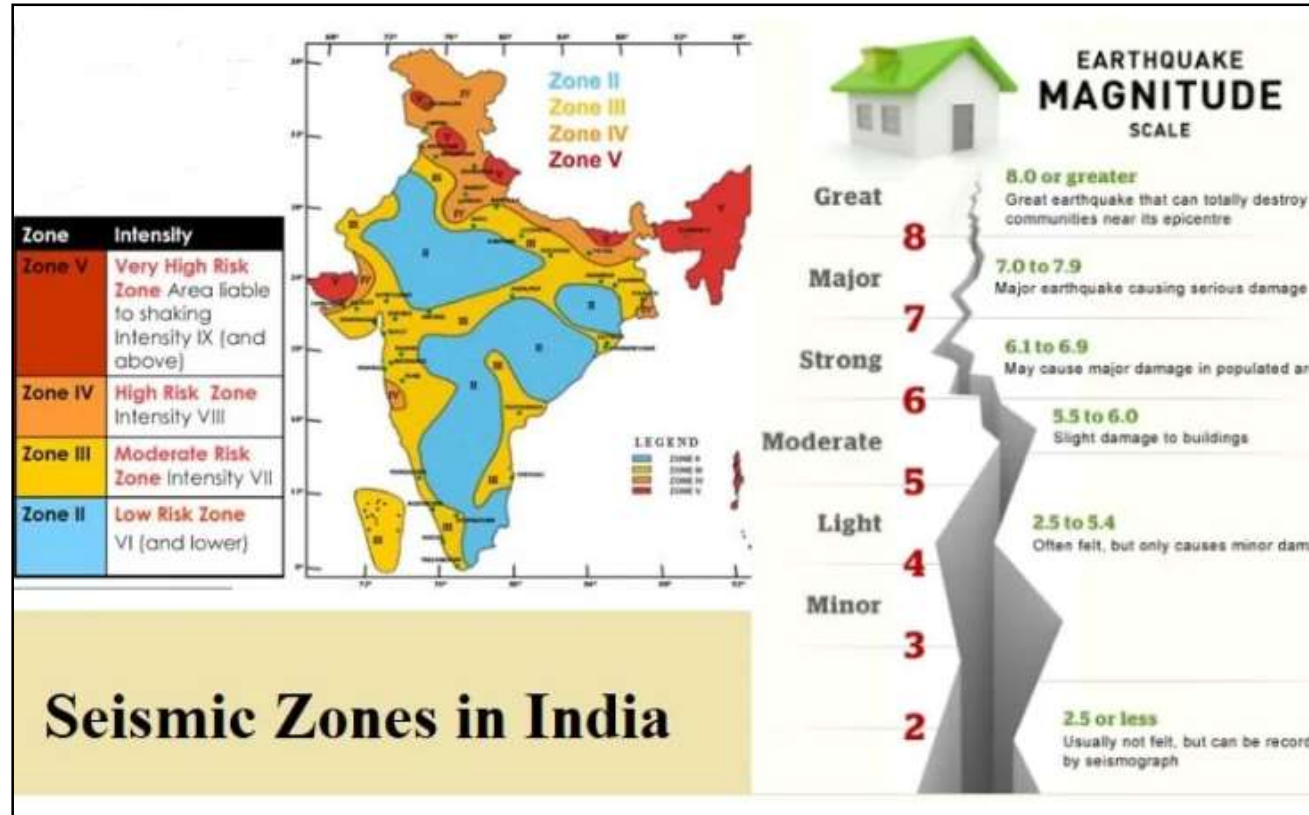
- ❑ India lies at the north western end of the Indo Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the huge Eurasian plate and going under the Eurasian plate.
- ❑ This process of one tectonic plate getting under another is responsible for making India a earthquake prone area.
- ❑ A number of significant earthquakes occurred in and around India over the past century. Some of these occurred in populated and urbanized areas and hence caused great damage.





❑ The latest version of seismic zoning map of India given in the earthquake resistant design code on India [IS 1893 (Part 1) 2002] assigns four levels of seismicity for India in terms of zone factors. In other words, the earthquake zoning map of India divides India into 4 seismic zones (Zone II, III, IV and V) unlike its previous version, which consisted of five or six zones for the country.

❑ Zones depicts highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.





## Fire Fighting System

Detailed guidelines for construction, maintenance and fire safety of the building structures given by National Building Code of India are strictly followed.

All buildings structures are equipped with Fire Fighting equipments as per the mandatory requirement.





# OTHER ATTRACTIONS

## CLOSENESS TO NATURE

### Magnificent Lake

For boating lovers, a large artificial lake has been set up in the centre of the Science City with a rowing distance of about 1 kilometer. There are manual paddle operating boats for the visitors to move through the lake and to have a look at the Dinosaurs Park which is made on an island surrounded by the lake.





## Environmental Documentaries

A large collection of environmental documentaries are available at PGSC. These documentaries have been shown to the participants during hosting of various science awareness days celebrations, conferences, seminars and workshops at Convention Hall.





## Large Format Film Projection Theatre

- ❑ Gear up for an immersive experience of with our Large Format Film Projection Theatre!
- ❑ The film size is 10 times larger than used in regular theatres and 3 times larger than standard 70mm film used in classic Hollywood epics.
- ❑ With a seating capacity of 327 persons, theatre projecting Large Format films on 23 meter-tilted dome is sure to give you larger-than-life thrill.
- ❑ It is a mesmerizing visual treat to watch the full-scale spectacle and experience the delight of sound clarity!







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# THANKS

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PUSHPA GUJRAL SCIENCE CITY,  
KAPURTHALA