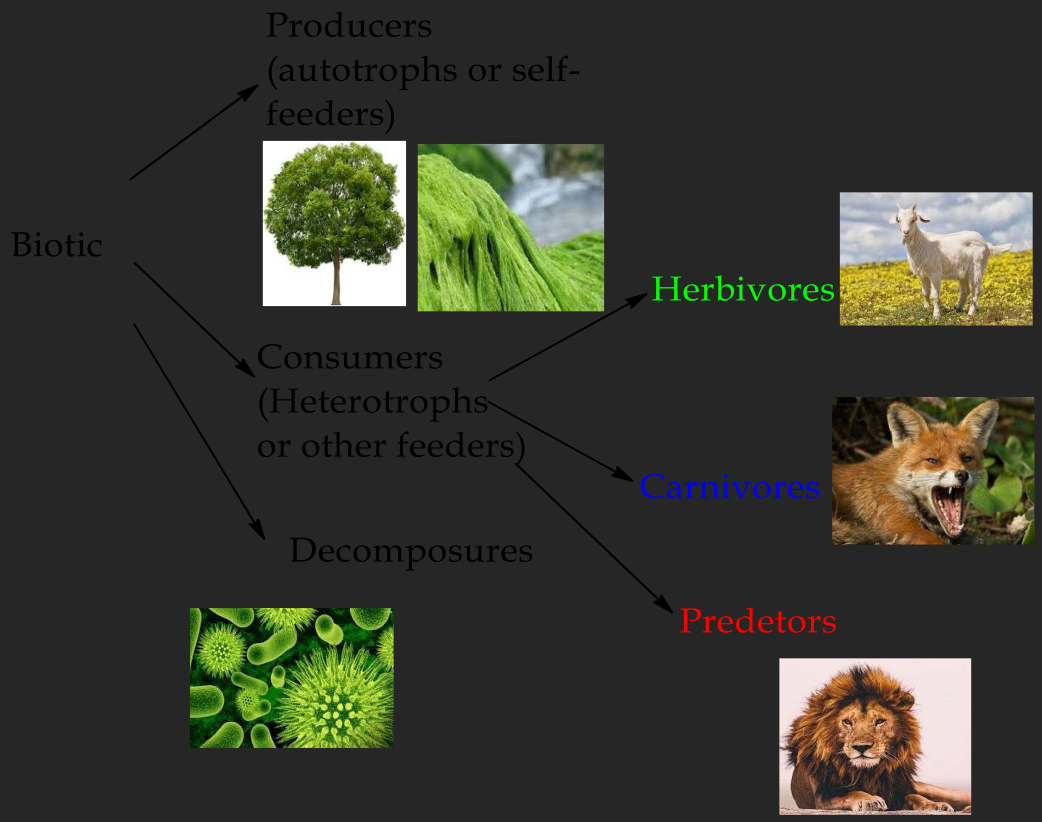
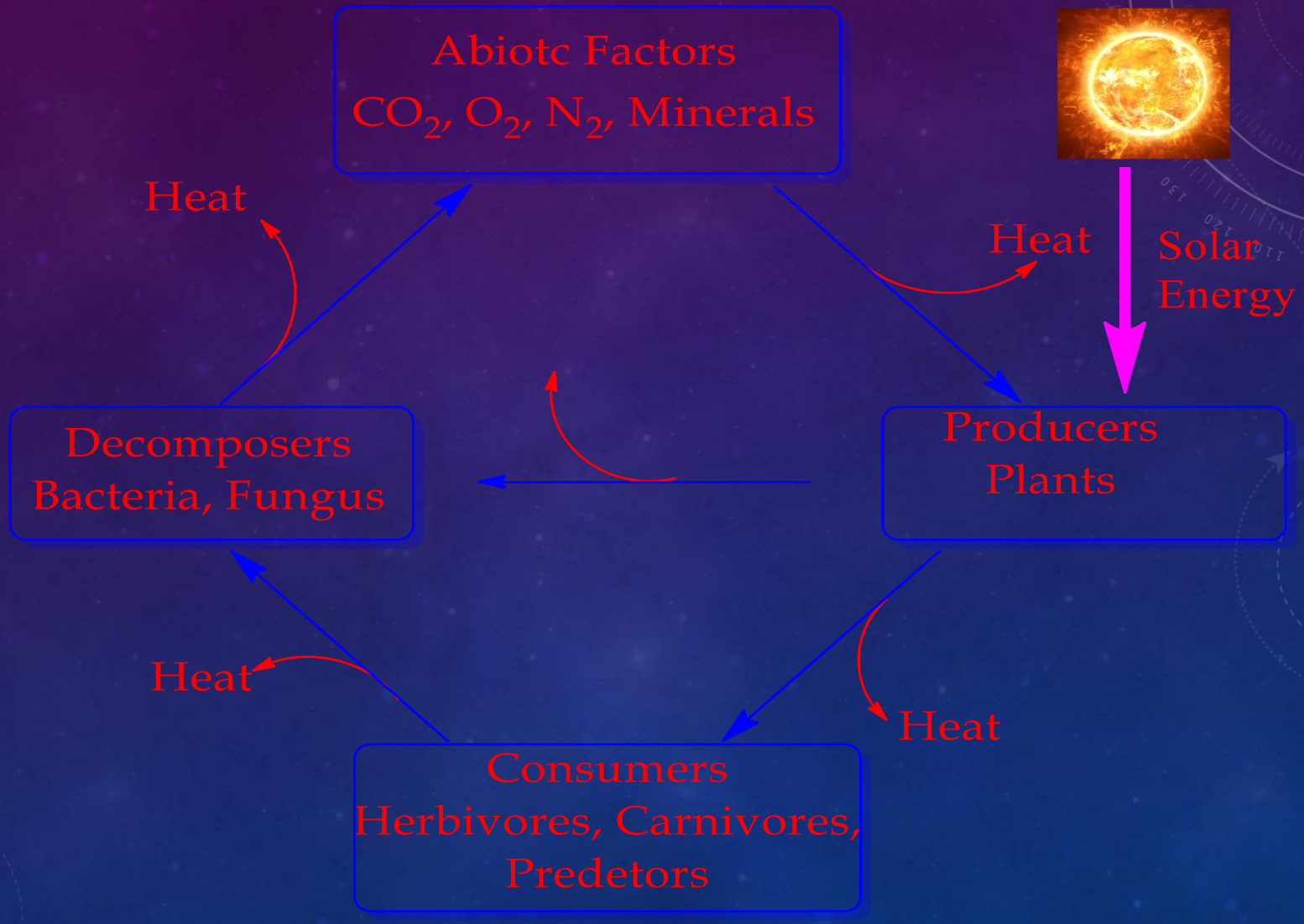
Introduction, Overview on Environment

- **Biotic Factors**



Introduction, Overview on Environment

Energy flow among Biotic and Abiotic components



Introduction, Overview on Environment

Terminologies

Pollutant

A substance which is a constituent of environment but when present in excess imparts detrimental effect on environment is known as pollutant.

e.g. lead, mercury, carbon monoxide etc.

Contaminant

A substance which is not a constituent of environment but introduced by only anthropogenic activity disturbing its composition is known as contaminant. When a contaminant exerts detrimental effect on environment it can be described as also pollutant.

e.g. MIC (methyl isocyanate) released into atmosphere in Bhopal gas tragedy In Dec. 3rd 1984 (10,000 people died, 1,000 became blind and more than 1 lakh people continue to suffer from various disorders)

CFCs (CFC-11, CFC-12)

Introduction, Overview on Environment

Receptor

The medium which is affected by the pollutant is known as receptor. e.g. Human being can be described as a receptor of photochemical smog

Sink

A medium which retains the pollutant and keep on interacting with it for a long time.

e.g. particulates for human being, acid for marble monuments

Pathway

The mechanism by virtue of which a pollutant is distributed from its source to different environmental segments is known as its pathway.

Introduction, Overview on Environment

Speciation

It refers to segregation and estimation of different species of a particular pollutant present in the environment. This helps to estimate the toxicity level/impact of that pollutant.

e.g. Hg, Hg_2^{2+}, Hg^{2+}, CH_3Hg^+, $(CH_3)_2Hg$ etc.

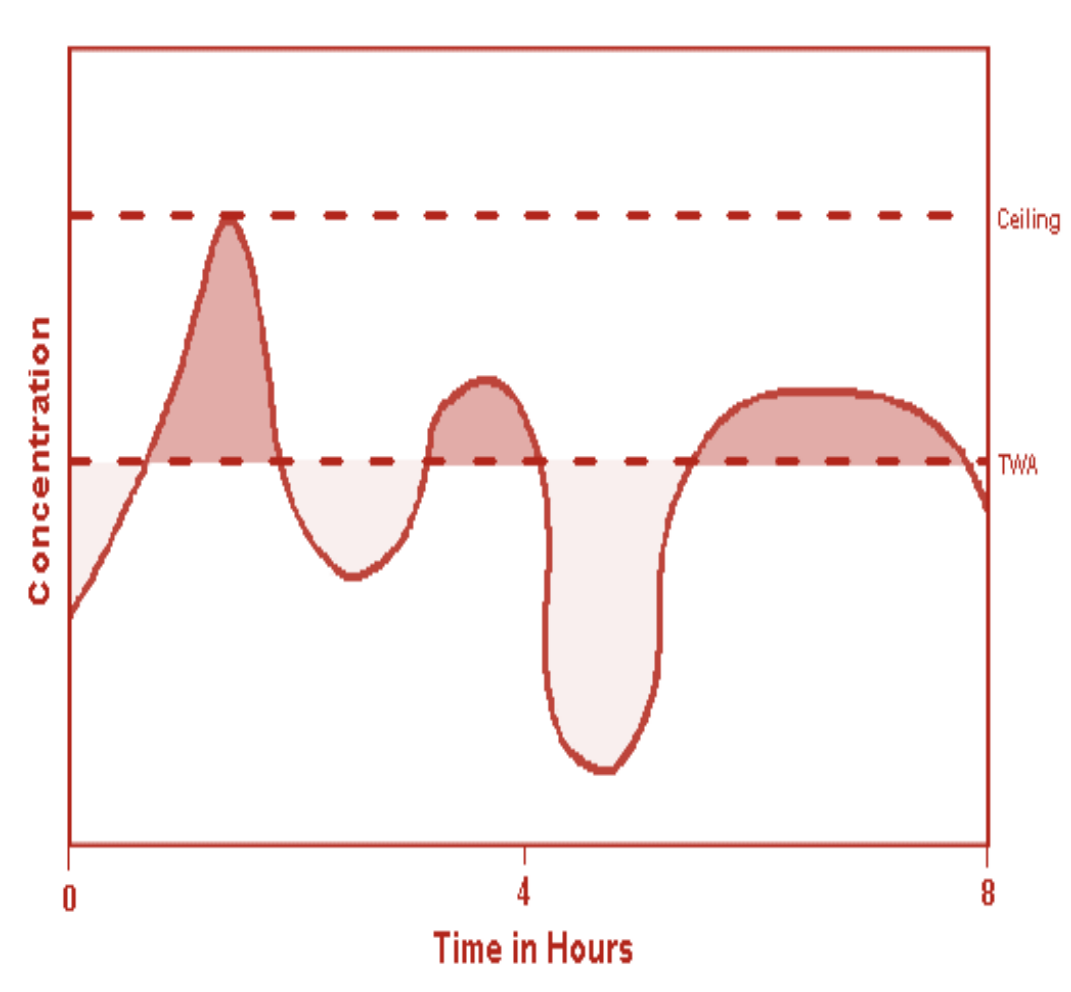
TLV

TLVs are the maximum average airborne conc. of a hazardous material to which healthy adult workers can be exposed during an 8-hour workday and 40-hour workweek—over a working lifetime—without experiencing significant adverse health effects.

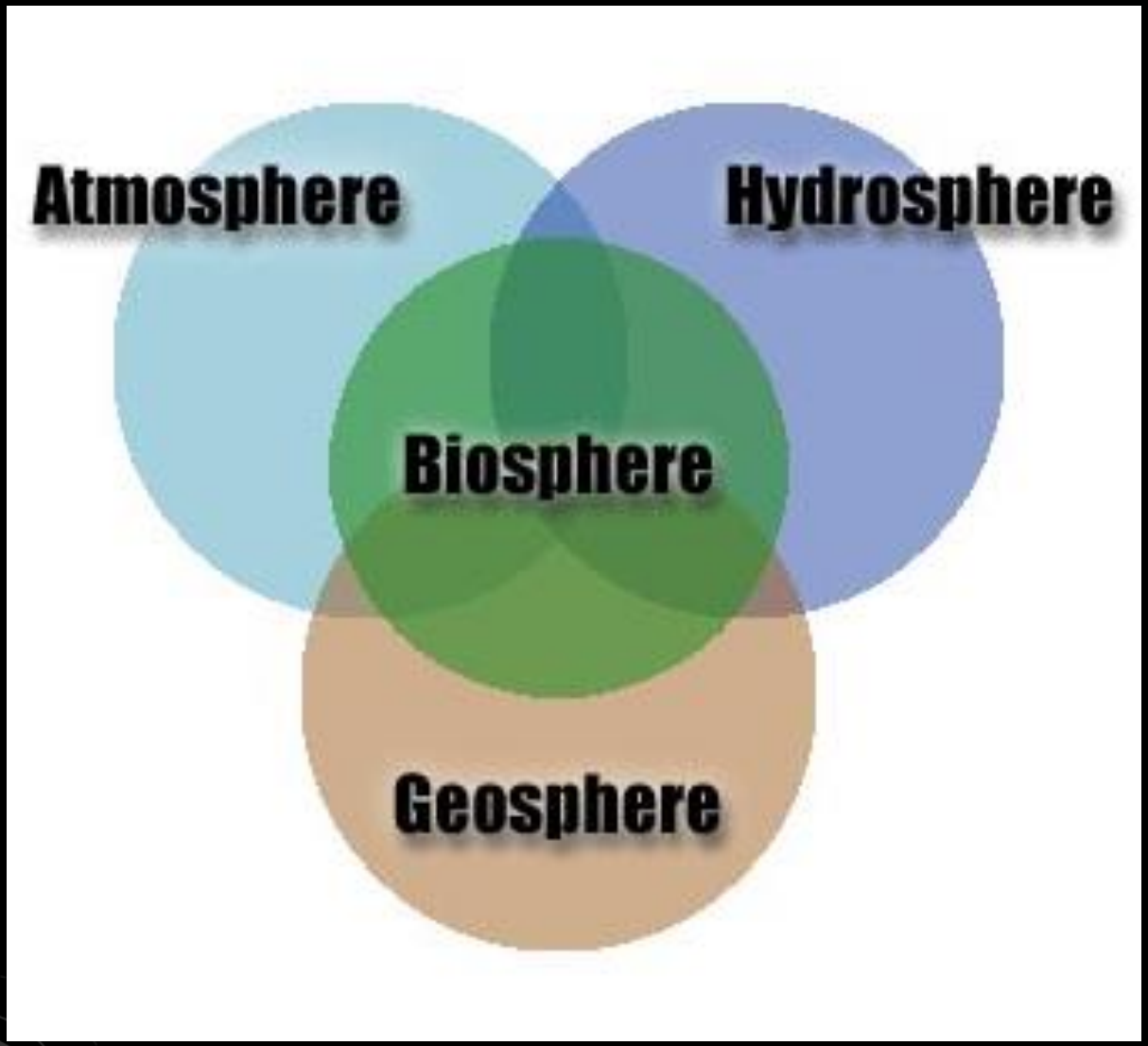
- **Time-weighted Average (TWA) concentration:** The concentration of a contaminant averaged over a workday (usually 8 hours long). It's measured in a workplace by sampling a worker's breathing zone for the whole workday. American Conference of Governmental Industrial Hygienists (ACGIH) recommends that the TWA should not be exceeded for up to an 8-hour workday during a 40-hour workweek.

Introduction, Overview on Environment

- **Ceiling value** A concentration of a toxic substance in air that ACGIH recommends should not be exceeded at any time during the workday. This value is often used in conjunction with the TWA.
- **Short-term Exposure Limit (STEL) value**: A TWA concentration over 15 minutes that ACGIH recommends not to exceed—even if the 8-hour TWA is within the standards.
  TWA-STELs are given for contaminants for which short-term hazards are known.



Components of earth: lithosphere, hydrosphere, atmosphere and biosphere



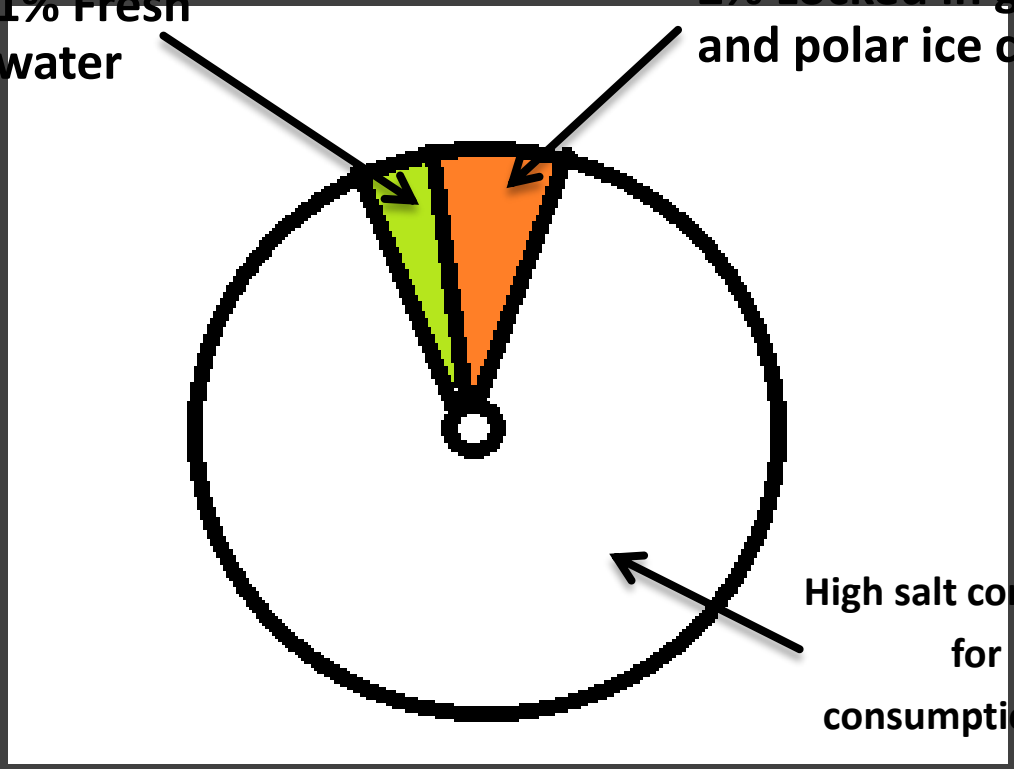
Different segments of environment

Atmosphere

- The air envelope surrounding the earth is known as Atmosphere.
- This protective envelope surrounding earth helps in sustaining life on earth and protect us from unfriendly environment of outer space
- It extends to the height of ~ 500 km from the earth surface
- It absorbs IR radiation emitted by the sun and reemitted from the earth and thereby control the temperature balance of the earth
- It allows radiation only in the regions of 300-2500 nm (near UV, visible and near IR) and 0.01 – 40 meters (radio waves) at the same time it filters harmful UV radiation below 300 nm

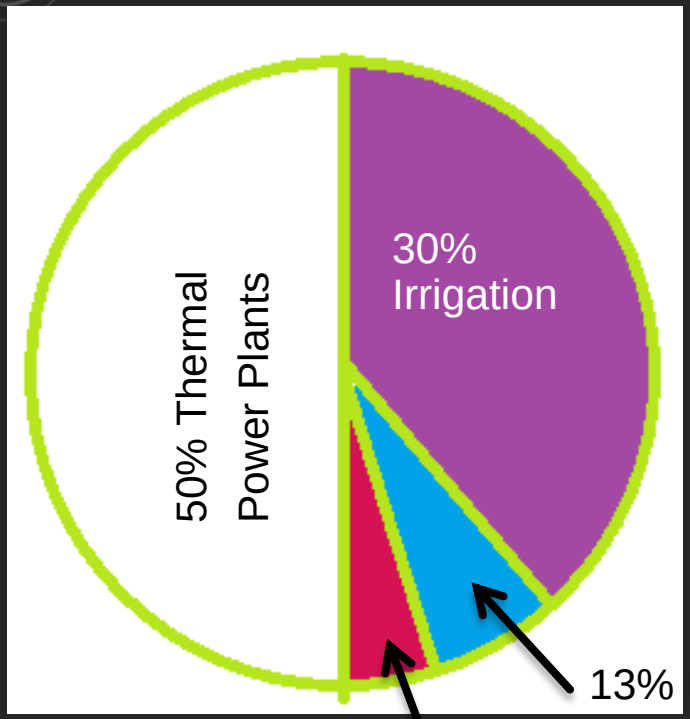
Cont.

- Acts as a source of CO_2 for photosynthesis in plants and O_2 for respiration of human beings / animals
- Transports water from water bodies to land
- Acts as a source of nitrogen for nitrogen fixing bacteria
- Helps to maintain of nutrient cycles
- Increase of human interference has changed the earth's radiation balance by changing the albedo i.e. fraction of sunlight reflected and scattered back to the atmosphere



Hydrosphere

- The hydrosphere is a collective term given to all different forms of water. It includes all types of water resources such as oceans, seas, rivers, lakes, streams, reservoirs and polar ice caps and ground water. The distribution of earth's water as follows

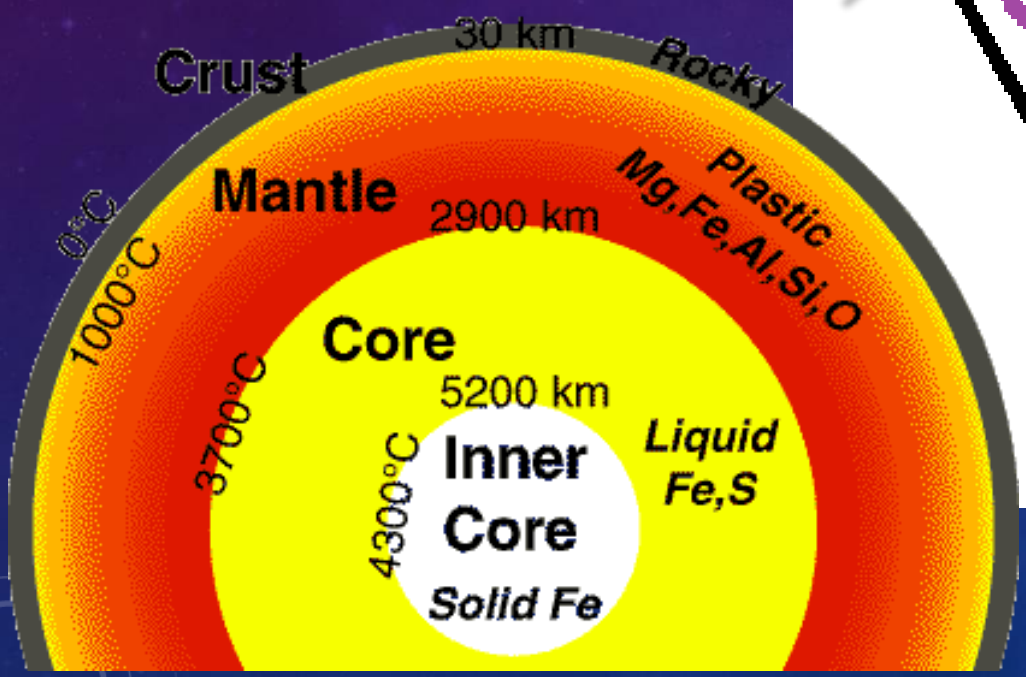


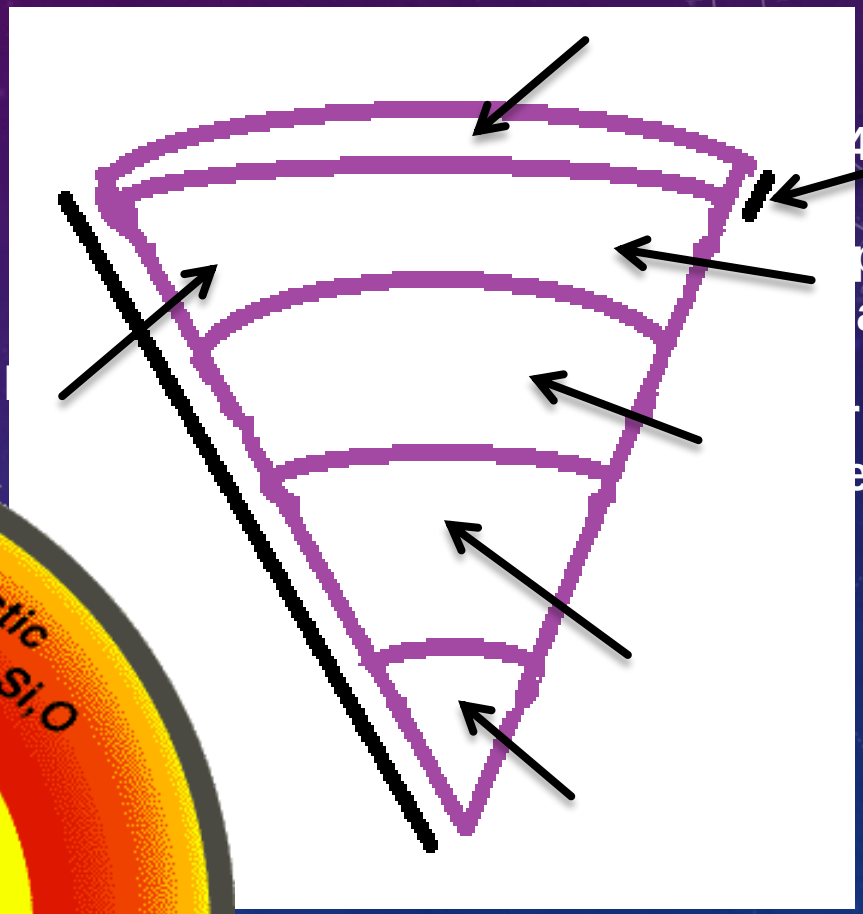
Use of Fresh water

- The 1% of total fresh water in the river, lake and streams and ground water is for human consumption and this is the use of fresh water as follows

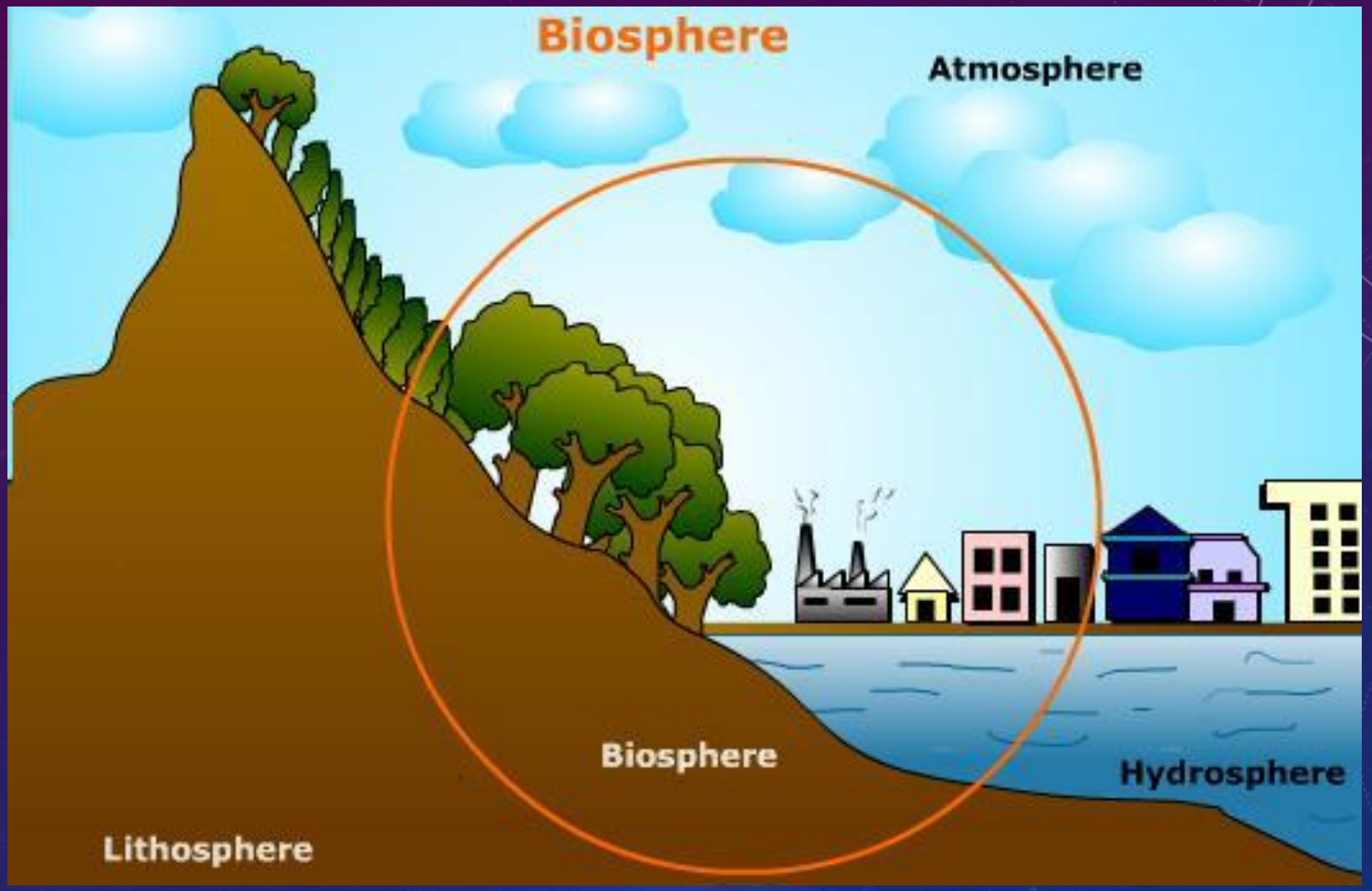
Lithosphere

The earth is divided into various layers as shown in the figure





Biosphere

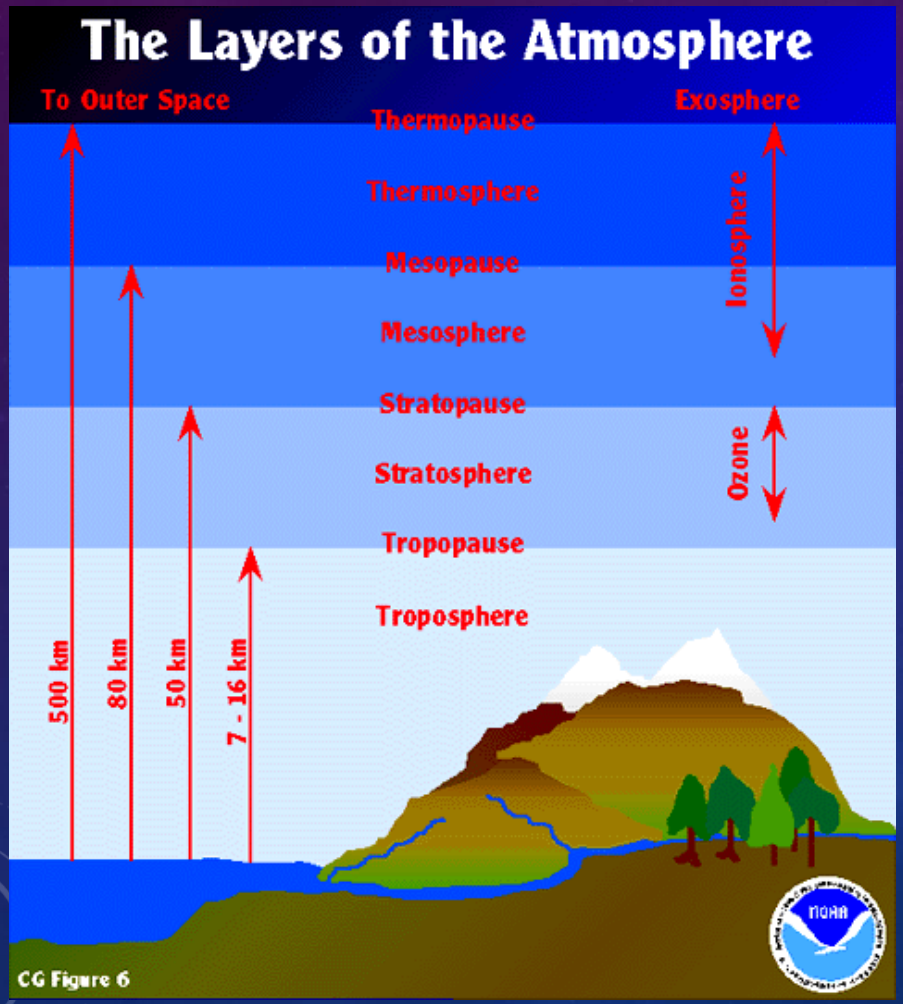


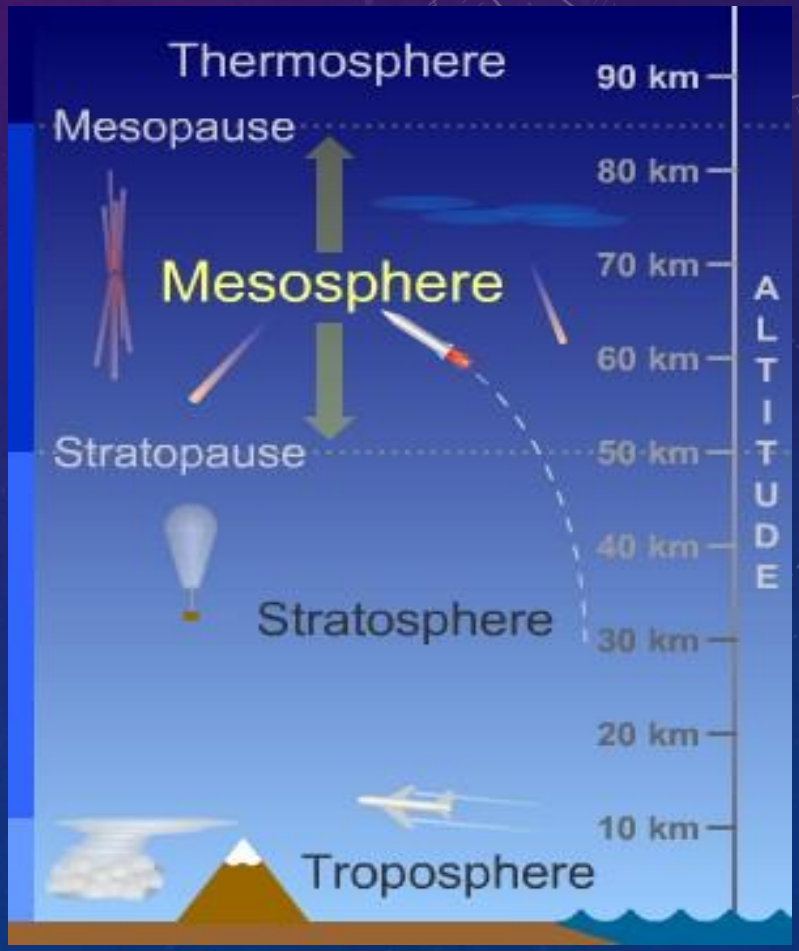
The biotic or living components include plants, animals and microbes living on the earth. A constant interaction between the abiotic and biotic components of the biosphere results in the transfer of food and energy, which makes it a dynamic but stable system. The biosphere is the biggest biological system. It consists of smaller functional units known as ecosystems or ecological systems

Different layers of Atmosphere

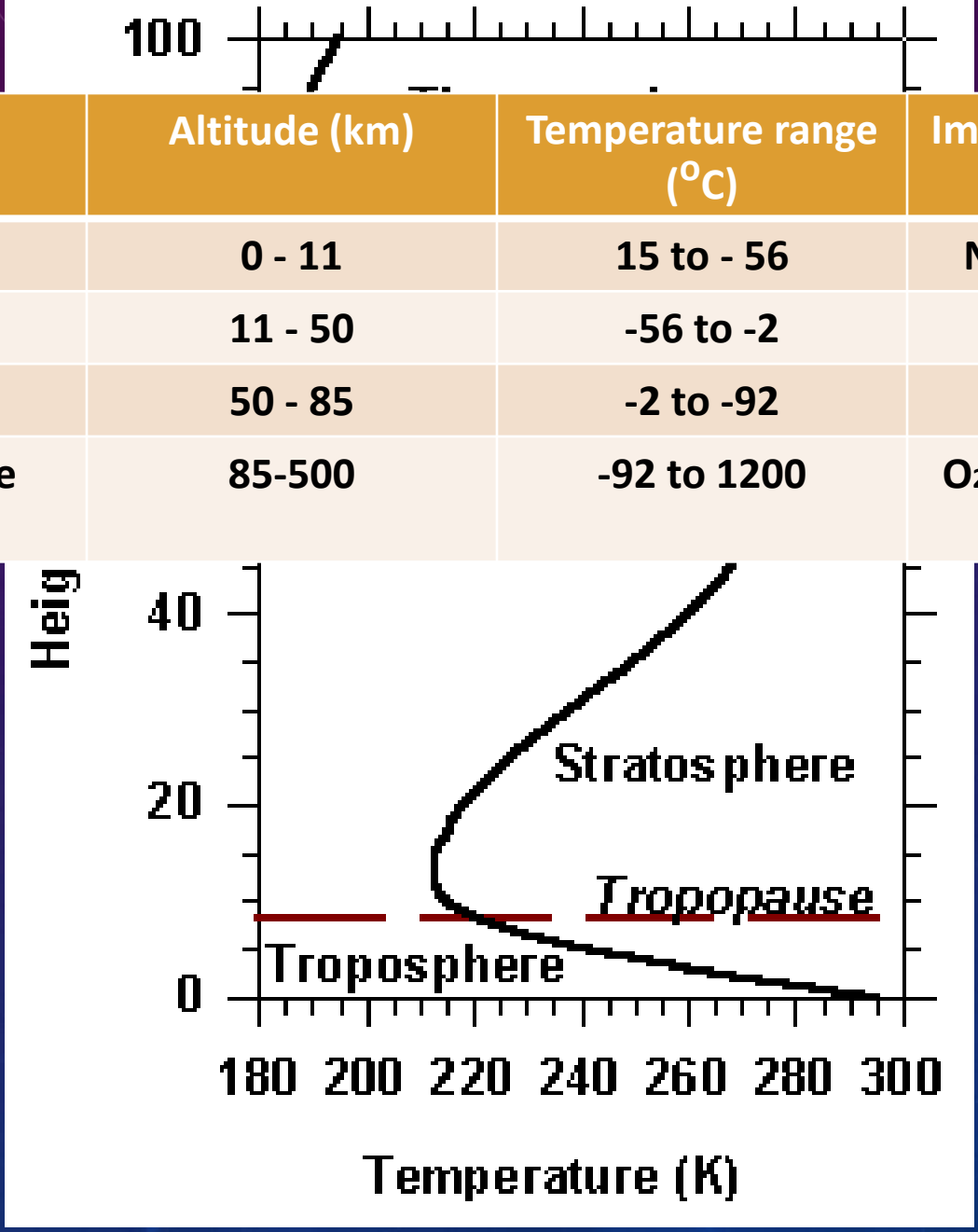
The atmosphere may be broadly divided into four regions

Troposphere
Stratosphere
Mesosphere
Thermosphere





Region	Altitude (km)	Temperature range (^{o}C)	Important chemical species
Troposphere	0 - 11	15 to - 56	N_2, O_2, CO_2, H_2O
Stratosphere	11 - 50	-56 to -2	O_3
Mesosphere	50 - 85	-2 to -92	O_2, NO
Thermosphere	85-500	-92 to 1200	O_2(+), O (+), NO(+)



Troposphere

- The troposphere contains 70% of the mass of the atmosphere. Here the air is far from uniform with respect to density and temperature.

- Density decreases exponentially with increasing altitude.

- In respect of composition, the troposphere is more or less homogeneous in the absence of air pollution, mainly due to the constant circulation of air in this region.

- The water content however varies due to hydrological cycle.

- The temperature in the troposphere falls of uniformly with increasing altitude.

- The temperature in the troposphere falls of uniformly with increasing altitude. Thus, this layer follows – ve lapse rate.

Note:- The lapse rate is defined as the rate of change of temperature with height or altitude of the atmospheric variable.

- The colder layer (-56^{O} C) at the top of the troposphere is called the tropopause, which marks temperature inversion i.e., transition from negative to positive lapse rate.

Stratosphere

- The stratosphere having a positive lapse rate. The temperature increases with increasing with increase in altitude with maximum of -2 ^{o}C which in the upper limit of stratosphere.

- Ozone in this region absorbs ultra violet (UV) radiation.

- It plays an important role in the stratosphere. It acts as a protection shielding for life on the earth from the injurious effects of the sun's ultra violet rays and at the same time, it supplies the heat sources for partitioning the atmosphere into a quiescent stratosphere and turbulent troposphere.

$O_3 + h\vartheta \longrightarrow O_2 + O$

The hotter layers (-2^{o}C) at the top of the stratosphere is called the stratopouse, which marks temperature inversion i.e., transition from positive to negative laps rate.

Mesosphere

- The mesosphere shows negative laps rate i.e., temperature falls with increasing altitude.

- Concentration of ozone is very low in this region and decreases rapidly with increase in height.

- So the is a decrease in the adsorption of solar radiation takes place and the temperature falls to – 92 ^{o}C.

- The dominant chemical species found in this region are O_2 and NO.

- The colder layers (- 92 ^{o}C) at the top the of the mesosphere is called mesopause, which marks temperature inversion i.e., transition from negative to positive laps rate.

Thermosphere

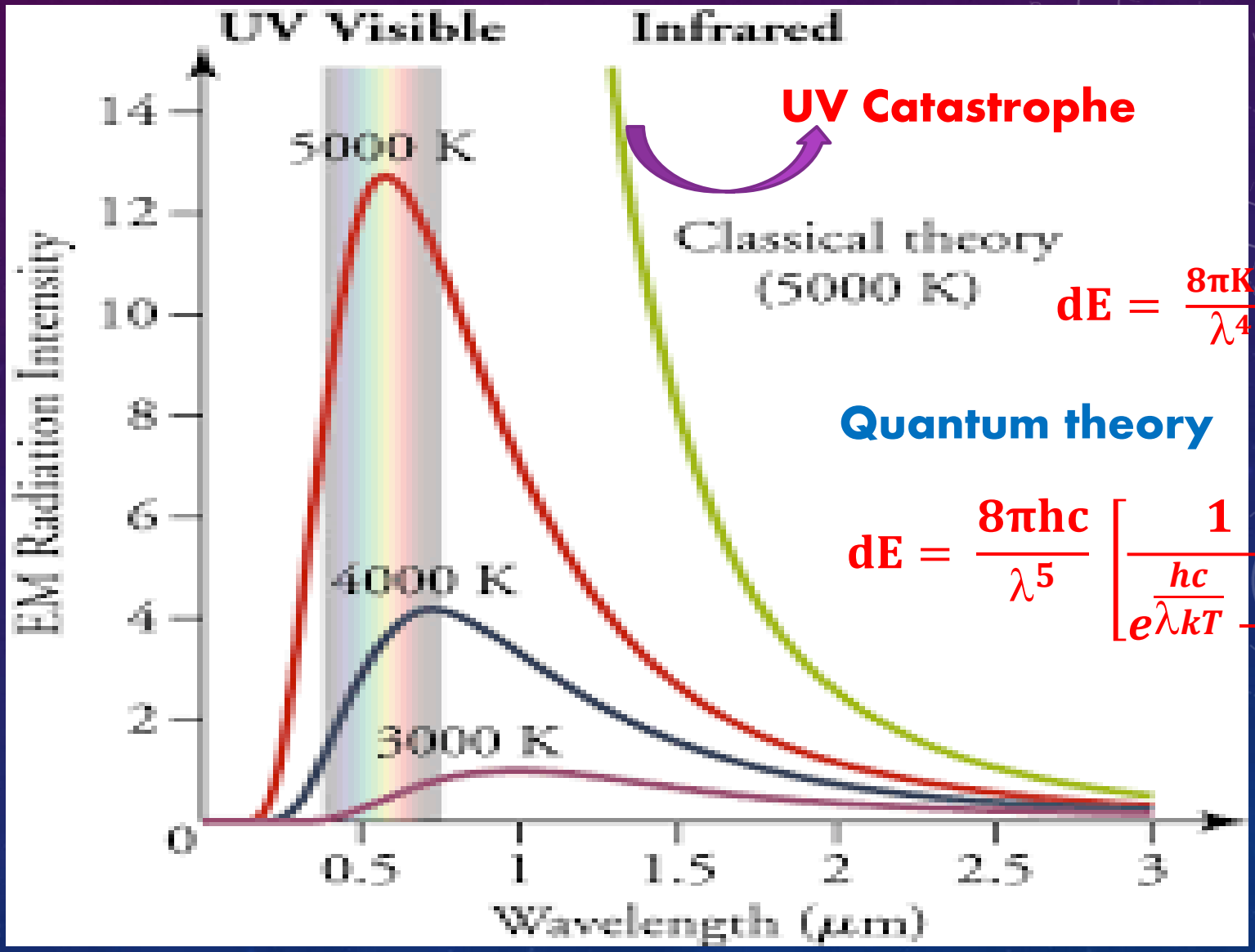
The thermosphere starts immediately above the mesosphere and the temperature rises once again, giving a positive laps rate.

The atmospheric gases are oxygen and nitric oxide and split into atoms and corresponding ions after absorption of solar radiation in the far ultra violet (UV) region.

This is also known as ionosphere and is high electrical conductor as it contains charge particles

Concept of black body radiation and albedo, Importance, scope and principle of EIA

Black body radiation



$$dE = \frac{8\pi KT}{\lambda^4} d\lambda$$

Quantum theory

$$dE = \frac{8\pi hc}{\lambda^5} \left[\frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \right] d\lambda$$

Cont.

- **Wien's Law-**

  The dominant wavelength at which a blackbody emits is inversely proportional to the temperature in absolute scale.

  Or, $\lambda_{max} = \frac{b}{T}$

  Where '**b**' is Wien's constant = 2.898×10^{-3} **mK**

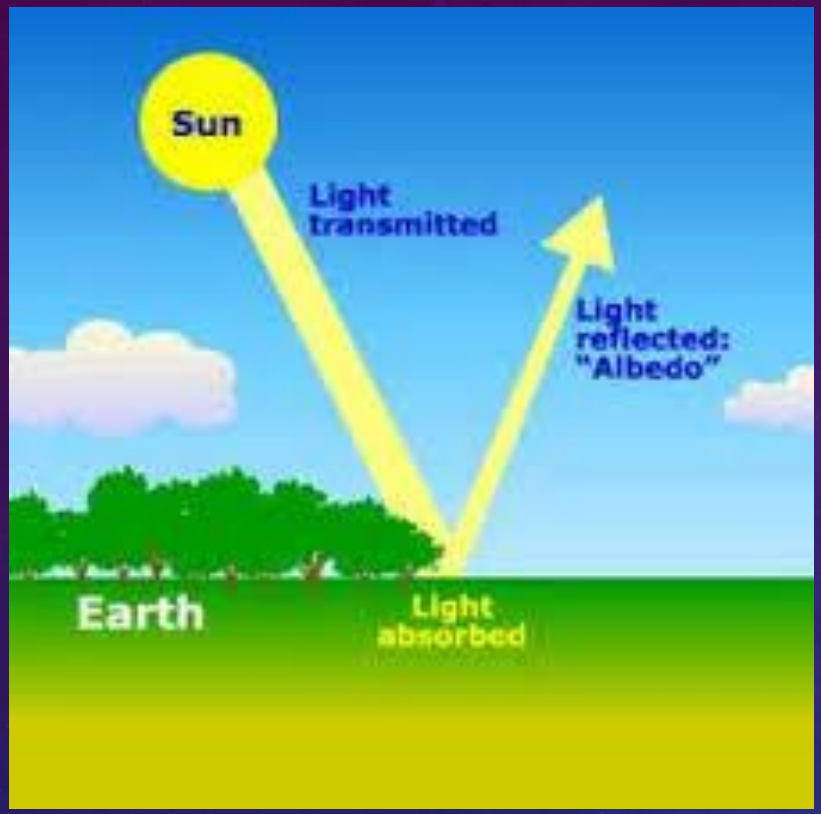
- **Stefan–Boltzmann law-**

  The total energy flux emitted by a blackbody remains proportional to the fourth power of temperature in absolute scale.

  $E = \sigma T^4$

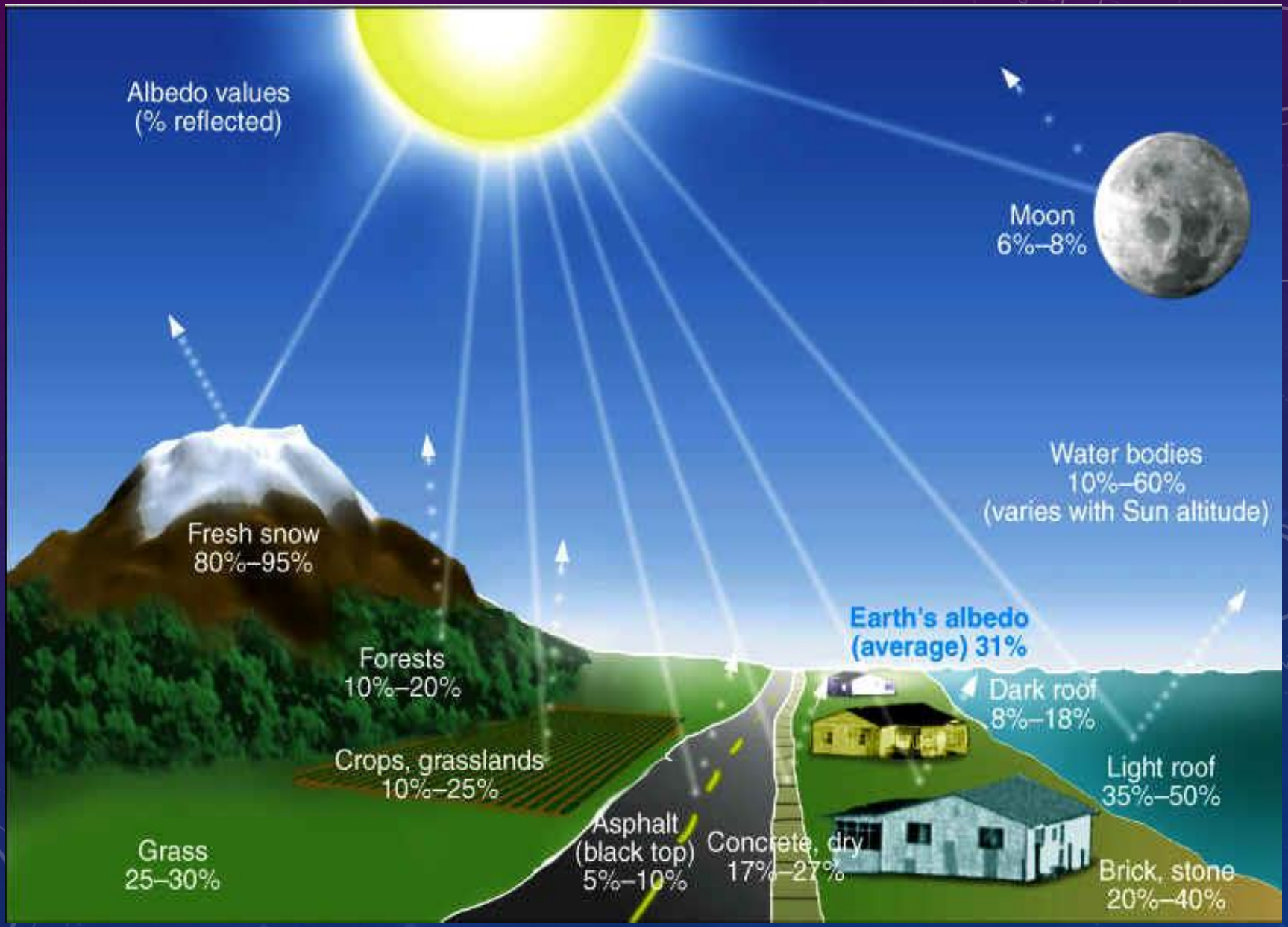
  Where 'σ' is Stefan's constant = 5.672×10^{-8} $Js^{-1}m^{-2}K^{-4}$

Albedo



- Earth receives a very large input of energy daily from the sun and maintains a steady state by giving off the bulk of this energy at the same rate.
- The earth absorbs radiation mainly in the visible region but emits radiation at the same rate in the infrared region.
- The solar flux incident on earth's upper atmosphere is 1372 W/ m^2 /min.
- The earth / atmosphere absorbs about 70 % of solar flux incident on it, while it reflects and scatters back into space 30 % (albedo) of the flux.

Note:- Fraction of sunlight reflected and scattered back to the atmosphere is known as albedo


Albedo values
(% reflected)
Moon
6%–8%
Water bodies
10%–60%
(varies with Sun altitude)
Fresh snow
80%–95%
Earth's albedo
(average) 31%
Forests
10%–20%
Dark roof
8%–18%
Crops, grasslands
10%–25%
Light roof
35%–50%
Asphalt
(black top)
5%–10%
Concrete, dry
17%–27%
Grass
25–30%
Brick, stone
20%–40%

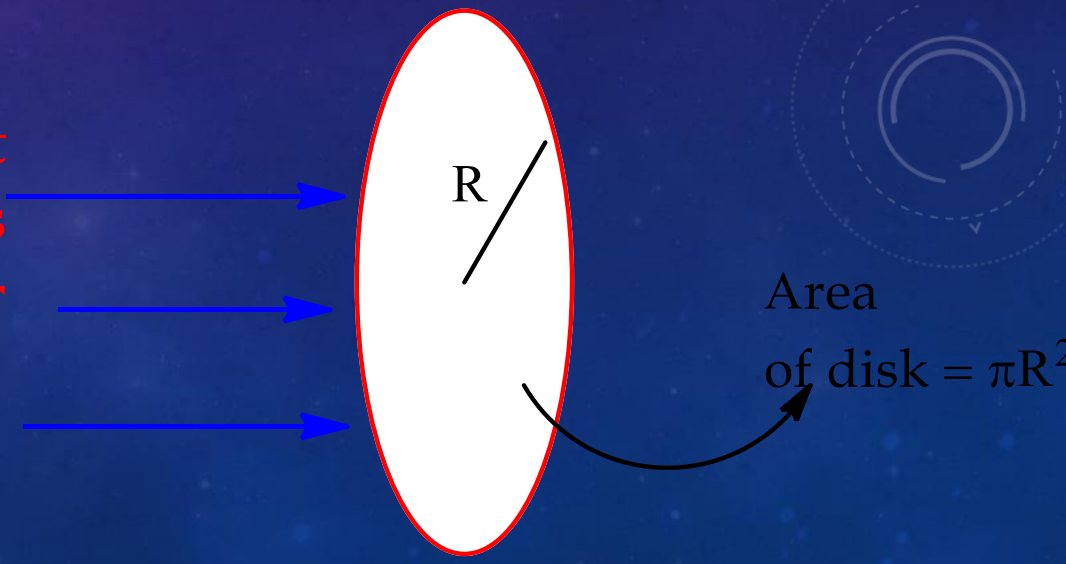
Radiation Balance Model

To overcome the difficulty posed by the fact that the planets are spherical and their surface tilts with respect to the incoming radiation, **is assumed that the amount distributed over the sphere is equal the amount that would be collected on the planets surface if it would have been a disk (with the same radius as the sphere), placed perpendicular to the sunlight**. If the planet's radius is **R** the area of that disk is πR^2.

Heat absorbed by planet = $(1 - \alpha)\ \pi R^2 S_o$

S_o - Solar radiative flux at the top of the planets atmosphere (for solar constant)

α- Albedo of the planet



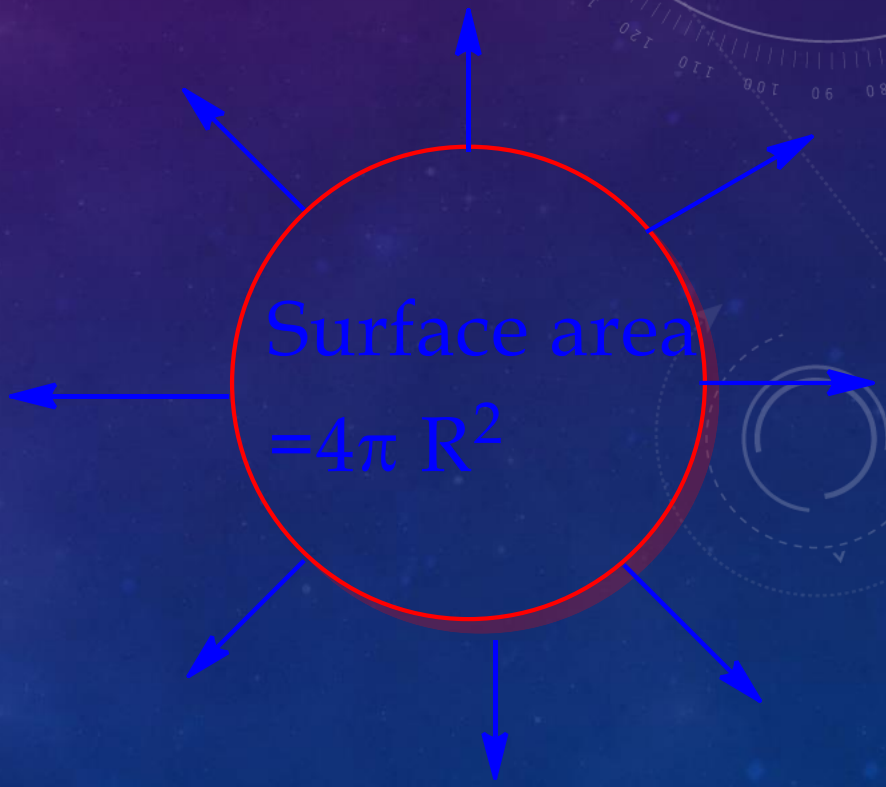
Cont.

The total heat radiated from the planet is equal to the energy flux implied by its effective temperature, T_e from the entire surface of the planet

Heat radiated from planet = $(4\pi R^2)\ \sigma T_e^4$

In radiative balance we thus have:

$(4\pi R^2)\ \sigma T_e^4 = (1 - \alpha)\ \pi R^2 S_o$



Solving this equation for effective temperature we obtain:

$$T_e = \left[\frac{(1-\alpha)S_0}{4\sigma}\right]^{1/4}$$

Cont.

- Subscript '**e**' to the temperature is used to emphasize that this would be the temperature at the surface of the planet if it had no atmosphere. It is referred to as the **effective temperature** of the planet. According to this calculation, the effective temperature of Earth is about 255 K (or -18 °C)

- With this temperature the Earth radiation will be centered on a wavelength of about 11 μm, well within the range of infrared (IR) radiation

- The effective temperature of Earth is much higher than what we calculated. Averaged over all seasons and the entire Earth, **the surface temperature of our planet is about 288 K (or 15°C)**

This difference is in the effect of the heat absorbing components of our atmosphere. This effect is known as the **greenhouse effect**

EIA

- **Environmental Impact Assessment** (**EIA**) is the assessment of the environmental consequences (positive and negative) of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action

- Environmental assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review

- The International Association for Impact Assessment (**IAIA**) defines an environmental impact assessment as **"the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made"**

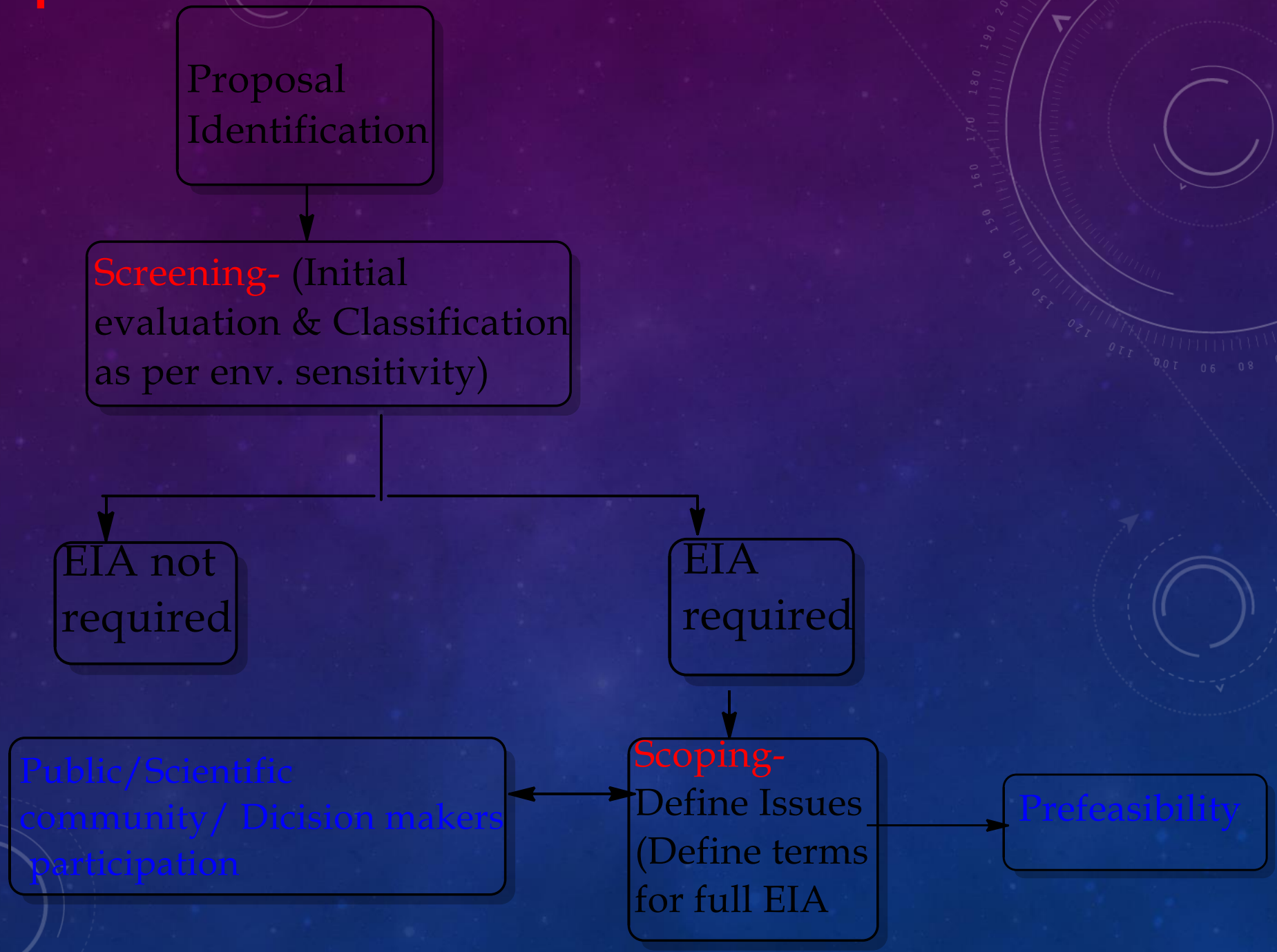
Environmental Clearance from central government is required for 32 categories of development projects – under industrial sectors:

- Mining
- Thermal power plants
- River valley
- Infrastructure (road, highways, ports, harbours, and airports)
- Industries including very small electroplating in foundry units

EIA benefits:

- Protection of Environment
- Optimum utilization of resources
- Saves overall time and cost of the project
- Promotes community participation
- Helps decision/policy makers to take appropriate decision
- Lays base for environmentally sound projects. History & Evolution of EIA

Steps in EIA


Proposal Identification
Screening- (Initial evaluation & Classification as per env. sensitivity)
EIA not required
EIA required
Public/Scientific community/ Dicision makers participation
Scoping- Define Issues (Define terms for full EIA
Prefeasibility

Screening is the First stage of EIA, which determines whether the proposed project requires an EIA and if requires, then the level of assessment required. Its criteria are based upon:

- **Scales of investment**
- **Type of development**
- **Location of development**

Project Category 'A' : Projects in this category typically require an EIA. The project type, scale and location determine this designation. The potentially significant environmental issues for these projects may lead to changes in land-use, as well as changes to social, physical, and biological environment.

Category 'B' : Only difference between projects in this category and those in Category 'A' is the scale. Larger Power plants fall under category 'A', Medium Sized Power Plants projects are in category 'B'. These projects are not located in environmentally sensitive area. Mitigation measures for these projects are more easily prescribed.

Category 'C': This category is for projects that typically do not require an EIA. These projects are unlikely to have adverse environmental impacts.

Scoping:

- This stage identifies key issues and impact that should be further investigated
- This stage also defines the boundary and the time limit of the study
- Quantifiable and non quantifiable impact (aesthetic or recreational value) are to be assessed
- Baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted

AIR

- Changes in the ambient level and the ground level concentrations due to emissions from point, line and area source
- Effects on soils, materials, vegetation and human health.

NOISE

- Changes in the ambient level due to noise generated from equipment and movement of vehicles
- Effects on fauna and human health.

WATER

- Availability to competing users
- Changes in the quality
- Sediment transport
- Ingress of saline water

LAND

- Changes in the land-use and drainage pattern
- Changes in land quality including effects of waste disposal
- Changes in shoreline/riverbank and their stability.

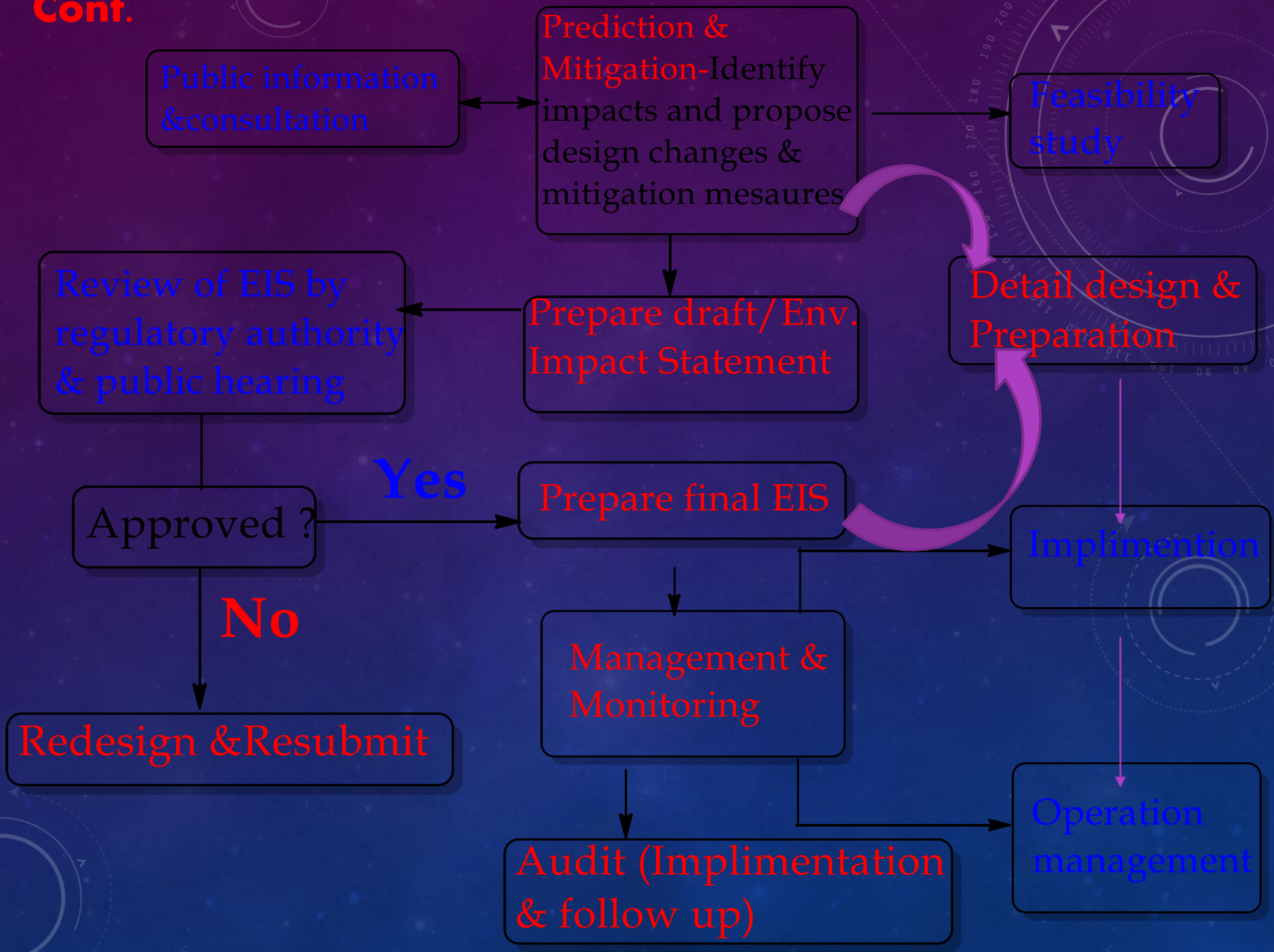
BIOLOGICAL

- Deforestation and shrinkage of animal habitat
- Impact on flora and fauna due to contaminants /pollutants
- Impact on rare and endangered species, endemic species and migratory path of animals including birds
- Impact on breeding and nesting grounds

SOCIO-ECONOMIC

- Impact on the local community including demographic changes
- Impact on economic status
- Impact on human health
- Impact of increased traffic

Cont.


Public information &consultation
Prediction & Mitigation-Identify impacts and propose design changes & mitigation mesaures
Feasibility study
Review of EIS by regulatory authority & public hearing
Prepare draft/Env. Impact Statement
Detail design & Preparation
Yes
Approved ?
Prepare final EIS
Implimention
No
Management & Monitoring
Redesign &Resubmit
Audit (Implimentation & follow up)
Operation management

Prediction and Mitigation

- Possible alternative should be identified and environmental attributes compared
- Alternatives for project location & process technologies
- Alternative of ‘no project’ should also be considered
- Ranking of alternatives based on the best environmental option for optimum economic benefits to the community at large
- Mitigation plan for the selected option have to be drawn, and is supplemented with the Environmental Management Plan (EMP) to guide towards, Environmental Improvement