

# **50 MOST IMPORTANT TOPICS**

## **UPSC CSE 2026**

# Thermogenesis in Plants

- Thermogenesis refers to the process by which **living organisms generate heat through metabolic activity.**
- Heat is produced during **cellular respiration** when mitochondria convert food into ATP (adenosine triphosphate).
- Only about **25% of energy becomes ATP**, while the remaining energy is released as **heat.**
- In some cases, mitochondria can convert almost all energy from sugars into heat.
- In plants, the **enzyme Alternative Oxidase (AOX)** facilitates this heat production.

# Thermogenesis in Plants

## Thermogenesis in Sacred Lotus (*Nelumbo nucifera*)

- Sacred Lotus is **native to North and Central India** and grows in ponds, lakes, and slow-flowing waters.
- The flower blooms for **3–4 days in early summer**.
- During blooming, the internal flower temperature remains around **30–35°C**, even when the **surrounding temperature falls to 10°C**.
- Thermogenesis begins when **petal tips of unopened flowers turn pink**.
- Heat generation helps release **fragrant scent molecules**, attracting pollinators.
- **Calcium ions** act as a trigger, increasing four-fold in cells to activate mitochondria for heat production.
- Heat generation consumes **large amounts of stored starch and fat**.

# Thermogenesis in Plants

## Significance of Thermogenesis

- Helps **attract pollinators** through scent dispersal.
- Provides **warm microhabitats** for insects.
- Facilitates **cross-pollination and reproductive success**.
- Demonstrates **adaptive plant evolution** in pollination strategies.

# Ocean Darkening

- Ocean darkening is the **reduction of sunlight penetration into the ocean** due to **increased turbidity**, causing the vital **upper "photic zone" to shrink**.
- A **major 2025 study from the University of Plymouth** (published in *Global Change Biology*) analyzed satellite data (MODIS Aqua) from 2003 to 2022.
- **Over 20% of the global ocean** has darkened in the **past two decades**, impacting marine ecosystems, food webs, and carbon cycling by forcing organisms into smaller habitats.
- Driven by **climate-induced changes**, including increased coastal runoff of sediment, nutrients from agriculture, and algal blooms.
- A 20-year study found **21% of the global ocean has darkened**.
- In some areas, the photic zone—where 90% of marine life exists—**has shrunk by over 50 meters**.
- It **reduces photosynthetic activity**, disrupts predators reliant on light, and limits habitats for species like *Calanus* copepods.

# Ecological Discolouration

- **Ecological Discolouration** is a recently highlighted environmental phenomenon describing **measurable changes, fading, dulling, or shifts** in the **vibrant natural colours** of ecosystems, animals, plants, and landscapes.
- It is primarily driven by **global warming, pollution, and habitat degradation**, serving as a **visible early-warning indicator** of broader ecosystem stress.

# Ecological Discolouration

- **Coral bleaching** occurs when corals expel their symbiotic algae (zooxanthellae) under thermal stress, exposing white skeletons and risking starvation/death.
- **Oceans greening:** Over 50–56% of global oceans have become greener in the last two decades due to shifts in phytoplankton and algal blooms (from nutrient changes and warming).
- **Insects adapting:** Dragonflies, ladybirds, and others in temperate regions are evolving paler/lighter colours to stay cool during heatwaves.
- **Butterflies in the Amazon:** High deforestation leads to loss of the most colourful species first; survivors show duller patterns suited to open, monotonous landscapes (restored forests regain vibrancy)

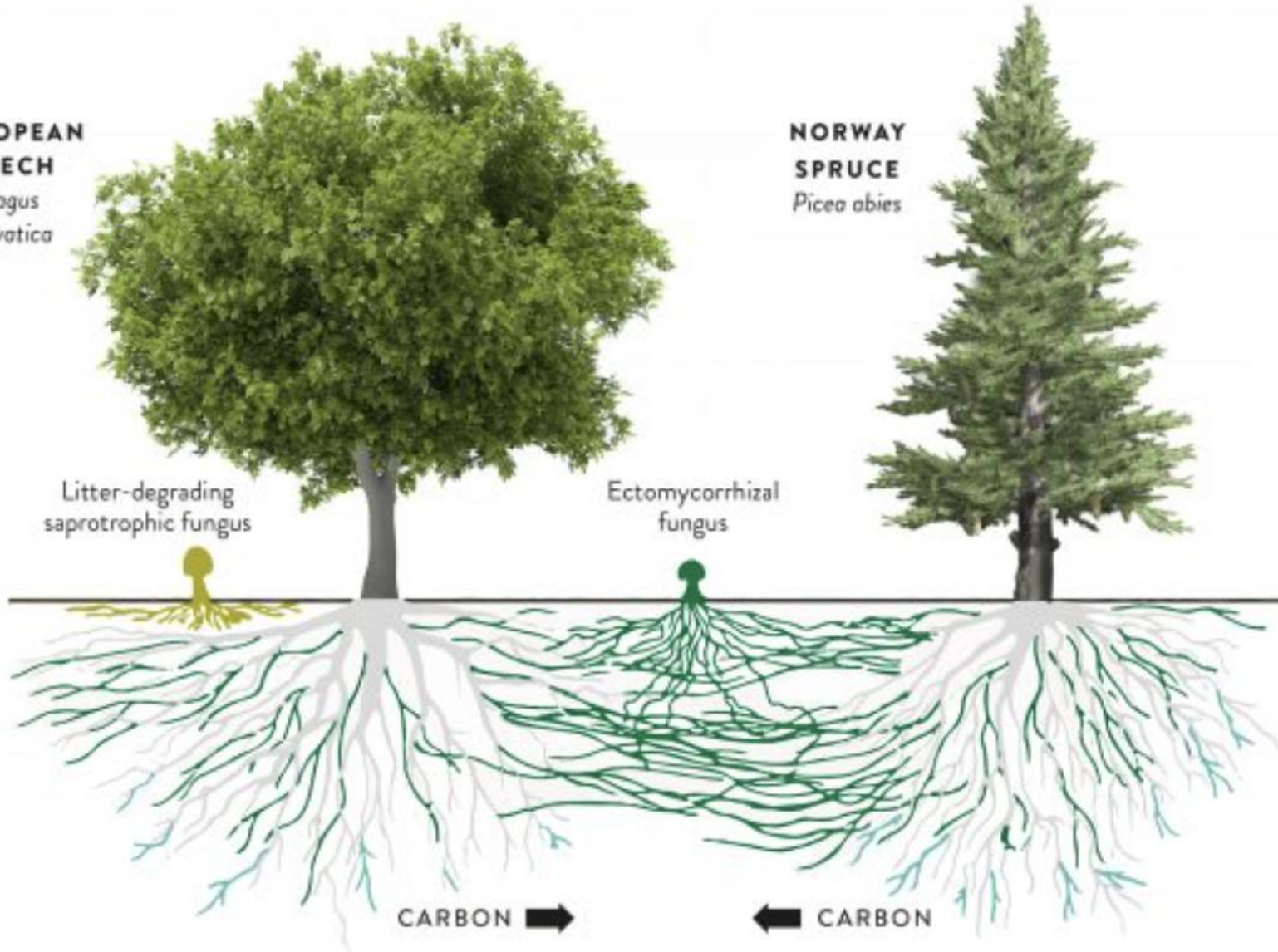
# Wood Wide Web

- The "wood wide web" refers to the **underground, mycorrhizal network of fungi and plant roots** that connects trees in a forest, allowing them to **share nutrients, water, and carbon**, as well as send chemical signals.
- Identified by **Dr. Suzanne Simard**, this symbiotic system helps trees **cooperate and support** each other, although the extent of this communication is currently debated by scientists.
- **Resource sharing** – Healthy trees can send nutrients/carbon to shaded, young, or damaged ones.
- **Communication** – Trees may send chemical signals (e.g., warnings about pests, drought, or disease) through the network.
- **Support for regeneration** – "Mother trees" nurture offspring or kin, boosting forest resilience.



**EUROPEAN  
BEECH**  
*Fagus  
sylvatica*

**NORWAY  
SPRUCE**  
*Picea abies*



# Wood Wide Web

- **American evolutionary biologist Toby Kiers** has been honored with the **Tyler Prize for Environmental Achievement** for pioneering research that reveals the complex, largely unseen world beneath our feet.
- Administered by the **University of Southern California**, it awards laureates a \$250,000 cash prize. Dr. Toby Kiers is the 2026 laureate for her work on fungal networks.

## Biologist Wins 'Environment Nobel' for Revealing Hidden Fungal Networks Underground

A biologist has been awarded the "Environment Nobel" for groundbreaking research on hidden fungal networks beneath the earth's surface. These underground systems, often called the "wood wide web," connect plants and trees, allowing them to exchange nutrients, water, and signals. The discovery has transformed scientific understanding of forest ecosystems, revealing how plants cooperate and communicate through fungi, and highlighting the critical role these networks play in maintaining biodiversity, ecosystem resilience, and overall environmental health.

# Trophic Cascade

- A **trophic cascade** is a powerful ecological process where **changes at the top of a food chain** (like the addition or removal of predators) ripple downward, dramatically altering populations, behavior, and even the physical structure of an entire ecosystem.
- It was first formally described in 1980 by ecologist **Robert Paine**, but the idea traces back to Charles Darwin and Aldo Leopold.
- **Top-down effect** - Predators control herbivores → herbivores control plants. When predators increase, herbivores decrease (or change behavior), which lets plants thrive. The reverse happens if predators are removed.

# Extinction Debt

- **Extinction debt/Extinction lag** is the **future loss** of species that is already inevitable because of **past environmental damage**, mainly **habitat destruction and fragmentation**, even though the species are still hanging on for now.
- These are often called the “**living dead**”: populations that look okay today but are doomed to disappear over decades or centuries because the landscape can no longer support them.

# Eco-anxiety

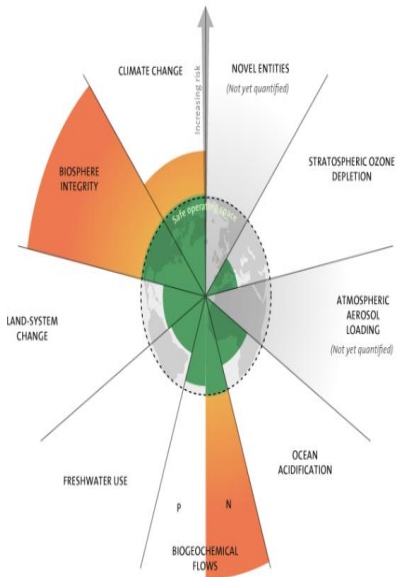
- Eco-anxiety (climate anxiety or climate distress) is the **chronic fear, worry, grief, or despair** people feel about the state of the environment and the impacts of climate change.
- It's not an **official clinical diagnosis** in the DSM-5, but a **rational emotional response** to very real threats—like extreme weather, biodiversity loss, and uncertain futures—rather than a disorder

# Solastalgia

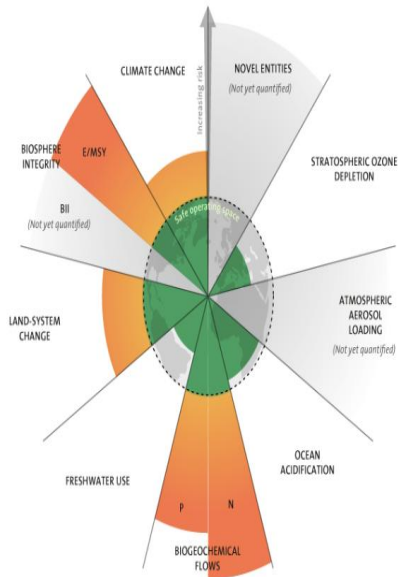
- It is the **emotional distress** or “**homesickness**” one feels when your **home environment changes in unwanted ways**, even though you’re still living there.
- It’s the pain of watching a beloved place lose its familiar comfort, solace, or identity due to environmental degradation.
- The term was coined in **2003** by Australian environmental philosopher **Glenn Albrecht** during his work with communities affected by **open-cut coal mining in New South Wales**.

# Planetary Boundaries

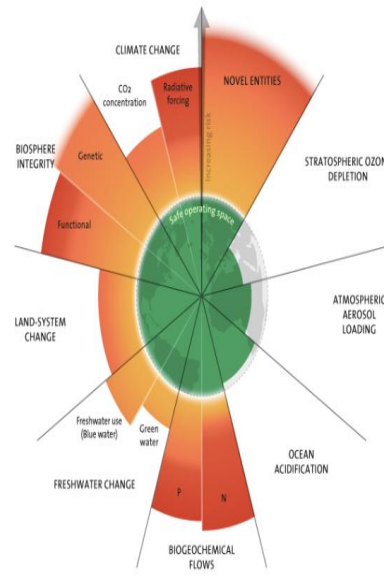
- Planetary boundaries define **nine critical, science-based limits** within which humanity can safely operate to ensure Earth's stability and resilience.
- Proposed in **2009** by **Johan Rockström** and colleagues, this framework highlights that breaching these thresholds risks irreversible environmental changes.
- As of 2025, **seven of the nine boundaries** are now considered transgressed.



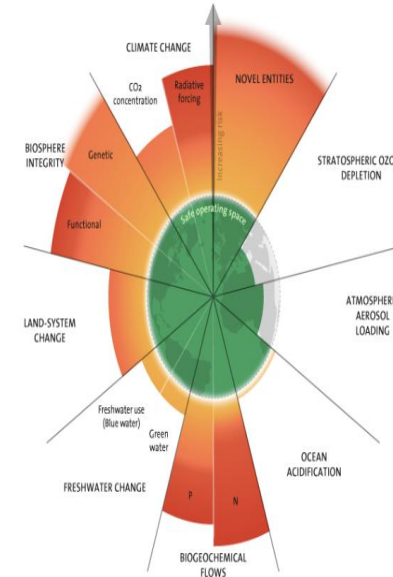
7 boundaries assessed,  
3 crossed



7 boundaries assessed,  
4 crossed



9 boundaries assessed,  
6 crossed



9 boundaries assessed,  
7 crossed

# Grey Rhino and Black Swan Event

- A Grey Rhino is a high-probability, high-impact risk that is obvious and visible, but still often ignored until it's too late. Example is climate change and Wayanad landslide in 2024.
- A Black Swan event is a rare, unpredictable event with an extremely large impact, which people try to explain only after it has happened.
- An example is the 2004 Indian Ocean Tsunami and the COVID-19 pandemic.

# Aerosol Masking Effect

- It is the **temporary, cooling influence** of atmospheric particles (aerosols) from pollution, which **reflect sunlight and brighten clouds, offsetting** a significant portion of greenhouse gas-induced **global warming**.
- By acting as a "mask," these particles, often **sulfates** from industry, hide the full extent of climate change.
- Temporary because aerosols have **very short atmospheric lifetimes**. Successfully cleaning up air pollution, the mask is slipping—contributing to the recent acceleration in observed warming.
- Link it to **Stratosphere Aerosol Injection/Volcanoes/Global Dimming**.

# Bamboo Brakes

- **Dense, thicket ecosystems** dominated by bamboo are found within several protected areas, particularly in Northeast India and parts of Southeast Asia, acting as critical habitats and ecological buffers.
- These areas are often categorized under forest conservation initiatives due to **their high biodiversity and role in preventing soil erosion.**
- **Key Protected Areas with Bamboo Brakes**
- **Intanki National Park (Nagaland, India):** Contains tropical evergreen forests, grassland patches, and significant bamboo brakes.
- **Rowa Wildlife Sanctuary (Tripura, India):** Features mixed moist deciduous secondary forests with patches of bamboo brakes.
- **Dampa Tiger Reserve (Mizoram, India):** Contains large tracts of secondary forest dominated by bamboo brakes, which serve as a habitat for various species.
- **Manas National Park (Assam, India):** Known for its rich biodiversity, which includes cane and bamboo brakes.
- **Amchang Wildlife Sanctuary (Assam, India):** Comprises miscellaneous species with evergreen patches and secondary bamboo brakes.
- **Panna Tiger Reserve (Madhya Pradesh, India):** Contains specific zones of Dry Bamboo Brakes (5/E9).

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