IUC ACADEMY
INCLUSIVE UNIVERSAL CAREERS ACADEMY
Learn. Prepare. Progress. • www.iucacademy.com
IUC ACADEMY NOTES

Complete Syllabus • Conceptual Flowcharts • Comparative Tables • Solved Practice Questions

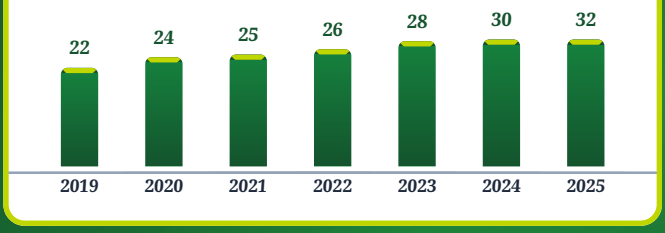
ENVIRONMENT, ECOLOGY, BIODIVERSITY & CLIMATE CHANGE — NOTES

Ecosystem Functions, Biogeochemical Cycles, Biodiversity Conservation, National Parks, 57 Tiger Reserves, 85+ Ramsar Wetlands, ISFR 2023, Environmental Legislation & Global Climate Conventions (UNFCCC/CBD)

Topic-Wise Exam Weightage Distribution (%)



Previous Years' Question Trend Analysis



Target Competitive, Entrance & Departmental Examinations

UPSC CSE & IFS • State PCS • SSC CGL/CHSL • Railway • NDA/CDS • UGC-NET Paper-1 • State Forest Exams

Core Syllabus Pillars & Exam Question Weightage (%)

- Protected Areas: National Parks, 57 Tiger Reserves, 18 Biosphere & 85+ Ramsar (26%)
- Ecology, Trophic Pyramids, Nutrient Cycles & Biotic Interactions (20%)
- Environmental Laws (WPA 1972/2022, EPA 1986, FCA, BDA, NGT 2010) (20%)
- Climate Change, UNFCCC COP Summits, Montreal/Kigali & Mission LiFE (18%)
- ISFR 2023 Forest Data, Pollution Control (NAQI, BS-VI) & EIA (16%)

Complete Theory
NCERT & Official Sources

Visual Flowcharts
Comparative Matrices

Memory Tricks
Exam Trap Alerts

75+ Solved MCQs
One-Liner Capsules

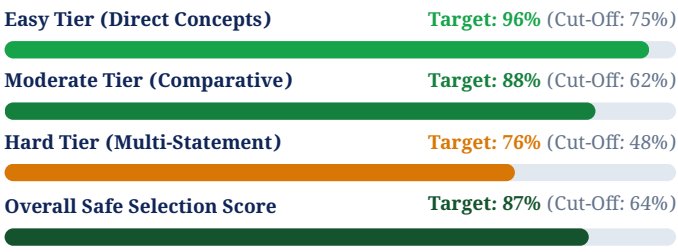
Preface, Exam Weightage Dashboard & Study Strategy — ENVIRONMENT, ECOLOGY, BIODIVERSITY & CLIMATE CHANGE — NOTES

IUC Academy (Inclusive Universal Careers Academy | www.iucacademy.com) • Official English Medium Study Notes

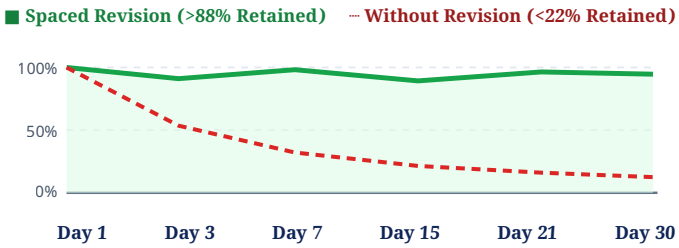
Dear Aspirants,

Modern competitive, entrance, and departmental promotion examinations demand a combination of deep conceptual clarity, statutory precision, and rapid revision tools. Prepared by **Inclusive Universal Careers Academy (IUC Academy — www.iucacademy.com)**, these comprehensive English-medium study notes integrate **structured chapter theory, 4-node conceptual process flowcharts, multi-column comparative tables, inline mathematical/scientific formulas, 'Did You Know?' boxes, 'Exam Trap Alert' callouts, 'Memory Trick' mnemonics, Chapter-End Analytical Synthesis Matrices, 75+ Step-by-Step Solved MCQs, and Rapid-Fire One-Liner Revision Capsules**.

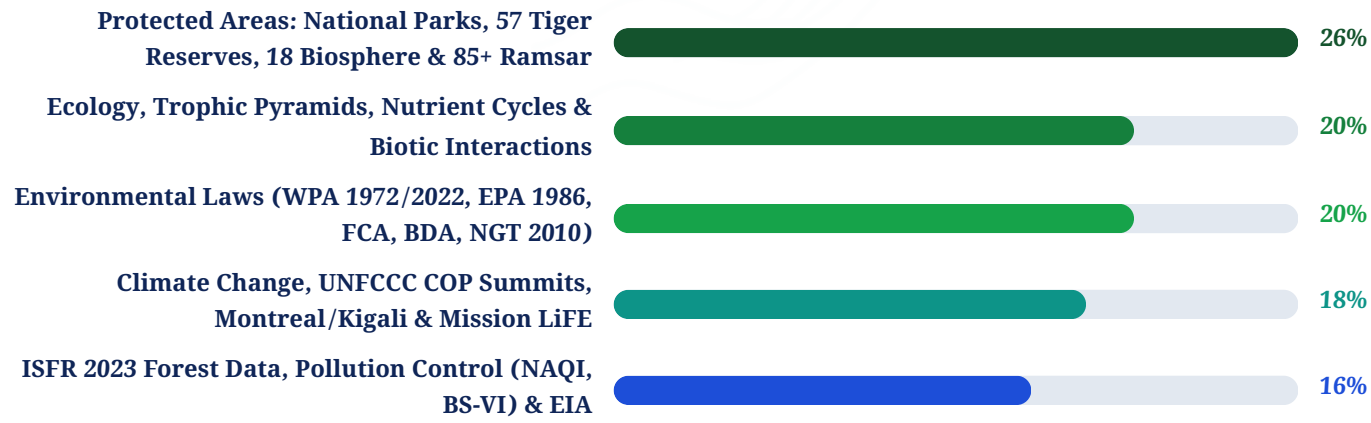
Target Accuracy vs Qualifying Cut-Off Benchmark (%)



Spaced Revision (1-3-7-21 Day Rule) & Retention Curve



Topic-Wise Exam Question Weightage Index (%)



Verified Official Curriculum & Statutory Reference Portals

- **Ministry of Environment, Forest & Climate Change (MoEFCC)** (https://moef.gov.in/)
- **Forest Survey of India (ISFR 2023)** (https://fsi.nic.in/forest-report-2023)
- **Press Information Bureau (PIB)** (https://www.pib.gov.in/)
- **NCERT Biology & Ecology** (https://ncert.nic.in/textbook.php)
- **IUC Academy Official Portal** (https://www.iucacademy.com)

Detailed Table of Contents & Chapter Architecture

ENVIRONMENT, ECOLOGY, BIODIVERSITY & CLIMATE CHANGE — NOTES • Complete Chapters, Comparative Matrices, Solved MCQs & Rapid Revision

1. Chapter 1: Fundamentals of Ecology, Ecosystems, Energy Flow & Biogeochemical Cycles

- 1.1 Levels of Ecological Organization, Ecotones & Ecological Niche
- 1.2 Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids
- 1.4 Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids

2. Chapter 2: Terrestrial & Aquatic Ecosystems — Mangroves, Coral Reefs, Wetlands & Estuaries

- 2.1 Aquatic Zonation, Lake Eutrophication & Algal Blooms
- 2.2 Coral Reefs, Coral Bleaching & Mangrove Adaptations

3. Chapter 3: Biodiversity, IUCN Red List, Hotspots & Conservation (In-Situ & Ex-Situ)

- 3.1 Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots
- 3.2 In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India
- 3.4 Master Table of India's 18 Biosphere Reserves & Flagship Endemic Fauna

4. Chapter 4: National Parks, Tiger Reserves, Wildlife Projects & Ramsar Wetlands of India

- 4.1 Flagship Wildlife Conservation Projects & Tiger Reserves of India
- 4.2 Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites

5. Chapter 5: India State of Forest Report (ISFR 2023) & Forest Types of India

- 5.1 Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data

6. Chapter 6: Environmental Legislation, Statutory Bodies & Movements in India

- 6.1 Landmark Environmental Acts & Institutional Architecture of India
- 6.3 Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements

7. Chapter 7: Environmental Pollution, Air Quality Index, Waste Management & Bioremediation

- 7.1 Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain
- 7.2 Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties
- 7.4 Master Reference Table of Pollution-Induced Diseases & International Waste Conventions

8. Chapter 8: Climate Change, Ozone Depletion, UNFCCC COP Summits & India's Net-Zero Panchamrit

- 8.1 Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols
- 8.2 Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29
- 8.4 Master Table of Global Environmental Conventions, Protocols & Summits

9. Solved Exam Practice Questions (MCQs)

10. Extended Comparative & Analytical Practice Set (Questions 36–75)

11. Rapid-Fire Last-Minute One-Liner Revision Capsule

Published by: Inclusive Universal Careers Academy (IUC Academy)

Academic Source Alignment: Ministry of Environment, Forest and Climate Change (MoEFCC), Forest Survey of India ISFR 2023, NCERT Biology & Ecology Textbooks, and Press Information Bureau (PIB) Environment Releases

Chapter 1: Fundamentals of Ecology, Ecosystems, Energy Flow & Biogeochemical Cycles

Chapter Key Study Pillars — Chapter 1: Fundamentals of Ecology, Ecosystems, Energy Flow & Biogeochemical Cycles

Key Study Pillar 1	Key Study Pillar 2	Key Study Pillar 3
Levels of Ecological Organization, Ecotones & Ecological Niche	**Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids**	**Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids**

1.1 Levels of Ecological Organization, Ecotones & Ecological Niche

• **Foundational Terminology (NCERT Class XII Biology):**

• **Ecology (*Oekologie*):** Coined by German biologist **Ernst Haeckel (1866)** from Greek *Oikos* (home/habitat) and *Logos* (study) to denote the scientific study of reciprocal interactions between living organisms and their abiotic environment.

• **Ecosystem:** Coined by British ecologist **Sir Arthur G. Tansley (1935)** as the structural and functional unit of nature integrating **Biotic** (Autotrophs/Producers, Heterotrophs/Consumers, and Saprotrophs/Decomposers) and **Abiotic** (temperature, light, water, soil, atmospheric gases) components.

• **Ecological Hierarchy:** Progresses from **Individual Organism → Population** (conspecific individuals in a defined geographical area) **→ Biological Community** (interacting populations of multiple species) **→ Ecosystem → Landscape → Biome → Biosphere**.

• **Habitat vs. Ecological Niche: Habitat** is the physical "address" where an organism lives, whereas **Ecological Niche** (coined by **Joseph Grinnell, 1917**, and developed by Charles Elton and G.E. Hutchinson) is the unique functional "profession" and resource-utilization role of a species; under **Gause's Competitive Exclusion Principle**, no two species can occupy the exact same ecological niche indefinitely in a stable habitat.

• **Ecotone & Edge Effect:** An **Ecotone** is a transitional zone of tension between two distinct ecosystems (e.g., **Mangroves** between marine and terrestrial ecosystems; **Estuaries** between fresh river water and saline sea water; **Grasslands** between forest and desert); the **Edge Effect** describes the phenomenon whereby species diversity and population density inside the ecotone are significantly greater than in either flanking ecosystem, hosting unique **Edge Species** (such as floodplain waterfowl).

1.2 Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids

• **Productivity Metrics (NCERT):**

• **Gross Primary Productivity (GPP):** Total rate of organic matter (biomass) production via photosynthesis per unit area per unit time (kcal/m^2/yr).

• **Net Primary Productivity (NPP = GPP - R):** Biomass remaining after subtracting plant respiratory losses (R); NPP represents the actual energy available for consumption by herbivores and decomposers.

• **Highest Productivity Ecosystems:** Tropical Rainforests, Coral Reefs, and Estuaries exhibit the highest mean Net Primary Productivity, whereas Open Oceans and Extreme Deserts have the lowest NPP per unit area (though Open Oceans contribute heavily to total global productivity due to covering ~71% of the planet).

• **Energy Flow & Lindeman's 10% Law (1942):** Energy flow in an ecosystem is **strictly unidirectional** (Sun → Producers → Primary Consumers → Secondary Consumers → Tertiary Consumers) and obeys the First and Second Laws of Thermodynamics; only **10% of energy** stored at one trophic level is transferred to the next higher trophic level, while 90% is lost as metabolic heat, limiting food chains to 4–5 trophic levels.

• **Grazing vs. Detritus Food Chains:** The **Grazing Food Chain (GFC)** begins with living green plants (primary source of energy flow in **aquatic ecosystems**), whereas the **Detritus Food Chain (DFC)** begins with dead organic matter decomposed by saprophytic fungi and bacteria (accounting for a much larger fraction of energy flow in **terrestrial forest ecosystems**).

• **Charles Elton's Ecological Pyramids (1927):**

• **Pyramid of Numbers: Upright** in Grassland and Pond ecosystems; **Inverted** or **Spindle-shaped** in a **Single Large Tree ecosystem** (1 large Banyan tree supports hundreds of frugivorous birds, which support thousands of ectoparasites).

• **Pyramid of Biomass: Upright** in almost all **Terrestrial ecosystems**; **Inverted** in **Aquatic/Marine ecosystems** where tiny microscopic **Phytoplankton** have a smaller standing crop biomass at any given instant than the larger **Zooplankton and Fish** they support via rapid reproductive turnover.

• **Pyramid of Energy: ALWAYS UPRIGHT without exception** in every ecosystem on Earth due to inevitable respiratory heat loss at each trophic transfer.

• **Bioaccumulation vs. Biomagnification: Bioaccumulation** is the gradual build-up of a persistent pollutant within a **single organism** over its lifetime, whereas **Biomagnification** is the progressive multiplication of non-biodegradable, **lipophilic (fat-soluble)** toxicants (such as **DDT, Mercury/Methylmercury, PCBs, and Endosulfan**) across successive trophic levels, causing eggshell thinning in piscivorous birds via calcium metabolism disruption.

• **Ecological Succession (Clements, 1916) & Biotic Interactions:** Progression from a **Pioneer Community** (e.g., **Lichens and Mosses** in *Xerarch/Lithosere* succession on bare rock; **Phytoplankton** in *Hydrarch/Hydrosere* succession in water) through intermediate **Seral Communities** to a stable **Climax Community**; **Primary Succession** occurs on sterile substrates without prior soil (lava, bare rock, newly formed sand dunes —very slow), while **Secondary Succession** occurs where pre-existing soil survives after forest fires, floods, or abandoned shifting cultivation (much faster).

1.3 Flowchart of Unidirectional Trophic Energy Flow & Biomagnification

Step-by-Step Conceptual Process Flowchart

STEP 1
Autotrophic Producers (1,000 kcal Solar Fixation | 0.04 ppm DDT)

STEP 2
Primary Consumers / Herbivores (100 kcal | 0.5 ppm DDT)

STEP 3
Secondary Consumers / Small Carnivores (10 kcal | 2.0 ppm DDT)

STEP 4
Apex Predators / Piscivorous Birds (1 kcal | 25 ppm DDT Biomagnified)

1.4 Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids

Biotic Interaction / Pyramid Type	Species A	Species B	Biological Mechanism & Classic NCERT Examples (NCERT)
Mutualism	+	+	Both species benefit obligatorily: **Lichens** (Algae + Fungi), **Mycorrhizae** (Fungi + Plant roots), **Fig tree & Wasp**, **Rhizobium** in legumes
Commensalism	+	0	One benefits, other unaffected: **Orchid epiphyte on Mango branch**, **Barnacles on Whale**, **Cattle Egret & grazing cattle**, **Clownfish & Sea Anemone**
Protocooperation	+	+	Non-obligatory mutual benefit: **Oxpecker bird** / **Plover** removing ticks from Rhinoceros or Crocodile
Predation & Parasitism	+	-	One benefits, host/prey harmed: Tiger & Deer; **Cuscuta (Amarbel)** on hedge plants; **Koel (Brood Parasitism)** in Crow's nest
Competition	-	-	Both harmed competing for limiting resources (or **Abingdon Tortoise** driven extinct by goats on Galapagos Islands)
Amensalism (Antibiosis)	-	0	One inhibited, other unaffected: **Penicillium** mould secreting penicillin killing bacteria; **Black Walnut (*Juglans nigra*)** secreting *Juglone*

Step-by-Step Conceptual Process Flowchart

STEP 1
Did You Know?: In the Nitrogen Cycle (NCERT), atmospheric N_2 is fixed into ammonia (NH_3) by free-living bacteria (Azotobacter, Clostridium), symbiotic bacteria (Rhizobium in pulses, Frankia in non-leguminous *Alnus* nodules), and cyanobacteria (Anabaena, Nostoc); Nitrosomonas and Nitrosococcus oxidize ammonia into Nitrite (NO_2^-), Nitrobacter oxidizes nitrite into plant-absorbable Nitrate (NO_3^-), and Pseudomonas and Thiobacillus perform Denitrification (NO_3^-**

STEP 2
N_2).

Exam Trap Alert: Never confuse **Gaseous Biogeochemical Cycles (Carbon, Nitrogen, Oxygen, and Water/Hydrological cycles**—reservoir in atmosphere/hydrosphere, rapid circulation) with **Sedimentary Biogeochemical Cycles (Phosphorus and Sulphur cycles**—reservoir in Earth's crustal rocks, slow circulation with minimal gaseous phase)!

★ **Memory Trick:** Remember Nitrogen Cycle bacteria in exact sequence with **"R-N-N-P"**: **R**hizobium/Azotobacter (Fixation to NH_3) → **N**itrosomonas (NH_3 → NO_2^-) → **N**itrobacter (NO_2^- → NO_3^-) → **P**seudomonas (Denitrification back to N_2).

Chapter *1* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Levels of Ecological Organization, Ecotones & Ecological Niche	**Ecology (*Oekologie*)**	Coined by German biologist **Ernst Haeckel (1866)** from Greek *Oikos* (home/habitat) and *Logos* (study) to denote the scientific study of reciprocal interactions between living organisms and their abiotic environment.
Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids	**Ecosystem**	Coined by British ecologist **Sir Arthur G. Tansley (1935)** as the structural and functional unit of nature integrating **Biotic** (Autotrophs/Producers, Heterotrophs/Consumers, and Saprotrophs/Decomposers) and **Abiotic** (temperature, light, water, soil, atmospheric gases) components.
Flowchart of Unidirectional Trophic Energy Flow & Biomagnification	**Ecological Hierarchy**	Progresses from **Individual Organism → Population** (conspecific individuals in a defined geographical area) **→ Biological Community** (interacting populations of multiple species) **→ Ecosystem → Landscape → Biome → Biosphere**.
Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids	**Habitat vs. Ecological Niche**	Habitat **is the physical "address" where an organism lives, whereas** Ecological Niche **(coined by** Joseph Grinnell, 1917**, and developed by Charles Elton and G.E. Hutchinson) is the unique functional "profession" and resource-utilization role of a species; under** Gause's Competitive Exclusion Principle**, no two species can occupy the exact same ecological niche indefinitely in a stable habitat.
Levels of Ecological Organization, Ecotones & Ecological Niche	**Ecotone & Edge Effect**	An **Ecotone** is a transitional zone of tension between two distinct ecosystems (e.g., **Mangroves** between marine and terrestrial ecosystems; **Estuaries** between fresh river water and saline sea water; **Grasslands** between forest and desert); the **Edge Effect** describes the phenomenon whereby species diversity and population density inside the ecotone are significantly greater than in either flanking ecosystem, hosting unique **Edge Species** (such as floodplain waterfowl).
Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids	**Gross Primary Productivity (GPP)**	Total rate of organic matter (biomass) production via photosynthesis per unit area per unit time (kcal/m^2/yr).
Flowchart of Unidirectional Trophic Energy Flow & Biomagnification	**Net Primary Productivity (NPP = GPP - R)**	Biomass remaining after subtracting plant respiratory losses (R); NPP represents the actual energy available for consumption by herbivores and decomposers.
Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids	**Highest Productivity Ecosystems**	Tropical Rainforests, Coral Reefs, and Estuaries exhibit the highest mean Net Primary Productivity, whereas Open Oceans and Extreme Deserts have the lowest NPP per unit area (though Open Oceans contribute heavily to total global productivity due to covering ~71% of the planet).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Levels of Ecological Organization, Ecotones & Ecological Niche	**Energy Flow & Lindeman's 10% Law (1942)**	Energy flow in an ecosystem is **strictly unidirectional** (Sun → Producers → Primary Consumers → Secondary Consumers → Tertiary Consumers) and obeys the First and Second Laws of Thermodynamics; only **10% of energy** stored at one trophic level is transferred to the next higher trophic level, while 90% is lost as metabolic heat, limiting food chains to 4–5 trophic levels.
Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids	**Grazing vs. Detritus Food Chains**	The **Grazing Food Chain (GFC)** begins with living green plants (primary source of energy flow in **aquatic ecosystems**), whereas the **Detritus Food Chain (DFC)** begins with dead organic matter decomposed by saprophytic fungi and bacteria (accounting for a much larger fraction of energy flow in **terrestrial forest ecosystems**).
Flowchart of Unidirectional Trophic Energy Flow & Biomagnification	**Pyramid of Numbers**	Upright **in Grassland and Pond ecosystems;** Inverted **or** Spindle-shaped **in a** Single Large Tree ecosystem** (*1* large Banyan tree supports hundreds of frugivorous birds, which support thousands of ectoparasites).
Comparative Matrix of Interspecific Biotic Interactions & Ecological Pyramids	**Pyramid of Biomass**	Upright **in almost all** Terrestrial ecosystems; Inverted **in** Aquatic/Marine ecosystems **where tiny microscopic** Phytoplankton **have a smaller standing crop biomass at any given instant than the larger** Zooplankton and Fish** they support via rapid reproductive turnover.
Levels of Ecological Organization, Ecotones & Ecological Niche	**Pyramid of Energy**	ALWAYS UPRIGHT without exception** in every ecosystem on Earth due to inevitable respiratory heat loss at each trophic transfer.
Trophic Dynamics, Lindeman's 10% Law & Ecological Pyramids	**Bioaccumulation vs. Biomagnification**	Bioaccumulation **is the gradual build-up of a persistent pollutant within a** single organism **over its lifetime, whereas** Biomagnification **is the progressive multiplication of non-biodegradable,** lipophilic (fat-soluble) **toxicants (such as** DDT, Mercury/Methylmercury, PCBs, and Endosulfan**) across successive trophic levels, causing eggshell thinning in piscivorous birds via calcium metabolism disruption.

Chapter *1* Multi-Statement Exam Verification Drills

Chapter 1 Statement-Verification Drill #1 — **Both Statements Verified Correct**

Statement-I (Ecology (*Oekologie*)): Coined by German biologist **Ernst Haeckel (1866)** from Greek *Oikos* (home/habitat) and *Logos* (study) to denote the scientific study of reciprocal interactions between living organisms and their abiotic environment.

Statement-II (Ecosystem): Coined by British ecologist **Sir Arthur G. Tansley (1935)** as the structural and functional unit of nature integrating **Biotic** (Autotrophs/Producers, Heterotrophs/Consumers, and Saprotrophs/Decomposers) and **Abiotic** (temperature, light, water, soil, atmospheric gases) components.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 1 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Ecological Hierarchy): Progresses from **Individual Organism → Population** (conspecific individuals in a defined geographical area) **→ Biological Community** (interacting populations of multiple species) **→ Ecosystem → Landscape → Biome → Biosphere**.

Statement-II (Habitat vs. Ecological Niche): Habitat **is the physical "address" where an organism lives, whereas** Ecological Niche **(coined by** Joseph Grinnell, 1917**, and developed by Charles Elton and G.E. Hutchinson) is the unique functional "profession" and resource-utilization role of a species; under** Gause's Competitive Exclusion Principle**, no two species can occupy the exact same ecological niche indefinitely in a stable habitat.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 1 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Ecotone & Edge Effect): An **Ecotone** is a transitional zone of tension between two distinct ecosystems (e.g., **Mangroves** between marine and terrestrial ecosystems; **Estuaries** between fresh river water and saline sea water; **Grasslands** between forest and desert); the **Edge Effect** describes the phenomenon whereby species diversity and population density inside the ecotone are significantly greater than in either flanking ecosystem, hosting unique **Edge Species** (such as floodplain waterfowl).

Statement-II (Gross Primary Productivity (GPP)): Total rate of organic matter (biomass) production via photosynthesis per unit area per unit time (kcal/m^2/yr).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 1 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Net Primary Productivity (NPP = GPP - R)): Biomass remaining after subtracting plant respiratory losses (R); NPP represents the actual energy available for consumption by herbivores and decomposers.

Statement-II (Highest Productivity Ecosystems): Tropical Rainforests, Coral Reefs, and Estuaries exhibit the highest mean Net Primary Productivity, whereas Open Oceans and Extreme Deserts have the lowest NPP per unit area (though Open Oceans contribute heavily to total global productivity due to covering ~71% of the planet).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 1 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Energy Flow & Lindeman's 10% Law (1942)): Energy flow in an ecosystem is **strictly unidirectional** (Sun → Producers → Primary Consumers → Secondary Consumers → Tertiary Consumers) and obeys the First and Second Laws of Thermodynamics; only **10% of energy** stored at one trophic level is transferred to the next higher trophic level, while 90% is lost as metabolic heat, limiting food chains to 4–5 trophic levels.

Statement-II (Grazing vs. Detritus Food Chains): The **Grazing Food Chain (GFC)** begins with living green plants (primary source of energy flow in **aquatic ecosystems**), whereas the **Detritus Food Chain (DFC)** begins with dead organic matter decomposed by saprophytic fungi and bacteria (accounting for a much larger fraction of energy flow in **terrestrial forest ecosystems**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 1 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Pyramid of Numbers): Upright **in Grassland and Pond ecosystems;** Inverted **or** Spindle-shaped **in a** Single Large Tree ecosystem** (*1 large Banyan tree supports hundreds of frugivorous birds, which support thousands of ectoparasites*).

Statement-II (Pyramid of Biomass): Upright **in almost all** Terrestrial ecosystems**;** Inverted **in** Aquatic/Marine ecosystems **where tiny microscopic** Phytoplankton **have a smaller standing crop biomass at any given instant than the larger** Zooplankton and Fish** they support via rapid reproductive turnover.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter *2:* Terrestrial & Aquatic Ecosystems — Mangroves, Coral Reefs, Wetlands & Estuaries

Chapter Key Study Pillars — Chapter 2: Terrestrial & Aquatic Ecosystems — Mangroves, Coral Reefs, Wetlands & Estuaries

Key Study Pillar 1
Aquatic Zonation, Lake Eutrophication & Algal Blooms

Key Study Pillar 2
Coral Reefs, Coral Bleaching & Mangrove Adaptations

2.1 Aquatic Zonation, Lake Eutrophication & Algal Blooms

• **Freshwater Lake Zonation (NCERT):**

• **Littoral Zone:** Shallow, warm nearshore water where sunlight penetrates all the way to the sediment floor, supporting rooted macrophytes.

• **Limnetic Zone:** Open well-lit surface water beyond the littoral zone dominated by phytoplankton and nekton down to the **Compensation Depth** (where gross photosynthesis equals respiration, bounded at ~200 m as the **Photic Zone**).

• **Profundal & Benthic Zones:** Dark **Aphotic Zone** below light penetration where heterotrophic decomposers consume sinking organic detritus on the bottom sediment (*Benthos*).

• **Oligotrophic vs. Eutrophic Lakes & BOD/COD:**

• **Oligotrophic Lakes:** Newly formed, deep, cold, crystal-clear lakes with low nutrient levels (N and P) and **high Dissolved Oxygen (DO)**.

• **Eutrophication & Cultural Eutrophication:** Nutrient enrichment (especially **Nitrates and Phosphates** from agricultural fertilizers, sewage, and detergents) triggers explosive **Algal Blooms**, blocking sunlight to submerged plants; when algae die, aerobic bacteria consume dissolved oxygen during decomposition, spiking **Biological Oxygen Demand (BOD)**, collapsing **Dissolved Oxygen (DO)**, creating hypoxic **"Dead Zones"**, and causing mass mortality of fish.

• **BOD vs. COD: Biological Oxygen Demand (BOD)** measures the dissolved oxygen required by **aerobic microorganisms** ONLY to decompose **biodegradable organic matter** over 5 days at 20^°C, whereas **Chemical Oxygen Demand (COD)** measures the oxygen equivalent required to chemically oxidize **BOTH biodegradable AND non-biodegradable organic pollutants** (hence, **COD is always numerically higher than BOD** for the same water sample).

2.2 Coral Reefs, Coral Bleaching & Mangrove Adaptations

• **Symbiotic Biology of Coral Reefs ("Rainforests of the Sea"):** Built by colonial marine invertebrates (**Coral Polyps**, phylum *Cnidaria*) living in obligatory mutualism with microscopic photosynthetic dinoflagellate algae called **Zooxanthellae**; the polyp provides protected calcium carbonate ($CaCO_3$) shelter and metabolic CO_2, while *Zooxanthellae* supply up to 90% of the coral's nutrition via photosynthesis and give corals their vibrant colors.

• **Ideal Conditions for Coral Growth:** Warm tropical/subtropical waters (30^° N to 30^° S) with water temperature **20^°C–27^°C**, shallow sunlight-rich depth (**<50 m**), clear sediment-free water (suspended silt clogs polyp mouths), and moderate salinity (**27–40 ppt**—hence corals never grow directly at the mouths of major freshwater rivers like the Ganga or Amazon).

• **Major Coral Reef Regions of India (MoEFCC):**

• **Fringing Reefs: Gulf of Mannar**, **Palk Bay**, **Gulf of Kutch**, and **Andaman & Nicobar Islands** (largest reef area in India).

• **Atolls (Ring-shaped reefs enclosing a lagoon): Lakshadweep Islands**.

• **Absent along East Coast Deltas:** Absent off the mouths of Ganga, Mahanadi, Godavari, and Krishna due to high freshwater influx and muddy turbidity (though deep-water patchy corals exist off Malvan, Maharashtra and Netrani Island, Karnataka).

• **Coral Bleaching:** Triggered when thermal anomalies (**El Niño ocean warming** of even 1^°–2^°C), ocean acidification, UV radiation, or xenobiotic pollution stress coral polyps into **expelling their symbiotic Zooxanthellae**, turning the colony stark white.

• **Mangrove Halophytic Adaptations (FSI ISFR 2023):** Salt-tolerant littoral trees/shrubs (*Halophytes*) growing in intertidal mudflats between 25^° N and 25^° S; possess **Pneumatophores** (blind upward-growing negatively geotropic breathing roots with *Lenticels* to absorb oxygen in anaerobic waterlogged mud, e.g., *Avicennia* and *Sonneratia*), **Stilt and Prop Roots** (*Rhizophora*—dissipating tsunami and cyclonic storm surges), **Vivipary** (seeds germinate while still attached to the parent tree before dropping into the saline mud), and **Salt-Excreting Foliar Glands**.

2.3 Flowchart of Cultural Eutrophication & Hypoxic Dead-Zone Formation

Step-by-Step Conceptual Process Flowchart

STEP 1
Nitrate & Phosphate Runoff from Fertilizers & Sewage into Lake

STEP 2
Explosive Surface Algal Bloom & Shading of Submerged Macrophytes

STEP 3
Algal Die-Off & Rapid Aerobic Bacterial Decomposition

STEP 4
Spike in Biological Oxygen Demand (BOD), Drop in Dissolved Oxygen (DO) & Fish Mortality

2.4 Comparative Table of Major Indian Mangrove Forests & Coral Reef Ecosystems

Ecosystem Site	State / Union Territory	Ecological Type	Key Indicator Species & Conservation Significance (MoEFCC)
Sundarbans Mangroves	West Bengal	Largest Tide-Dominated Mangrove Delta (~42% of India's mangroves)	*Heritiera fomes* (**Sundari** tree), Royal Bengal Tiger, Estuarine Crocodile
Bhitarkanika Mangroves	Odisha (Brahmani-Baitarani delta)	Second-largest contiguous mangrove ecosystem in India	**Gahirmatha Beach** (world's largest **Olive Ridley Sea Turtle** *Arribada* rookery)
Pichavaram & Muthupet	Tamil Nadu (Cauvery delta)	Backwater island mangrove network	*Rhizophora* and *Avicennia* shields that buffered the 2004 Indian Ocean Tsunami
Coringa Mangroves	Andhra Pradesh (Godavari estuary)	Estuarine mangrove sanctuary	Smooth-coated Otter, Fishing Cat, and Hope Island spit protection
Gulf of Kutch & Pirotan	Gujarat (Kutch, Jamnagar)	Arid-zone mangroves & Fringing Coral Reef	**Kharai Camel** (swimming camel that feeds on mangroves); Marine National Park
Gulf of Mannar & Lakshadweep	Tamil Nadu & Lakshadweep	Fringing Reef (Mannar) & Coral Atolls (Lakshadweep)	**Dugong (Sea Cow)** in Gulf of Mannar; ring-shaped coral lagoons in Lakshadweep

Did You Know?: According to the Ministry of Environment, Forest and Climate Change (MoEFCC) and PIB, India launched the **MISHTI Scheme (*Mangrove Initiative for Shoreline Habitats & Tangible Incomes*)** in Union Budget 2023–24 to restore and afforest **540 sq. km of mangroves across 9 coastal states and 4 Union Territories** over five years through convergence with CAMPA and MGNREGS!

Exam Trap Alert: Remember the inverse relationship between **Dissolved Oxygen (DO)** and **Biological Oxygen Demand (BOD)**: clean, unpolluted drinking water has **High DO and Very Low BOD (<1–2 mg/L)**, whereas heavily sewage-polluted water has **High BOD and Very Low DO**!

★ **Memory Trick:** Remember Mangrove survival adaptations with **"P-S-V = Pneumatophores (Breathing roots), Stilt roots (Mechanical wave support), Vivipary (In-tree seed germination)"**.

Chapter *2* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Aquatic Zonation, Lake Eutrophication & Algal Blooms	**Littoral Zone**	Shallow, warm nearshore water where sunlight penetrates all the way to the sediment floor, supporting rooted macrophytes.
Coral Reefs, Coral Bleaching & Mangrove Adaptations	**Limnetic Zone**	Open well-lit surface water beyond the littoral zone dominated by phytoplankton and nekton down to the **Compensation Depth** (where gross photosynthesis equals respiration, bounded at ~200 m as the **Photic Zone**).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flowchart of Cultural Eutrophication & Hypoxic Dead-Zone Formation	**Profundal & Benthic Zones**	Dark **Aphotic Zone** below light penetration where heterotrophic decomposers consume sinking organic detritus on the bottom sediment (*Benthos*).
Comparative Table of Major Indian Mangrove Forests & Coral Reef Ecosystems	**Oligotrophic Lakes**	Newly formed, deep, cold, crystal-clear lakes with low nutrient levels (N and P) and **high Dissolved Oxygen (DO)**.
Aquatic Zonation, Lake Eutrophication & Algal Blooms	**Eutrophication & Cultural Eutrophication**	Nutrient enrichment (especially **Nitrates and Phosphates** from agricultural fertilizers, sewage, and detergents) triggers explosive **Algal Blooms**, blocking sunlight to submerged plants; when algae die, aerobic bacteria consume dissolved oxygen during decomposition, spiking **Biological Oxygen Demand (BOD)**, collapsing **Dissolved Oxygen (DO)**, creating hypoxic **"Dead Zones"**, and causing mass mortality of fish.
Coral Reefs, Coral Bleaching & Mangrove Adaptations	**BOD vs. COD**	Biological Oxygen Demand (BOD) **measures the dissolved oxygen required by** aerobic microorganisms **ONLY to decompose** biodegradable organic matter **over 5 days at 20^°C, whereas** Chemical Oxygen Demand (COD) **measures the oxygen equivalent required to chemically oxidize** BOTH biodegradable AND non-biodegradable organic pollutants **(hence,** COD is always numerically higher than BOD** for the same water sample).
Flowchart of Cultural Eutrophication & Hypoxic Dead-Zone Formation	**Symbiotic Biology of Coral Reefs ("Rainforests of the Sea")**	Built by colonial marine invertebrates **(Coral Polyps**, phylum *Cnidaria*) living in obligatory mutualism with microscopic photosynthetic dinoflagellate algae called **Zooxanthellae**; the polyp provides protected calcium carbonate (CaCO_3) shelter and metabolic CO_2, while *Zooxanthellae* supply up to 90% of the coral's nutrition via photosynthesis and give corals their vibrant colors.
Comparative Table of Major Indian Mangrove Forests & Coral Reef Ecosystems	**Ideal Conditions for Coral Growth**	Warm tropical/subtropical waters (30^° N to 30^° S) with water temperature **20^°C–27^°C**, shallow sunlight-rich depth (**<50 m**), clear sediment-free water (suspended silt clogs polyp mouths), and moderate salinity (**27–40 ppt**— hence corals never grow directly at the mouths of major freshwater rivers like the Ganga or Amazon).
Aquatic Zonation, Lake Eutrophication & Algal Blooms	**Fringing Reefs**	Gulf of Mannar**,** Palk Bay**,** Gulf of Kutch**, and** Andaman & Nicobar Islands** (largest reef area in India).
Coral Reefs, Coral Bleaching & Mangrove Adaptations	**Atolls (Ring-shaped reefs enclosing a lagoon)**	Lakshadweep Islands**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flowchart of Cultural Eutrophication & Hypoxic Dead-Zone Formation	**Absent along East Coast Deltas**	Absent off the mouths of Ganga, Mahanadi, Godavari, and Krishna due to high freshwater influx and muddy turbidity (though deep-water patchy corals exist off Malvan, Maharashtra and Netrani Island, Karnataka).
Comparative Table of Major Indian Mangrove Forests & Coral Reef Ecosystems	**Coral Bleaching**	Triggered when thermal anomalies (**El Niño ocean warming** of even 1^°–2^°C), ocean acidification, UV radiation, or xenobiotic pollution stress coral polyps into **expelling their symbiotic Zooxanthellae**, turning the colony stark white.
Aquatic Zonation, Lake Eutrophication & Algal Blooms	**Mangrove Halophytic Adaptations (FSI ISFR 2023)**	Salt-tolerant littoral trees/shrubs (*Halophytes*) growing in intertidal mudflats between 25^° N and 25^° S; possess **Pneumatophores** (blind upward-growing negatively geotropic breathing roots with *Lenticels* to absorb oxygen in anaerobic waterlogged mud, e.g., *Avicennia* and *Sonneratia*), **Stilt and Prop Roots** (*Rhizophora*—dissipating tsunami and cyclonic storm surges), **Vivipary** (seeds germinate while still attached to the parent tree before dropping into the saline mud), and **Salt-Excreting Foliar Glands**.

Chapter *2* Multi-Statement Exam Verification Drills

Chapter 2 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Littoral Zone): Shallow, warm nearshore water where sunlight penetrates all the way to the sediment floor, supporting rooted macrophytes.

Statement-II (Limnetic Zone): Open well-lit surface water beyond the littoral zone dominated by phytoplankton and nekton down to the **Compensation Depth** (where gross photosynthesis equals respiration, bounded at ~200 m as the **Photic Zone**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 2 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Profundal & Benthic Zones): Dark **Aphotic Zone** below light penetration where heterotrophic decomposers consume sinking organic detritus on the bottom sediment (*Benthos*).

Statement-II (Oligotrophic Lakes): Newly formed, deep, cold, crystal-clear lakes with low nutrient levels (N and P) and **high Dissolved Oxygen (DO)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 2 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Eutrophication & Cultural Eutrophication): Nutrient enrichment (especially **Nitrates and Phosphates** from agricultural fertilizers, sewage, and detergents) triggers explosive **Algal Blooms**, blocking sunlight to submerged plants; when algae die, aerobic bacteria consume dissolved oxygen during decomposition, spiking **Biological Oxygen Demand (BOD)**, collapsing **Dissolved Oxygen (DO)**, creating hypoxic **"Dead Zones"**, and causing mass mortality of fish.

Statement-II (BOD vs. COD): Biological Oxygen Demand (BOD) **measures the dissolved oxygen required by** aerobic microorganisms **ONLY to decompose** biodegradable organic matter **over 5 days at 20^°C, whereas** Chemical Oxygen Demand (COD) **measures the oxygen equivalent required to chemically oxidize** BOTH biodegradable AND non-biodegradable organic pollutants **(hence,** COD is always numerically higher than BOD** for the same water sample).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 2 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Symbiotic Biology of Coral Reefs ("Rainforests of the Sea")): Built by colonial marine invertebrates (**Coral Polyps**, phylum *Cnidaria*) living in obligatory mutualism with microscopic photosynthetic dinoflagellate algae called **Zooxanthellae**; the polyp provides protected calcium carbonate (CaCO_3) shelter and metabolic CO_2, while *Zooxanthellae* supply up to 90% of the coral's nutrition via photosynthesis and give corals their vibrant colors.

Statement-II (Ideal Conditions for Coral Growth): Warm tropical/subtropical waters (30^° N to 30^° S) with water temperature **20^°C–27^°C**, shallow sunlight-rich depth (**<50 m**), clear sediment-free water (suspended silt clogs polyp mouths), and moderate salinity (**27–40 ppt**—hence corals never grow directly at the mouths of major freshwater rivers like the Ganga or Amazon).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 2 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Fringing Reefs): Gulf of Mannar**,** Palk Bay**,** Gulf of Kutch**, and** Andaman & Nicobar Islands** (largest reef area in India).

Statement-II (Atolls (Ring-shaped reefs enclosing a lagoon)): Lakshadweep Islands**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 2 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Absent along East Coast Deltas): Absent off the mouths of Ganga, Mahanadi, Godavari, and Krishna due to high freshwater influx and muddy turbidity (though deep-water patchy corals exist off Malvan, Maharashtra and Netrani Island, Karnataka).

Statement-II (Coral Bleaching): Triggered when thermal anomalies (**El Niño ocean warming** of even 1^°–2^°C), ocean acidification, UV radiation, or xenobiotic pollution stress coral polyps into **expelling their symbiotic Zooxanthellae**, turning the colony stark white.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3: Biodiversity, IUCN Red List, Hotspots & Conservation (In-Situ & Ex-Situ)

Chapter Key Study Pillars — Chapter 3: Biodiversity, IUCN Red List, Hotspots & Conservation (In-Situ & Ex-Situ)

Key Study Pillar 1	Key Study Pillar 2	Key Study Pillar 3
Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots	**In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India**	**Master Table of India's 18 Biosphere Reserves & Flagship Endemic Fauna**

3.1 Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots

• **Origin & Three Levels of Biodiversity (NCERT):** Popularized by sociobiologist **Edward O. Wilson** (after Walter G. Rosen coined the contracted term in 1985); encompasses **Genetic Diversity** (e.g., *Rauwolfia vomitoria* across the Himalayas varying in potency of the active chemical *Reserpine*, or 50,000+ rice strains in India), **Species Diversity** (higher amphibian diversity in the Western Ghats than the Eastern Ghats), and **Ecological / Ecosystem Diversity** (deserts, rainforests, mangroves, alpine meadows).

• **Whittaker's Diversity Indices (1972): Alpha (α) Diversity** measures species richness *within* a single homogeneous community/habitat; **Beta (β) Diversity** measures the rate of change (turnover) of species composition *between* two adjacent communities along an environmental gradient; **Gamma (γ) Diversity** measures the overall diversity across an entire landscape or geographical region.

• **Norman Myers' Biodiversity Hotspots (1988):** To qualify as one of the world's **36 Biodiversity Hotspots** (administered by Conservation International), a region must satisfy **two strict quantitative criteria**:

1. **Species Endemism:** It must contain at least **1,500 species (0.5\% of global total) of vascular plants as endemics** (found nowhere else on Earth).

2. **Degree of Threat:** It must have **lost at least 70% of its original primary native vegetation** (i.e., have 30\% or less of its original natural habitat remaining).

• **Four Biodiversity Hotspots Spanning India (MoEFCC):**

1. **The Himalayas:** Includes the entire Indian Himalayan region (and falling in Pakistan, Tibet, Nepal, Bhutan, China, and Myanmar).

2. **Indo-Burma:** Covers **Northeast India (south of the Brahmaputra River)**, Andaman Group of Islands, Myanmar, Thailand, Vietnam, Laos, Cambodia, and southern China.

3. **Western Ghats and Sri Lanka:** Covers the Sahyadri hills along India's western coast and the island of Sri Lanka.

4. **Sundaland:** Covers the **Nicobar Group of Islands** (along with Indonesia, Malaysia, Singapore, Brunei, and the Philippines).

3.2 In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India

• **In-Situ Conservation (On-Site in Natural Habitat):** Includes **National Parks** (106 in India), **Wildlife Sanctuaries** (573 in India), **Biosphere Reserves** (18 in India), **Tiger Reserves** (56+ in India), **Conservation Reserves**, **Community Reserves**, and **Sacred Groves** (*Kavu* in Kerala, *Deorai* in Maharashtra, *Orans* in Rajasthan, *Law Kyntang* / *Mawphlang* in Meghalaya, *Sarna* in Jharkhand).

• **Ex-Situ Conservation (Off-Site Outside Natural Habitat):** Includes **Botanical Gardens**, **Zoological Parks**, **Seed Banks** (e.g., India's National Seed Vault at **Chang La, Ladakh**), **Cryopreservation** (preservation of gametes, embryos, and pollen in liquid nitrogen at **-196^°C**), **Tissue Culture**, and **Gene Banks**.

• **UNESCO Man and the Biosphere (MAB) Programme (1971):** Biosphere Reserves consist of three concentric zones: **Core Zone** (strictly protected legal National Park/Sanctuary where only non-destructive monitoring is permitted), **Buffer Zone** (limited eco-tourism, grazing, research, and environmental education), and **Transition Zone** (outermost cooperative zone allowing sustainable human settlements, cropping, and forestry).

• **India's *18* Biosphere Reserves (*12* Recognized in UNESCO's World Network of Biosphere Reserves — WNBR):**

• ***12* UNESCO WNBR Sites: Nilgiri** (*1986*, first in India—Tamil Nadu, Kerala, Karnataka), **Gulf of Mannar** (TN), **Sundarbans** (WB), **Nanda Devi** (Uttarakhand), **Nokrek** (Meghalaya), **Pachmarhi** (MP), **Simlipal** (Odisha), **Achanakmar-Amarkantak** (Chhattisgarh-MP), **Great Nicobar** (A&N Islands), **Agasthyamalai** (Kerala-TN), **Khangchendzonga** (Sikkim), and **Panna** (MP, added to UNESCO WNBR in *2020*).

• ***6* Domestic Biosphere Reserves (Not yet in UNESCO WNBR): Manas** (Assam), **Dibru-Saikhowa** (Assam—**smallest** by area), **Dehang-Debang** (Arunachal Pradesh), **Cold Desert** (Pin Valley/Chandratal, Himachal Pradesh), **Kachchh (Great Rann of Kutch)** (Gujarat—**largest** by area), and **Seshachalam Hills** (Andhra Pradesh).

3.3 Flowchart of UNESCO Biosphere Reserve Concentric Zonation & Conservation Hierarchy

Step-by-Step Conceptual Process Flowchart

STEP 1
Inner Core Zone (Strict Legal Protection — Zero Human Interference)

STEP 2
Middle Buffer Zone (Research, Education, Controlled Eco-Tourism)

STEP 3
Outer Transition Zone (Sustainable Tribal Settlements & Agro-Forestry)

STEP 4
UNESCO MAB World Network Recognition (12 of 18 Indian Sites)

3.4 Master Table of India's *18* Biosphere Reserves & Flagship Endemic Fauna

Biosphere Reserve Name	State(s) / UT	UNESCO MAB Status	Key Flagship & Endemic Species (MoEFCC)
1. Nilgiri (*1986* — First)	TN, Kerala, Karnataka	Yes (Year *2000*)	**Nilgiri Tahr**, **Lion-tailed Macaque** (Includes Mudumalai, Mukurthi, Nagarhole, Bandipur, Silent Valley, Wayanad)
2. Nanda Devi	Uttarakhand	Yes (*2004*)	**Snow Leopard**, Himalayan Musk Deer, Bharal (Blue Sheep)
3. Nokrek	Meghalaya (West Garo Hills)	Yes (*2009*)	**Red Panda**, Hoolock Gibbon, *Citrus indica* (wild mother citrus gene pool)
4. Gulf of Mannar	Tamil Nadu	Yes (*2001*)	**Dugong (Sea Cow)**, Sea Cucumber, Coral reefs

Biosphere Reserve Name	State(s) / UT	UNESCO MAB Status	Key Flagship & Endemic Species (MoEFCC)
5. Sundarbans	West Bengal	Yes (2001)	**Royal Bengal Tiger**, Saltwater Crocodile, River Terrapin
6. Simlipal	Odisha (Mayurbhanj)	Yes (2009)	Melanistic (Black) Tiger, Asian Elephant, Gaur
7. Pachmarhi & 8. Panna	Madhya Pradesh	Yes (2009 & 2020)	**Giant Squirrel** & Flying Squirrel (Pachmarhi); Ken River Gharial & Tiger (Panna)
9. Achanakmar-Amarkantak	Chhattisgarh & MP	Yes (2012)	Four-horned Antelope (*Chousingha*), Saras Crane, White-rumped Vulture
10. Great Nicobar	Andaman & Nicobar Islands	Yes (2013)	**Nicobar Scrubfowl**, Saltwater Crocodile, Giant Leatherback Turtle
11. Agasthyamalai	Kerala & Tamil Nadu	Yes (2016)	**Nilgiri Tahr**, *Kanikkar* tribal community, *Neelakurinji* (*Strobilanthes kunthiana*)
12. Khangchendzonga	Sikkim	Yes (2018)	**Red Panda**, Snow Leopard, Blood Pheasant
13. Kachchh (Largest) & **14. Seshachalam**	Gujarat & Andhra Pradesh	Domestic (Non-MAB)	**Indian Wild Ass (*Khur*)** (Kachchh); **Slender Loris & Red Sanders** (Seshachalam)
15. Manas, 16. Dibru-Saikhowa, 17. Dehang-Debang, 18. Cold Desert	Assam (2), Arunachal (1), Himachal Pradesh (1)	Domestic (Non-MAB)	**Pygmy Hog & Golden Langur** (Manas); **Feral Horses & White-winged Wood Duck** (Dibru-Saikhowa)

Did You Know?: In the **Andaman & Nicobar Islands**, the **Andaman Group of Islands** falls under the **Indo-Burma Biodiversity Hotspot**, whereas the **Nicobar Group of Islands** (separated by the Ten Degree Channel) falls under the **Sundaland Biodiversity Hotspot** (MoEFCC)!

Exam Trap Alert: Do not confuse **National Parks** and **Wildlife Sanctuaries** under the Wildlife (Protection) Act, 1972: in a **National Park**, human activities such as livestock grazing and private land rights are **completely prohibited**, and a National Park is never created for a single species; in a **Wildlife Sanctuary**, the **Chief Wildlife Warden** may regulate and permit limited grazing by local communities, and a sanctuary can be notified for a specific flagship species (e.g., Grizzled Squirrel Wildlife Sanctuary).

★ **Memory Trick:** Remember the **6 Indian Biosphere Reserves NOT in UNESCO's MAB list** with the acronym **"M-D-D-C-K-S = My Dear Doctor Cures Kidney Stones"**: **M**anas, **D**ibru-Saikhowa, **D**ehang-Debang, **C**old Desert, **K**achchh, and **S**eshachalam!

Chapter 3 Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots	**Origin & Three Levels of Biodiversity (NCERT)**	Popularized by sociobiologist **Edward O. Wilson** (after Walter G. Rosen coined the contracted term in *1985*); encompasses **Genetic Diversity** (e.g., *Rauwolfia vomitoria* across the Himalayas varying in potency of the active chemical *Reserpine*, or *50,000+* rice strains in India), **Species Diversity** (higher amphibian diversity in the Western Ghats than the Eastern Ghats), and **Ecological / Ecosystem Diversity** (deserts, rainforests, mangroves, alpine meadows).
In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India	**Whittaker's Diversity Indices (1972)**	Alpha (α) Diversity **measures species richness *within* a single homogeneous community/habitat;** Beta (β) Diversity **measures the rate of change (turnover) of species composition *between* two adjacent communities along an environmental gradient;** Gamma (γ) Diversity** measures the overall diversity across an entire landscape or geographical region.
Flowchart of UNESCO Biosphere Reserve Concentric Zonation & Conservation Hierarchy	**Norman Myers' Biodiversity Hotspots (1988)**	To qualify as one of the world's **36 Biodiversity Hotspots** (administered by Conservation International), a region must satisfy **two strict quantitative criteria
Master Table of India's 18 Biosphere Reserves & Flagship Endemic Fauna	**Species Endemism**	It must contain at least **1,500 species (0.5\% of global total) of vascular plants as endemics** (found nowhere else on Earth).
Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots	**Degree of Threat**	It must have **lost at least 70% of its original primary native vegetation** (i.e., have 30\% or less of its original natural habitat remaining).
In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India	**The Himalayas**	Includes the entire Indian Himalayan region (and falling in Pakistan, Tibet, Nepal, Bhutan, China, and Myanmar).
Flowchart of UNESCO Biosphere Reserve Concentric Zonation & Conservation Hierarchy	**Indo-Burma**	Covers **Northeast India (south of the Brahmaputra River)**, Andaman Group of Islands, Myanmar, Thailand, Vietnam, Laos, Cambodia, and southern China.
Master Table of India's 18 Biosphere Reserves & Flagship Endemic Fauna	**Western Ghats and Sri Lanka**	Covers the Sahyadri hills along India's western coast and the island of Sri Lanka.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots	**Sundaland**	Covers the **Nicobar Group of Islands** (along with Indonesia, Malaysia, Singapore, Brunei, and the Philippines).
In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India	**In-Situ Conservation (On-Site in Natural Habitat)**	Includes **National Parks** (*106* in India), **Wildlife Sanctuaries** (*573* in India), **Biosphere Reserves** (*18* in India), **Tiger Reserves** (*56+* in India), **Conservation Reserves**, **Community Reserves**, and **Sacred Groves** (*Kavu* in Kerala, *Deorai* in Maharashtra, *Orans* in Rajasthan, *Law Kyntang* / *Mawphlang* in Meghalaya, *Sarna* in Jharkhand).
Flowchart of UNESCO Biosphere Reserve Concentric Zonation & Conservation Hierarchy	**Ex-Situ Conservation (Off-Site Outside Natural Habitat)**	Includes **Botanical Gardens**, **Zoological Parks**, **Seed Banks** (e.g., India's National Seed Vault at **Chang La, Ladakh**), **Cryopreservation** (preservation of gametes, embryos, and pollen in liquid nitrogen at **-196^°C**), **Tissue Culture**, and **Gene Banks**.
Master Table of India's 18 Biosphere Reserves & Flagship Endemic Fauna	**UNESCO Man and the Biosphere (MAB) Programme (1971)**	Biosphere Reserves consist of three concentric zones: **Core Zone** (strictly protected legal National Park/Sanctuary where only non-destructive monitoring is permitted), **Buffer Zone** (limited eco-tourism, grazing, research, and environmental education), and **Transition Zone** (outermost cooperative zone allowing sustainable human settlements, cropping, and forestry).
Biodiversity Gradients, Alpha-Beta-Gamma Diversity & Hotspots	**12 UNESCO WNBR Sites**	Nilgiri **(1986, first in India—Tamil Nadu, Kerala, Karnataka),** Gulf of Mannar **(TN),** Sundarbans **(WB),** Nanda Devi **(Uttarakhand),** Nokrek **(Meghalaya),** Pachmarhi **(MP),** Simlipal **(Odisha),** Achanakmar-Amarkantak **(Chhattisgarh-MP),** Great Nicobar **(A&N Islands),** Agasthyamalai **(Kerala-TN),** Khangchendzonga **(Sikkim), and** Panna** (MP, added to UNESCO WNBR in *2020*).
In-Situ vs. Ex-Situ Conservation & The 18 Biosphere Reserves of India	**6 Domestic Biosphere Reserves (Not yet in UNESCO WNBR)**	Manas **(Assam),** Dibru-Saikhowa **(Assam**—smallest **by area),** Dehang-Debang **(Arunachal Pradesh),** Cold Desert **(Pin Valley/Chandratal, Himachal Pradesh),** Kachchh (Great Rann of Kutch) **(Gujarat**—largest **by area), and** Seshachalam Hills** (Andhra Pradesh).

Chapter *3* Multi-Statement Exam Verification Drills

Chapter 3 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Origin & Three Levels of Biodiversity (NCERT)): Popularized by sociobiologist **Edward O. Wilson** (after Walter G. Rosen coined the contracted term in *1985*); encompasses **Genetic Diversity** (e.g., *Rauwolfia vomitoria* across the Himalayas varying in potency of the active chemical *Reserpine*, or *50,000+* rice strains in India), **Species Diversity** (higher amphibian diversity in the Western Ghats than the Eastern Ghats), and **Ecological / Ecosystem Diversity** (deserts, rainforests, mangroves, alpine meadows).

Statement-II (Whittaker's Diversity Indices (1972)): Alpha (α) Diversity **measures species richness *within* a single homogeneous community/habitat;** Beta (β) Diversity **measures the rate of change (turnover) of species composition *between* two adjacent communities along an environmental gradient;** Gamma (γ) Diversity** measures the overall diversity across an entire landscape or geographical region.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Norman Myers' Biodiversity Hotspots (1988)): To qualify as one of the world's **36 Biodiversity Hotspots** (administered by Conservation International), a region must satisfy **two strict quantitative criteria

Statement-II (Species Endemism): It must contain at least **1,500 species (0.5\% of global total) of vascular plants as endemics** (found nowhere else on Earth).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Degree of Threat): It must have **lost at least 70% of its original primary native vegetation** (i.e., have 30\% or less of its original natural habitat remaining).

Statement-II (The Himalayas): Includes the entire Indian Himalayan region (and falling in Pakistan, Tibet, Nepal, Bhutan, China, and Myanmar).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Indo-Burma): Covers **Northeast India (south of the Brahmaputra River)**, Andaman Group of Islands, Myanmar, Thailand, Vietnam, Laos, Cambodia, and southern China.

Statement-II (Western Ghats and Sri Lanka): Covers the Sahyadri hills along India's western coast and the island of Sri Lanka.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Sundaland): Covers the **Nicobar Group of Islands** (along with Indonesia, Malaysia, Singapore, Brunei, and the Philippines).

Statement-II (In-Situ Conservation (On-Site in Natural Habitat)): Includes **National Parks** (106 in India), **Wildlife Sanctuaries** (573 in India), **Biosphere Reserves** (18 in India), **Tiger Reserves** (56+ in India), **Conservation Reserves**, **Community Reserves**, and **Sacred Groves** (*Kavu* in Kerala, *Deorai* in Maharashtra, *Orans* in Rajasthan, *Law Kyntang* / *Mawphlang* in Meghalaya, *Sarna* in Jharkhand).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 3 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Ex-Situ Conservation (Off-Site Outside Natural Habitat)): Includes **Botanical Gardens**, **Zoological Parks**, **Seed Banks** (e.g., India's National Seed Vault at **Chang La, Ladakh**), **Cryopreservation** (preservation of gametes, embryos, and pollen in liquid nitrogen at **-196^°C**), **Tissue Culture**, and **Gene Banks**.

Statement-II (UNESCO Man and the Biosphere (MAB) Programme (1971)): Biosphere Reserves consist of three concentric zones: **Core Zone** (strictly protected legal National Park/Sanctuary where only non-destructive monitoring is permitted), **Buffer Zone** (limited eco-tourism, grazing, research, and environmental education), and **Transition Zone** (outermost cooperative zone allowing sustainable human settlements, cropping, and forestry).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter *4:* National Parks, Tiger Reserves, Wildlife Projects & Ramsar Wetlands of India

Chapter Key Study Pillars — Chapter 4: National Parks, Tiger Reserves, Wildlife Projects & Ramsar Wetlands of India

Key Study Pillar 1
Flagship Wildlife Conservation Projects & Tiger Reserves of India

Key Study Pillar 2
Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites

4.1 Flagship Wildlife Conservation Projects & Tiger Reserves of India

• **Project Tiger (Launched April 1, 1973 at Jim Corbett National Park, Uttarakhand):** Administered by the **National Tiger Conservation Authority (NTCA)**—a statutory body established via the **2006 Amendment to the Wildlife (Protection) Act, 1972**, chaired by the **Union Minister of Environment, Forest and Climate Change (MoEFCC)**.

• **5th Cycle All-India Tiger Estimation & Latest Tiger Reserves (PIB):**

• India is home to **3,682 wild tigers** (accounting for **>75% of the world's wild tiger population**), growing at ~6.1% per annum using the **M-STrIPES** (*Monitoring System for Tigers - Intensive Protection and Ecological Status*) mobile/GIS software and camera-trap photo-identification.

• **Top Tiger Population States: Madhya Pradesh (785 tigers — "Tiger State of India")**, followed by **Karnataka (563)**, **Uttarakhand (560)**, and **Maharashtra (444)**; **Jim Corbett Tiger Reserve** holds the highest

number of tigers inside a single reserve (260), while **Nagarjunasagar-Srisailam Tiger Reserve** (Andhra Pradesh) is the **largest Tiger Reserve by area**.

• **Recent Tiger Reserves (53rd to 56th+): Ranipur Tiger Reserve** (Chitrakoot, UP), **Veerangana Durgavati Tiger Reserve** (Nauradehi-Rani Durgavati, MP—7th in MP), **Dholpur-Karauli Tiger Reserve** (Rajasthan), and **Guru Ghasidas-Tamor Pingla Tiger Reserve** (Chhattisgarh, notified in November 2024 as the 56th Tiger Reserve, becoming the 3rd largest in India after Nagarjunasagar-Srisailam and Manas).

• **Key Flagship Species Conservation Projects (MoEFCC):**

• **Project Elephant (1992):** Implemented across 33 Elephant Reserves (including *Terai Elephant Reserve* in UP); **Karnataka** holds the highest elephant population in India, and the **MIKE (*Monitoring the Illegal Killing of Elephants*)** programme operates under CITES at 10 Indian sites.

• **Project Crocodile (1975):** Conserves India's three native crocodilians—**Gharial** (*Gavialis gangeticus*, **Critically Endangered**, natural stronghold in the **Chambal River Sanctuary**), **Mugger / Marsh Crocodile** (*Vulnerable*), and **Saltwater / Estuarine Crocodile** (*Least Concern*, highest concentration in **Bhitarkanika, Odisha**).

• **Project Rhino (1987 & Indian Rhino Vision 2020):** Conserves the **Greater One-Horned Rhinoceros** (*Rhinoceros unicornis*, *Vulnerable*) across **Kaziranga, Pobitora** (highest density), **Manas, Orang** (Assam), **Jaldapara, Gorumara** (West Bengal), and **Dudhwa** (Uttar Pradesh).

• **Project Snow Leopard (2009) & First Snow Leopard Population Assessment in India (SPAI 2024, PIB):** Recorded **718 Snow Leopards** in India, with the highest population in **Ladakh (477)**, followed by **Uttarakhand (124)**, **Himachal Pradesh (51)**, Arunachal Pradesh (36), Sikkim (21), and Jammu & Kashmir (9).

• **Project Cheetah (September 17, 2022):** World's first intercontinental translocation of large carnivores, introducing African Cheetahs from Namibia and South Africa to **Kuno National Park** (and **Gandhi Sagar Wildlife Sanctuary**) in Madhya Pradesh.

• **Project Dolphin (2020) & Vulture Action Plan (2020–2025):** Conserves the **Gangetic River Dolphin** (*Platanista gangetica*, India's **National Aquatic Animal**, blind mammal navigating by ultrasonic **Echolocation / Susu** in **Vikramshila Gangetic Dolphin Sanctuary**, Bhagalpur, Bihar); the **Vulture Action Plan** banned veterinary **Diclofenac**, as well as **Aceclofenac and Ketoprofen** (2023), which caused fatal renal (kidney) failure in *Gyps* vultures.

4.2 Ramsar Convention on Wetlands *(1971)* & India's *85+* Ramsar Sites

• **Ramsar Convention & Montreux Record (MoEFCC):** Signed on **February 2, 1971** in the Iranian city of **Ramsar** on the shores of the Caspian Sea (celebrated annually as **World Wetlands Day on February 2**; came into force in 1975, with India acceding on **February 1, 1982**).

• **Montreux Record:** A register of Ramsar wetland sites where changes in ecological character have occurred, are occurring, or are likely to occur due to technological developments, pollution, or human interference; currently, **TWO Indian wetlands** are listed on the Montreux Record:

1. **Keoladeo National Park (Bharatpur, Rajasthan)**—listed in 1990 due to water shortage and invasive grass *Paspalum distichum*.

2. **Loktak Lake (Manipur)**—listed in 1993 due to deforestation, siltation, and the **Ithai Barrage** disrupting the natural hydrology of floating biomass islands (**Phumdis**) that sustain the **Critically Endangered Sangai (Brow-antlered Dancing Deer)** in **Keibul Lamjao National Park** (the world's **ONLY floating National Park**).

• (*Note*: ***Chilika Lake, Odisha*** *was placed on the Montreux Record in* 1993 *due to siltation choking its sea mouth, but was* ***removed in*** *2002 following successful hydrological restoration by the Chilika Development Authority, winning the Ramsar Wetland Conservation Award!*)

• **Key Facts on India's Ramsar Network (PIB):**

• **Total Sites:** Expanded to **85 Ramsar Sites** by August 2024 (with **Nagi and Nakti Bird Sanctuaries** in Bihar, **Nanjarayan Bird Sanctuary and Kazhuveli Bird Sanctuary** in Tamil Nadu, and **Tawa Reservoir** in Madhya Pradesh added in 2024).

• **State with Highest Number of Ramsar Sites: Tamil Nadu (18 Ramsar Sites)** ranks first, followed by **Uttar Pradesh (10 Ramsar Sites)**.

• **First Ramsar Sites of India (1981): Chilika Lake** (Odisha) and **Keoladeo National Park** (Rajasthan).

• **Largest vs. Smallest Ramsar Site in India: Sundarbans Wetland (West Bengal)** is the **largest** Ramsar site in India, while **Renuka Wetland (Himachal Pradesh)** is the **smallest**.

4.3 Flowchart of Ramsar Designation & Montreux Record Restoration Protocol

Step-by-Step Conceptual Process Flowchart

STEP 1
MoEFCC Nominates Ecologically Significant Wetland under 9 Ramsar Criteria

STEP 2
Inscription on Ramsar List of Wetlands of International Importance (85+ in India)

STEP 3
Ecological Degradation Triggers Montreux Record Listing (Keoladeo & Loktak)

STEP 4
Hydrological Restoration & Removal (As Achieved by Chilika Lake in 2002)

4.4 Comparative Table of Iconic Indian National Parks, Flagship Fauna & River Systems

National Park / Sanctuary	State / UT	River Flowing Through / Nearby	Unique Flagship Species & Distinction (MoEFCC)
Hemis National Park	Ladakh	Indus & Zanskar Rivers	**Largest National Park in India**; stronghold of **Snow Leopard**
Jim Corbett (Ramganga) NP	Uttarakhand	**Ramganga** & Kosi Rivers	**First National Park of India (1936, Hailey NP)**; highest tiger count
Keibul Lamjao National Park	Manipur (Loktak Lake)	Manipur River basin	**World's ONLY Floating National Park** (*Phumdis*); **Sangai Deer**
Kaziranga & Raimona / Dihing Patkai	Assam	Brahmaputra, Diphlu, Mora Dhansiri	**One-Horned Rhinoceros**, Swamp Deer, Wild Water Buffalo (7 NPs in Assam)
Kuno National Park	Madhya Pradesh	**Kuno River** (Chambal tributary)	Host site of **Project Cheetah** (12 National Parks in Madhya Pradesh—highest in India)

National Park / Sanctuary	State / UT	River Flowing Through / Nearby	Unique Flagship Species & Distinction (MoEFCC)
Silent Valley & Eravikulam NP	Kerala	**Kunthipuzha River** (Silent Valley)	**Lion-tailed Macaque** (Silent Valley); **Nilgiri Tahr** & Anamudi Peak (Eravikulam)
Dachigam National Park	Jammu & Kashmir	Dagwan River	Sole surviving habitat of the **Critically Endangered Hangul (Kashmir Stag)**
Desert National Park	Rajasthan (Jaisalmer/ Barmer)	Arid Thar basin	**Critically Endangered Great Indian Bustard (*Go dawan*)**

Did You Know?: According to MoEFCC and PIB, **Madhya Pradesh** holds the highest number of **National Parks (12)** in India, the **Andaman & Nicobar Islands** hold the highest number of **Wildlife Sanctuaries (97)** (and the smallest National Park, **South Button Island National Park**), **Assam** holds the second-highest number of National Parks among states (7—Kaziranga, Manas, Nameri, Orang, Dibru-Saikhowa, plus **Raimona and Dihing Patkai** notified in 2021), and **Tamil Nadu** holds the highest number of **Ramsar Sites (18)**!

Exam Trap Alert: Examiners frequently ask which Indian wetlands are *currently* on the **Montreux Record**: the correct answer is ONLY **Keoladeo National Park (Rajasthan)** and **Loktak Lake (Manipur)**—do NOT select **Chilika Lake**, as it was removed from the Montreux Record in **2002**!

★ **Memory Trick:** Remember the **Critically Endangered Mammals & Birds of India** by **"H-P-M-S-G-J"**: **H**angul (Dachigam), **P**ygmy Hog (Manas), **M**alabar Large-spotted Civet, **S**angai (Keibul Lamjao), **G**reat Indian Bustard (Rajasthan), and **J**erdon's Courser (Sri Lankamalleswara, Andhra Pradesh).

Chapter 4 Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flagship Wildlife Conservation Projects & Tiger Reserves of India	**Project Tiger (Launched April 1, 1973 at Jim Corbett National Park, Uttarakhand)**	Administered by the **National Tiger Conservation Authority (NTCA)**—a statutory body established via the **2006 Amendment to the Wildlife (Protection) Act, 1972**, chaired by the **Union Minister of Environment, Forest and Climate Change (MoEFCC)**.
Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites	**Top Tiger Population States**	Madhya Pradesh (785 tigers — "Tiger State of India"), **followed by** Karnataka (563), Uttarakhand (560), **and** Maharashtra (444); Jim Corbett Tiger Reserve **holds the highest number of tigers inside a single reserve (260), while** Nagarjunasagar-Srisailam Tiger Reserve **(Andhra Pradesh) is the** largest Tiger Reserve by area**.
Flowchart of Ramsar Designation & Montreux Record Restoration Protocol	**Recent Tiger Reserves (53rd to 56th+)**	Ranipur Tiger Reserve **(Chitrakoot, UP)**, Veerangana Durgavati Tiger Reserve **(Nauradehi-Rani Durgavati, MP—7th in MP)**, Dholpur-Karauli Tiger Reserve **(Rajasthan), and** Guru Ghasidas-Tamor Pingla Tiger Reserve** (Chhattisgarh, notified in November 2024 as the 56th Tiger Reserve, becoming the 3rd largest in India after Nagarjunasagar-Srisailam and Manas).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Comparative Table of Iconic Indian National Parks, Flagship Fauna & River Systems	**Project Elephant (1992)**	Implemented across 33 Elephant Reserves (including *Terai Elephant Reserve* in UP); **Karnataka** holds the highest elephant population in India, and the **MIKE (*Monitoring the Illegal Killing of Elephants*)** programme operates under CITES at 10 Indian sites.
Flagship Wildlife Conservation Projects & Tiger Reserves of India	**Project Crocodile (1975)**	Conserves India's three native crocodilians—**Gharial** (*Gavialis gangeticus*, **Critically Endangered**, natural stronghold in the **Chambal River Sanctuary**), **Mugger / Marsh Crocodile** (*Vulnerable*), and **Saltwater / Estuarine Crocodile** (*Least Concern*, highest concentration in **Bhitarkanika, Odisha**).
Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites	**Project Rhino (1987 & Indian Rhino Vision 2020)**	Conserves the **Greater One-Horned Rhinoceros** (*Rhinoceros unicornis*, *Vulnerable*) across **Kaziranga, Pobitora** (highest density), **Manas, Orang** (Assam), **Jaldapara, Gorumara** (West Bengal), and **Dudhwa** (Uttar Pradesh).
Flowchart of Ramsar Designation & Montreux Record Restoration Protocol	**Project Snow Leopard (2009) & First Snow Leopard Population Assessment in India (SPAI 2024, PIB)**	Recorded **718 Snow Leopards** in India, with the highest population in **Ladakh (477)**, followed by **Uttarakhand (124)**, **Himachal Pradesh (51)**, Arunachal Pradesh (36), Sikkim (21), and Jammu & Kashmir (9).
Comparative Table of Iconic Indian National Parks, Flagship Fauna & River Systems	**Project Cheetah (September 17, 2022)**	World's first intercontinental translocation of large carnivores, introducing African Cheetahs from Namibia and South Africa to **Kuno National Park** (and **Gandhi Sagar Wildlife Sanctuary**) in Madhya Pradesh.
Flagship Wildlife Conservation Projects & Tiger Reserves of India	**Project Dolphin (2020) & Vulture Action Plan (2020–2025)**	Conserves the **Gangetic River Dolphin** (*Platanista gangetica*, India's **National Aquatic Animal**, blind mammal navigating by ultrasonic **Echolocation / Susu** in **Vikramshila Gangetic Dolphin Sanctuary**, Bhagalpur, Bihar); the **Vulture Action Plan** banned veterinary **Diclofenac**, as well as **Aceclofenac and Ketoprofen** (2023), which caused fatal renal (kidney) failure in *Gyps* vultures.
Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites	**Ramsar Convention & Montreux Record (MoEFCC)**	Signed on **February 2, 1971** in the Iranian city of **Ramsar** on the shores of the Caspian Sea (celebrated annually as **World Wetlands Day on February 2**; came into force in 1975, with India acceding on **February 1, 1982**).
Flowchart of Ramsar Designation & Montreux Record Restoration Protocol	**Montreux Record**	A register of Ramsar wetland sites where changes in ecological character have occurred, are occurring, or are likely to occur due to technological developments, pollution, or human interference; currently, **TWO Indian wetlands** are listed on the Montreux Record
Comparative Table of Iconic Indian National Parks, Flagship Fauna & River Systems	**Keoladeo National Park (Bharatpur, Rajasthan)**	listed in 1990 due to water shortage and invasive grass *Paspalum distichum*.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flagship Wildlife Conservation Projects & Tiger Reserves of India	**Loktak Lake (Manipur)**	listed in 1993 due to deforestation, siltation, and the **Ithai Barrage** disrupting the natural hydrology of floating biomass islands (**Phumdis**) that sustain the **Critically Endangered Sangai (Brow-antlered Dancing Deer)** in **Keibul Lamjao National Park** (the world's **ONLY floating National Park**).
Ramsar Convention on Wetlands (1971) & India's 85+ Ramsar Sites	**Total Sites**	Expanded to **85 Ramsar Sites** by August 2024 (with **Nagi and Nakti Bird Sanctuaries** in Bihar, **Nanjarayan Bird Sanctuary and Kazhuveli Bird Sanctuary** in Tamil Nadu, and **Tawa Reservoir** in Madhya Pradesh added in 2024).

Chapter 4 Multi-Statement Exam Verification Drills

Chapter 4 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Project Tiger (Launched April 1, 1973 at Jim Corbett National Park, Uttarakhand)): Administered by the **National Tiger Conservation Authority (NTCA)**—a statutory body established via the **2006 Amendment to the Wildlife (Protection) Act, 1972**, chaired by the **Union Minister of Environment, Forest and Climate Change (MoEFCC)**.

Statement-II (Top Tiger Population States): Madhya Pradesh (785 tigers — "Tiger State of India"), **followed by** Karnataka (563), Uttarakhand (560), **and** Maharashtra (444); Jim Corbett Tiger Reserve **holds the highest number of tigers inside a single reserve (260), while** Nagarjunasagar-Srisailam Tiger Reserve **(Andhra Pradesh) is the** largest Tiger Reserve by area**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 4 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Recent Tiger Reserves (53rd to 56th+)): Ranipur Tiger Reserve **(Chitrakoot, UP),** Veerangana Durgavati Tiger Reserve **(Nauradehi-Rani Durgavati, MP—7th in MP),** Dholpur-Karauli Tiger Reserve **(Rajasthan), and** Guru Ghasidas-Tamor Pingla Tiger Reserve** (Chhattisgarh, notified in November 2024 as the 56th Tiger Reserve, becoming the 3rd largest in India after Nagarjunasagar-Srisailam and Manas).

Statement-II (Project Elephant (1992)): Implemented across 33 Elephant Reserves (including *Terai Elephant Reserve* in UP); **Karnataka** holds the highest elephant population in India, and the **MIKE (*Monitoring the Illegal Killing of Elephants*)** programme operates under CITES at 10 Indian sites.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 4 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Project Crocodile (1975)): Conserves India's three native crocodilians—**Gharial** (*Gavialis gangeticus*, **Critically Endangered**, natural stronghold in the **Chambal River Sanctuary**), **Mugger / Marsh Crocodile** (*Vulnerable*), and **Saltwater / Estuarine Crocodile** (*Least Concern*, highest concentration in **Bhitarkanika, Odisha**).

Statement-II (Project Rhino (1987 & Indian Rhino Vision 2020)): Conserves the **Greater One-Horned Rhinoceros** (*Rhinoceros unicornis*, *Vulnerable*) across **Kaziranga, Pobitora** (highest density), **Manas, Orang** (Assam), **Jaldapara, Gorumara** (West Bengal), and **Dudhwa** (Uttar Pradesh).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 4 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Project Snow Leopard (2009) & First Snow Leopard Population Assessment in India (SPAI 2024, PIB)): Recorded **718 Snow Leopards** in India, with the highest population in **Ladakh (477)**, followed by **Uttarakhand (124)**, **Himachal Pradesh (51)**, Arunachal Pradesh (36), Sikkim (21), and Jammu & Kashmir (9).

Statement-II (Project Cheetah (September 17, 2022)): World's first intercontinental translocation of large carnivores, introducing African Cheetahs from Namibia and South Africa to **Kuno National Park** (and **Gandhi Sagar Wildlife Sanctuary**) in Madhya Pradesh.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 4 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Project Dolphin (2020) & Vulture Action Plan (2020–2025)): Conserves the **Gangetic River Dolphin** (*Platanista gangetica*, India's **National Aquatic Animal**, blind mammal navigating by ultrasonic **Echolocation** / **Susu** in **Vikramshila Gangetic Dolphin Sanctuary**, Bhagalpur, Bihar); the **Vulture Action Plan** banned veterinary **Diclofenac**, as well as **Aceclofenac and Ketoprofen** (2023), which caused fatal renal (kidney) failure in *Gyps* vultures.

Statement-II (Ramsar Convention & Montreux Record (MoEFCC)): Signed on **February 2, 1971** in the Iranian city of **Ramsar** on the shores of the Caspian Sea (celebrated annually as **World Wetlands Day on February 2**; came into force in 1975, with India acceding on **February 1, 1982**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 4 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Montreux Record): A register of Ramsar wetland sites where changes in ecological character have occurred, are occurring, or are likely to occur due to technological developments, pollution, or human interference; currently, **TWO Indian wetlands** are listed on the Montreux Record

Statement-II (Keoladeo National Park (Bharatpur, Rajasthan)): listed in 1990 due to water shortage and invasive grass *Paspalum distichum*.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5: India State of Forest Report (ISFR 2023) & Forest Types of India

5.1 Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data

• **Institutional & Satellite Framework (FSI ISFR 2023 & PIB):** Published biennially since **1987** by the **Forest Survey of India (FSI, headquartered in Dehradun, Uttarakhand)** under MoEFCC; the **18th edition (ISFR 2023)** utilizes indigenous **Resourcesat-2 LISS-III** satellite data at 23.5 m spatial resolution.

• **Forest Cover vs. Tree Cover Definitions:**

• **Forest Cover:** Any land parcel of **1 hectare or more** having a **tree canopy density of 10% or more**, **irrespective of legal ownership or land use** (includes bamboo, orchards, palms, and tea/coffee estates meeting the ≥ 1 ha and ≥ 10\% canopy criteria).

• **Tree Cover:** All patches of trees occurring **outside Recorded Forest Area (RFA)** that are **less than 1 hectare** in extent.

• **Three Forest Canopy Density Classes:**

1. **Very Dense Forest (VDF):** Canopy density **70% and above**.
2. **Moderately Dense Forest (MDF):** Canopy density **40% to 70%**.
3. **Open Forest (OF):** Canopy density **10% to 40%**.

(*Note*: ***Scrub*** *has canopy density* ***less than*** **10%** *and is* ***NOT counted*** *inside Total Forest Cover.*)

• **Key Quantitative Findings of ISFR 2023 (FSI Official Report):**

• **Total Forest and Tree Cover of India: 8,27,357 sq. km**, which constitutes **25.17% of India's total geographical area** (up by **1,445 sq. km** compared to 2021).

• **Total Forest Cover Alone: 7,15,343 sq. km** (**21.76%** of geographical area, an increase of 156 sq. km).

• **Total Tree Cover Alone: 1,12,014 sq. km** (**3.41%** of geographical area, an increase of 1,289 sq. km).

• **Top States by Total Forest & Tree Cover Area: 1. Madhya Pradesh**, **2. Arunachal Pradesh**, **3. Maharashtra**; for **Forest Cover Area alone**: **1. Madhya Pradesh**, **2. Arunachal Pradesh**, **3. Chhattisgarh**, **4. Odisha**, **5. Maharashtra**.

• **Top States/UTs by Forest Cover Percentage (relative to geographical area):** Among UTs/Overall: **Lakshadweep (91.33%)**; among **States**: **1. Mizoram (85.34%)**, **2. Arunachal Pradesh (79.04%)**, **3. Meghalaya (76.00%)**, **4. Manipur**, **5. Nagaland**.

• **Top States Showing Maximum Increase in Forest & Tree Cover (ISFR 2023): 1. Chhattisgarh (+684 sq. km)**, **2. Uttar Pradesh (+559 sq. km)**, **3. Odisha (+559 sq. km)**, **4. Rajasthan (+394 sq. km)**; for **Forest Cover increase alone**: **1. Mizoram (+242 sq. km)**, **2. Gujarat (+180 sq. km)**, **3. Odisha (+152 sq. km)**.

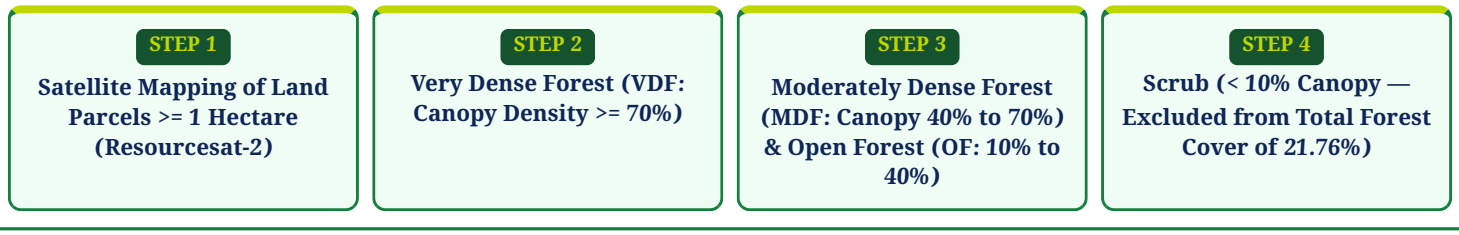
• **Mangrove Cover in India: 4,992 sq. km** (**0.15%** of India's geographical area); top 3 states/UTs are **1. West Bengal (~42.45%)**, **2. Gujarat (~23.32%)**, and **3. Andaman & Nicobar Islands (~12.19%)**, followed by **Andhra Pradesh**.

• **India's Forest Carbon Stock:** Reached **30.43 billion tonnes of CO_2 equivalent** (an increase of 81.5 million tonnes of carbon / ~299 million tonnes of CO_2 equivalent since 2021, placing India well on track toward its **NDC target of 2.5 to 3.0 billion tonnes of additional CO_2 equivalent sink by 2030**), with **Arunachal Pradesh** holding the highest carbon stock, followed by **Madhya Pradesh, Chhattisgarh, and Maharashtra**.

• **Bamboo Bearing Area: Madhya Pradesh** has the largest bamboo-bearing area in India, followed by **Arunachal Pradesh, Maharashtra, and Odisha**.

5.2 Flowchart of FSI Forest Cover Classification by Canopy Density

Step-by-Step Conceptual Process Flowchart



5.3 Comparative Table of ISFR *2023* State Rankings & Champion-Seth Forest Types

Metric / Forest Parameter (FSI ISFR 2023)	Rank 1 State / UT	Rank 2 State / UT	Rank 3 State / UT	Key Exam Insight
Largest Forest Cover by Area	**Madhya Pradesh**	**Arunachal Pradesh**	**Chhattisgarh**	Followed by Odisha (4th) and Maharashtra (5th)
Largest Forest + Tree Cover by Area	**Madhya Pradesh**	**Arunachal Pradesh**	**Maharashtra**	Total India Forest + Tree Cover = **25.17%** (8,27,357 sq. km)
Highest Forest Cover by % (States)	**Mizoram (85.34%)**	**Arunachal Pradesh (79.04%)**	**Meghalaya (76.00%)**	Overall including UTs: **Lakshadweep (91.33%)** is #1
Highest Gain in Forest + Tree Cover	**Chhattisgarh (+684 sq. km)**	**Uttar Pradesh (+559 sq. km)**	**Odisha (+559 sq. km)**	Highest gain in *Forest Cover alone*: **Mizoram (+242 sq. km)**
Largest Mangrove Cover	**West Bengal (~42.45%)**	**Gujarat (~23.32%)**	**Andaman & Nicobar**	Among states alone: West Bengal (1), Gujarat (2), Andhra Pradesh (3)
Largest Forest Carbon Stock	**Arunachal Pradesh**	**Madhya Pradesh**	**Chhattisgarh**	Total Carbon Stock = **7,285.5 Mt C (30.43 billion tonnes CO_2 eq.)**
Champion & Seth (1968) Most Extensive Forest Type	**Tropical Moist & Dry Deciduous Forests**	**Tropical Thorn Forests**	**Tropical Wet Evergreen**	**Tropical Dry Deciduous** (~38–40%) + **Moist Deciduous** (~30%) dominate India

Did You Know?: Under the **Indian Forest (Amendment) Act, 2017** (MoEFCC), **Bamboo** grown in **non-forest areas** was legally excluded from the definition of "Tree" (though taxonomically bamboo is already a **Grass** of family *Poaceae*), thereby exempting farmers and tribal artisans from requiring felling or transit permits to harvest and transport bamboo grown on private/non-forest land!

Exam Trap Alert: Watch the wording of ISFR 2023 questions carefully: if asked for **"Total Forest Cover"** alone, the percentage is **21.76%** (and top gain is **Mizoram**); if asked for **"Total Forest AND Tree Cover combined"**, the percentage is **25.17%** (and top gain is **Chhattisgarh**, followed by **Uttar Pradesh** and **Odisha**; note that India's **National Forest Policy, 1988** sets a target of bringing **33% [one-third]** of geographical area under forest and tree cover).

★ **Memory Trick:** Remember the **Top 5 States in Area-wise Forest Cover** with **"M-A-C-O-M"**: **M**adhya Pradesh, **A**runachal Pradesh, **C**hhattisgarh, **O**disha, and **M**aharashtra!

Chapter *5* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data	**Institutional & Satellite Framework (FSI ISFR 2023 & PIB)**	Published biennially since **1987** by the **Forest Survey of India (FSI, headquartered in Dehradun, Uttarakhand)** under MoEFCC; the **18th edition (ISFR 2023)** utilizes indigenous **Resourcesat-2 LISS-III** satellite data at 23.5 m spatial resolution.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flowchart of FSI Forest Cover Classification by Canopy Density	**Forest Cover**	Any land parcel of **1 hectare or more** having a **tree canopy density of 10% or more**, **irrespective of legal ownership or land use** (includes bamboo, orchards, palms, and tea/coffee estates meeting the ≥ 1 ha and ≥ 10\% canopy criteria).
Comparative Table of ISFR 2023 State Rankings & Champion-Seth Forest Types	**Tree Cover**	All patches of trees occurring **outside Recorded Forest Area (RFA)** that are **less than 1 hectare** in extent.
Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data	**Very Dense Forest (VDF)**	Canopy density **70% and above**.
Flowchart of FSI Forest Cover Classification by Canopy Density	**Moderately Dense Forest (MDF)**	Canopy density **40% to 70%**.
Comparative Table of ISFR 2023 State Rankings & Champion-Seth Forest Types	**Open Forest (OF)**	Canopy density **10% to 40%**.
Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data	**Total Forest and Tree Cover of India**	8,27,357 sq. km, **which constitutes** 25.17% of India's total geographical area **(up by** 1,445 sq. km** compared to 2021).
Flowchart of FSI Forest Cover Classification by Canopy Density	**Total Forest Cover Alone**	7,15,343 sq. km **(**21.76%** of geographical area, an increase of 156 sq. km).
Comparative Table of ISFR 2023 State Rankings & Champion-Seth Forest Types	**Total Tree Cover Alone**	1,12,014 sq. km **(**3.41%** of geographical area, an increase of 1,289 sq. km).
Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data	**Top States by Total Forest & Tree Cover Area**	1. Madhya Pradesh, 2. Arunachal Pradesh, 3. Maharashtra; **for** Forest Cover Area alone: 1. Madhya Pradesh, 2. Arunachal Pradesh, 3. Chhattisgarh, 4. Odisha, 5. Maharashtra**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flowchart of FSI Forest Cover Classification by Canopy Density	**Top States/UTs by Forest Cover Percentage (relative to geographical area)**	Among UTs/Overall: **Lakshadweep (91.33%)**; among **States: 1. Mizoram (85.34%), 2. Arunachal Pradesh (79.04%), 3. Meghalaya (76.00%), 4. Manipur, 5. Nagaland**.
Comparative Table of ISFR 2023 State Rankings & Champion-Seth Forest Types	**Top States Showing Maximum Increase in Forest & Tree Cover (ISFR 2023)**	1. Chhattisgarh (+684 sq. km), 2. Uttar Pradesh (+559 sq. km), 3. Odisha (+559 sq. km), 4. Rajasthan (+394 sq. km); **for** Forest Cover increase alone: 1. Mizoram (+242 sq. km), 2. Gujarat (+180 sq. km), 3. Odisha (+152 sq. km)**.
Official Forest Survey of India (FSI) Methodology & ISFR 2023 Data	**Mangrove Cover in India**	4,992 sq. km **(0.15% of India's geographical area); top 3 states/UTs are** 1. West Bengal (~42.45%), 2. Gujarat (~23.32%), **and** 3. Andaman & Nicobar Islands (~12.19%), **followed by** Andhra Pradesh**.
Flowchart of FSI Forest Cover Classification by Canopy Density	**India's Forest Carbon Stock**	Reached **30.43 billion tonnes of CO_2 equivalent** (an increase of 81.5 million tonnes of carbon / ~299 million tonnes of CO_2 equivalent since 2021, placing India well on track toward its **NDC target of 2.5 to 3.0 billion tonnes of additional CO_2 equivalent sink by 2030**), with **Arunachal Pradesh** holding the highest carbon stock, followed by **Madhya Pradesh, Chhattisgarh, and Maharashtra**.

Chapter 5 Multi-Statement Exam Verification Drills

Chapter 5 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Institutional & Satellite Framework (FSI ISFR 2023 & PIB)): Published biennially since **1987** by the **Forest Survey of India (FSI, headquartered in Dehradun, Uttarakhand)** under MoEFCC; the **18th edition (ISFR 2023)** utilizes indigenous **Resourcesat-2 LISS-III** satellite data at 23.5 m spatial resolution.

Statement-II (Forest Cover): Any land parcel of **1 hectare or more** having a **tree canopy density of 10% or more, irrespective of legal ownership or land use** (includes bamboo, orchards, palms, and tea/coffee estates meeting the ≥ 1 ha and ≥ 10\% canopy criteria).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Tree Cover): All patches of trees occurring **outside Recorded Forest Area (RFA)** that are **less than 1 hectare** in extent.

Statement-II (Very Dense Forest (VDF)): Canopy density **70% and above**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (Moderately Dense Forest (MDF)): Canopy density **40% to 70%**.

Statement-II (Open Forest (OF)): Canopy density **10% to 40%**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I (Total Forest and Tree Cover of India): 8,27,357 sq. km, **which constitutes** 25.17% of India's total geographical area **(up by** 1,445 sq. km** compared to 2021).

Statement-II (Total Forest Cover Alone): 7,15,343 sq. km **(**21.76%** of geographical area, an increase of 156 sq. km).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (Total Tree Cover Alone): 1,12,014 sq. km **(**3.41%** of geographical area, an increase of 1,289 sq. km).

Statement-II (Top States by Total Forest & Tree Cover Area): 1. Madhya Pradesh, 2. Arunachal Pradesh, 3. Maharashtra; **for** Forest Cover Area alone: 1. Madhya Pradesh, 2. Arunachal Pradesh, 3. Chhattisgarh, 4. Odisha, 5. Maharashtra**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 5 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Top States/UTs by Forest Cover Percentage (relative to geographical area)): Among UTs/Overall: **Lakshadweep (91.33%)**; among **States**: **1. Mizoram (85.34%)**, **2. Arunachal Pradesh (79.04%)**, **3. Meghalaya (76.00%)**, **4. Manipur**, **5. Nagaland**.

Statement-II (Top States Showing Maximum Increase in Forest & Tree Cover (ISFR 2023)): 1. Chhattisgarh (+684 sq. km), 2. Uttar Pradesh (+559 sq. km), 3. Odisha (+559 sq. km), 4. Rajasthan (+394 sq. km); **for** Forest Cover increase alone: 1. Mizoram (+242 sq. km), 2. Gujarat (+180 sq. km), 3. Odisha (+152 sq. km)**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter *6:* Environmental Legislation, Statutory Bodies & Movements in India

Chapter Key Study Pillars — Chapter 6: Environmental Legislation, Statutory Bodies & Movements in India

Key Study Pillar 1
Landmark Environmental Acts & Institutional Architecture of India

Key Study Pillar 2
Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements

6.1 Landmark Environmental Acts & Institutional Architecture of India

• **Constitutional Provisions for the Environment:** Inserted by the **42nd Constitutional Amendment Act, 1976** (following the 1972 Stockholm Conference): **Article 48A** (Directive Principle of State Policy directing the State to protect and improve the environment and safeguard forests and wildlife) and **Article 51A(g)** (Fundamental Duty of every citizen to protect the natural environment including forests, lakes, rivers, and

wildlife); furthermore, the Supreme Court (in *Subhash Kumar vs. State of Bihar* and *M.C. Mehta* cases) read the **Right to a Clean and Pollution-Free Environment into Article 21 (Right to Life)**.

• **Wildlife (Protection) Act, 1972 & The 2022 Amendment (MoEFCC):**

• Originally enacted in **1972** with **6 Schedules** (where Schedule V listed *Vermin* and Schedule VI listed specified plants).

• **Crucial Update — Wildlife (Protection) Amendment Act, 2022 (enforced from April 1, 2023):** Rationalized the Act from **6 Schedules down to 4 Schedules** and completely **eliminated the separate 'Vermin' Schedule**!

• **New Schedule I:** Animal species accorded the **highest level of legal protection** (e.g., Tiger, Lion, Elephant, Snow Leopard, Great Indian Bustard, Gangetic Dolphin).

• **New Schedule II:** Animal species accorded a **lesser degree of protection**.

• **New Schedule III: Protected Plant Species** (such as *Beddomes' cycad*, *Blue Vanda*, *Kuth*, *Ladies Slipper Orchid*, *Pitcher Plant*, *Red Vanda*).

• **New Schedule IV:** Specimens listed in the Appendices of **CITES** (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*).

• **Statutory Bodies Created under WPA 1972: National Board for Wildlife (NBWL)** (chaired by the **Prime Minister of India**—its Standing Committee approval is mandatory for any boundary alteration of National Parks or Wildlife Sanctuaries), **Central Zoo Authority (CZA, 1992)**, **Wildlife Crime Control Bureau (WCCB, 2007)**, and **National Tiger Conservation Authority (NTCA, 2006)**.

• **Other Pillars of Indian Environmental Law (MoEFCC):**

• **Water (Prevention and Control of Pollution) Act, 1974:** Created the **Central Pollution Control Board (CPCB)** and State Pollution Control Boards (SPCBs).

• **Forest (Conservation) Act, 1980 (Amended in 2023 as *Van (Sanrakshan Evam Samvardhan) Adhiniyam*):** Restricts the de-reservation of forests or use of forest land for non-forest purposes without prior Central Government approval.

• **Air (Prevention and Control of Pollution) Act, 1981:** Entrusted air quality regulation to CPCB and included **Noise** as an air pollutant via the 1987 amendment.

• **Environment (Protection) Act, 1986 (EPA 1986):** Enacted as an **"Umbrella Legislation"** under **Article 253** in the wake of the **1984 Bhopal Gas Tragedy** (Methyl Isocyanate [CH_3NCO] leak); empowers the Centre to notify **Coastal Regulation Zones (CRZ)**, **Eco-Sensitive Zones (ESZ)**, **Environmental Impact Assessment (EIA)** norms, and the **Genetic Engineering Appraisal Committee (GEAC)** (which approves GM crops such as *Bt Cotton* and *DMH-11 Mustard*).

• **Biological Diversity Act, 2002 (Amended in 2023):** Enacted to implement the **UN Convention on Biological Diversity (CBD, 1992)**; establishes a **three-tier structure—National Biodiversity Authority (NBA, headquartered in Chennai)**, **State Biodiversity Boards (SBBs)**, and local **Biodiversity Management Committees (BMCs)** (which prepare **People's Biodiversity Registers [PBRs]** and manage **Biodiversity Heritage Sites**).

• **Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, *2006* (FRA *2006*):** Administered by the **Ministry of Tribal Affairs**; vests the **Gram Sabha** as the initiating authority for determining individual (up to 4 hectares) and community forest rights, including right over **Minor Forest Produce (MFP)** and notification of **Critical Wildlife Habitats (CWH)**.

• **National Green Tribunal (NGT) Act, *2010*:** Established the **NGT** (Principal Bench in **New Delhi**, regional benches in Bhopal, Pune, Kolkata, and Chennai) guided by **Principles of Natural Justice** (not bound by the Code of Civil Procedure, *1908*) to dispose of environmental cases within **6 months**; enforces 7 **Civil Laws** (Water Act *1974*, Water Cess Act *1977*, Forest Conservation Act *1980*, Air Act *1981*, EPA *1986*, Public Liability Insurance Act *1991*, and Biological Diversity Act *2002*), while **EXCLUDING the Wildlife (Protection) Act, *1972* and the Forest Rights Act, *2006*** from its jurisdiction!

6.2 Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, *2002*

Step-by-Step Conceptual Process Flowchart

STEP 1
UN Convention on Biological Diversity (1992) & Nagoya ABS Protocol

STEP 2
National Biodiversity Authority (NBA, Chennai) — Regulates Foreign Entities & IPR

STEP 3
State Biodiversity Boards (SBBs) — Regulates Commercial Use by Indian Entities

STEP 4
Local Biodiversity Management Committees (BMCs) — Prepares People's Biodiversity Registers (PBRs)

6.3 Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements

Act / Statutory Body / Movement	Year	Chairperson / Key Leader	Crucial Exam Mandate & Jurisdiction (MoEFCC)
Wildlife (Protection) Act (Amended 2022)	1972 / 2022	**PM** chairs **NBWL**; **Environment Minister** chairs **NTCA**	Reduced **6 Schedules to 4 Schedules** (I: Highest animal protection; II: Lower animal; III: Plants; IV: CITES)
Central Pollution Control Board (CPCB)	1974	Appointed by Central Govt (under MoEFCC)	Created under **Water Act, 1974**; also exercises powers under **Air Act, 1981**; executes **NAMP & NAQI**
Environment (Protection) Act (EPA)	1986	Central Govt (MoEFCC)	Enacted under **Article 253** after Bhopal Gas Tragedy; notifies **ESZ, CRZ, EIA, and GEAC**
National Biodiversity Authority (NBA)	2003	Appointed by Central Govt (**HQ: Chennai**)	Statutory body under **Biological Diversity Act, 2002**; prevents biopiracy & enforces Access-Benefit Sharing
National Green Tribunal (NGT)	2010	Retired Supreme Court Judge / Chief Justice of HC	Enforces 7 **environmental laws**; **CANNOT hear cases under Wildlife Protection Act, 1972 or FRA, *2006***
Chipko & Appiko Movements	1973 & 1983	**Sunderlal Bahuguna, Chandi Prasad Bhatt, Gaura Devi** (Chipko); **Pandurang Hegde** (Appiko)	Chamoli, Uttarakhand (1973, inspired by 1730 **Bishnoi movement of Amrita Devi** in Khejarli, Rajasthan); Uttara Kannada, Karnataka (1983)
Silent Valley & Narmada Bachao	1973 & 1985	**Sugathakumari & KSSP** (Silent Valley); **Medha Patkar & Baba Amte** (NBA)	Saved tropical evergreen rainforest on **Kunthipuzha River** (Kerala) from hydroelectric submergence

Did You Know?: Who chairs the **National Board for Wildlife (NBWL)** vs. the **National Tiger Conservation Authority (NTCA)** vs. the **National Ganga Council**? The **Prime Minister of India** chairs the **National Board for Wildlife (NBWL)** and the **National Ganga Council**, whereas the **Union Minister of Environment, Forest and Climate Change** chairs the **NTCA** and the **Animal Welfare Board of India** (established in *1962* under the **Prevention of Cruelty to Animals Act, 1960**, pioneered by **Rukmini Devi Arundale**)!

Exam Trap Alert: Two classic UPSC/PCS traps: (1) The **National Green Tribunal (NGT)** has **NO jurisdiction** over the **Wildlife (Protection) Act, 1972** or the **Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006**; (2) Under the **Wildlife (Protection) Amendment Act, 2022**, there are now **4 Schedules (not 6)**, and **Protected Plants** are now in **Schedule III** (formerly Schedule VI), while the old Schedule V (*Vermin*) has been completely abolished!

★ **Memory Trick:** Remember the **4 Schedules of the amended Wildlife (Protection) Act, 2022** with **"1-Top, 2-Sub, 3-Tree, 4-Trade (CITES)"**: Schedule I = Top animal protection, Schedule II = Secondary animal protection, Schedule III = Trees/Plants, Schedule IV = International Trade (CITES)!

Chapter *6* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Landmark Environmental Acts & Institutional Architecture of India	**Constitutional Provisions for the Environment**	Inserted by the **42nd Constitutional Amendment Act, 1976** (following the 1972 Stockholm Conference): **Article 48A** (Directive Principle of State Policy directing the State to protect and improve the environment and safeguard forests and wildlife) and **Article 51A(g)** (Fundamental Duty of every citizen to protect the natural environment including forests, lakes, rivers, and wildlife); furthermore, the Supreme Court (in *Subhash Kumar vs. State of Bihar* and *M.C. Mehta* cases) read the **Right to a Clean and Pollution-Free Environment into Article 21 (Right to Life)**.
Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, 2002	**Crucial Update — Wildlife (Protection) Amendment Act, 2022 (enforced from April 1, 2023)**	Rationalized the Act from **6 Schedules down to 4 Schedules** and completely **eliminated the separate 'Vermin' Schedule**!
Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements	**New Schedule I**	Animal species accorded the **highest level of legal protection** (e.g., Tiger, Lion, Elephant, Snow Leopard, Great Indian Bustard, Gangetic Dolphin).
Landmark Environmental Acts & Institutional Architecture of India	**New Schedule II**	Animal species accorded a **lesser degree of protection**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, 2002	**New Schedule III**	Protected Plant Species* (*such as* Beddomes' cycad, Blue Vanda, Kuth, Ladies Slipper Orchid, Pitcher Plant, Red Vanda*).
Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements	**New Schedule IV**	Specimens listed in the Appendices of **CITES** (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*).
Landmark Environmental Acts & Institutional Architecture of India	**Statutory Bodies Created under WPA 1972**	National Board for Wildlife (NBWL) **(chaired by the** Prime Minister of India **—its Standing Committee approval is mandatory for any boundary alteration of National Parks or Wildlife Sanctuaries),** Central Zoo Authority (CZA, 1992)**,** Wildlife Crime Control Bureau (WCCB, 2007)**, and** National Tiger Conservation Authority (NTCA, 2006)**.
Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, 2002	**Water (Prevention and Control of Pollution) Act, 1974**	Created the **Central Pollution Control Board (CPCB)** and State Pollution Control Boards (SPCBs).
Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements	**Forest (Conservation) Act, 1980 (Amended in 2023 as *Van (Sanrakshan Evam Samvardhan) Adhiniyam*)**	Restricts the de-reservation of forests or use of forest land for non-forest purposes without prior Central Government approval.
Landmark Environmental Acts & Institutional Architecture of India	**Air (Prevention and Control of Pollution) Act, 1981**	Entrusted air quality regulation to CPCB and included **Noise** as an air pollutant via the 1987 amendment.
Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, 2002	**Environment (Protection) Act, 1986 (EPA 1986)**	Enacted as an **"Umbrella Legislation"** under **Article 253** in the wake of the **1984 Bhopal Gas Tragedy** (Methyl Isocyanate [CH_3NCO] leak); empowers the Centre to notify **Coastal Regulation Zones (CRZ)**, **Eco-Sensitive Zones (ESZ)**, **Environmental Impact Assessment (EIA)** norms, and the **Genetic Engineering Appraisal Committee (GEAC)** (which approves GM crops such as *Bt Cotton* and *DMH-11 Mustard*).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Master Table of Indian Environmental Acts, Statutory Bodies & Grassroots Movements	**Biological Diversity Act, 2002 (Amended in 2023)**	Enacted to implement the **UN Convention on Biological Diversity (CBD, 1992)**; establishes a **three-tier structure—National Biodiversity Authority (NBA, headquartered in Chennai)**, **State Biodiversity Boards (SBBs)**, and local **Biodiversity Management Committees (BMCs)** (which prepare **People's Biodiversity Registers [PBRs]** and manage **Biodiversity Heritage Sites**).
Landmark Environmental Acts & Institutional Architecture of India	**Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA 2006)**	Administered by the **Ministry of Tribal Affairs**; vests the **Gram Sabha** as the initiating authority for determining individual (up to 4 hectares) and community forest rights, including right over **Minor Forest Produce (MFP)** and notification of **Critical Wildlife Habitats (CWH)**.
Flowchart of the Three-Tier Institutional Framework under the Biological Diversity Act, 2002	**National Green Tribunal (NGT) Act, 2010**	Established the **NGT** (Principal Bench in **New Delhi**, regional benches in Bhopal, Pune, Kolkata, and Chennai) guided by **Principles of Natural Justice** (not bound by the Code of Civil Procedure, 1908) to dispose of environmental cases within **6 months**; enforces 7 **Civil Laws** (Water Act 1974, Water Cess Act 1977, Forest Conservation Act 1980, Air Act 1981, EPA 1986, Public Liability Insurance Act 1991, and Biological Diversity Act 2002), while **EXCLUDING the Wildlife (Protection) Act, 1972 and the Forest Rights Act, 2006** from its jurisdiction!

Chapter 6 Multi-Statement Exam Verification Drills

Chapter 6 Statement-Verification Drill #1 — Both Statements Verified Correct

Statement-I (Constitutional Provisions for the Environment): Inserted by the **42nd Constitutional Amendment Act, 1976** (following the 1972 Stockholm Conference): **Article 48A** (Directive Principle of State Policy directing the State to protect and improve the environment and safeguard forests and wildlife) and **Article 51A(g)** (Fundamental Duty of every citizen to protect the natural environment including forests, lakes, rivers, and wildlife); furthermore, the Supreme Court (in *Subhash Kumar vs. State of Bihar* and *M.C. Mehta* cases) read the **Right to a Clean and Pollution-Free Environment into Article 21 (Right to Life)**.

Statement-II (Crucial Update — Wildlife (Protection) Amendment Act, 2022 (enforced from April 1, 2023)): Rationalized the Act from **6 Schedules down to 4 Schedules** and completely **eliminated the separate 'Vermin' Schedule**!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 6 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (New Schedule I): Animal species accorded the **highest level of legal protection** (e.g., Tiger, Lion, Elephant, Snow Leopard, Great Indian Bustard, Gangetic Dolphin).

Statement-II (New Schedule II): Animal species accorded a **lesser degree of protection**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 6 Statement-Verification Drill #3 — **Both Statements Verified Correct**

Statement-I (New Schedule III): Protected Plant Species* (*such as* Beddomes' cycad, Blue Vanda, Kuth, Ladies Slipper Orchid, Pitcher Plant, Red Vanda*).

Statement-II (New Schedule IV): Specimens listed in the Appendices of **CITES** (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 6 Statement-Verification Drill #4 — **Both Statements Verified Correct**

Statement-I (Statutory Bodies Created under WPA 1972): National Board for Wildlife (NBWL) **(chaired by the** Prime Minister of India—**its Standing Committee approval is mandatory for any boundary alteration of National Parks or Wildlife Sanctuaries),** Central Zoo Authority (CZA, 1992)**,** Wildlife Crime Control Bureau (WCCB, 2007)**, and** National Tiger Conservation Authority (NTCA, 2006)**.

Statement-II (Water (Prevention and Control of Pollution) Act, 1974): Created the **Central Pollution Control Board (CPCB)** and State Pollution Control Boards (SPCBs).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 6 Statement-Verification Drill #5 — **Both Statements Verified Correct**

Statement-I (Forest (Conservation) Act, 1980 (Amended in 2023 as *Van (Sanrakshan Evam Samvardhan) Adhiniyam*)): Restricts the de-reservation of forests or use of forest land for non-forest purposes without prior Central Government approval.

Statement-II (Air (Prevention and Control of Pollution) Act, 1981): Entrusted air quality regulation to CPCB and included **Noise** as an air pollutant via the 1987 amendment.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 6 Statement-Verification Drill #6 — **Both Statements Verified Correct**

Statement-I (Environment (Protection) Act, 1986 (EPA 1986)): Enacted as an **"Umbrella Legislation"** under **Article 253** in the wake of the **1984 Bhopal Gas Tragedy** (Methyl Isocyanate [CH_3NCO] leak); empowers the Centre to notify **Coastal Regulation Zones (CRZ)**, **Eco-Sensitive Zones (ESZ)**, **Environmental Impact Assessment (EIA)** norms, and the **Genetic Engineering Appraisal Committee (GEAC)** (which approves GM crops such as *Bt Cotton* and *DMH-11 Mustard*).

Statement-II (Biological Diversity Act, 2002 (Amended in 2023)): Enacted to implement the **UN Convention on Biological Diversity (CBD, 1992)**; establishes a **three-tier structure—National Biodiversity Authority (NBA, headquartered in Chennai)**, **State Biodiversity Boards (SBBs)**, and local **Biodiversity Management Committees (BMCs)** (which prepare **People's Biodiversity Registers [PBRs]** and manage **Biodiversity Heritage Sites**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7: Environmental Pollution, Air Quality Index, Waste Management & Bioremediation

Chapter Key Study Pillars — Chapter 7: Environmental Pollution, Air Quality Index, Waste Management & Bioremediation

Key Study Pillar 1	Key Study Pillar 2	Key Study Pillar 3
Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain	**Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties**	**Master Reference Table of Pollution-Induced Diseases & International Waste Conventions**

7.1 Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain

• **Primary vs. Secondary Air Pollutants (NCERT & MoEFCC):**

• **Primary Pollutants (emitted directly from a source):** Particulate Matter (PM_{10} and PM_{2.5}), Carbon Monoxide (CO—binds with haemoglobin ~200–250 times more strongly than oxygen to form stable **Carboxyhaemoglobin**), Carbon Dioxide (CO_2), Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x), Lead (Pb), and Volatile Organic Compounds (VOCs).

• **Secondary Pollutants (formed in the atmosphere via chemical/photochemical reactions among primary pollutants): Tropospheric (Surface) Ozone (O_3)**, **Peroxyacetyl Nitrate (PAN)**, **Sulphuric Acid (H_2SO_4)**, **Nitric Acid (HNO_3)**, and **Photochemical Smog**.

• **Classical (London) Smog vs. Photochemical (Los Angeles) Smog:**

• **Classical / Sulphurous Smog:** Occurs in **cool, humid winter climates** due to burning of sulphur-rich coal (Smoke + Fog + SO_2); chemically **Reducing Smog**.

• **Photochemical Smog:** Occurs in **warm, dry, sunny climates** by the action of ultraviolet sunlight on unsaturated hydrocarbons (VOCs) and Nitrogen Oxides (NO_x) from vehicular exhaust, producing **Ozone (O_3), PAN, Acrolein, and Formaldehyde**; chemically **Oxidizing Smog**.

• **National Air Quality Index (NAQI — "One Number, One Colour, One Description"):** Launched in **2014** by MoEFCC and CPCB covering **6 AQI Categories** (*Good* [0–50], *Satisfactory* [51–100], *Moderately Polluted* [101–200], *Poor* [201–300], *Very Poor* [301–400], *Severe* [401–500]) based on **8 Measured Pollutants**:

1. **PM_{10}** (Particulate Matter ≤ 10 µm)
2. **PM_{2.5}** (Fine Particulate Matter ≤ 2.5 µm)
3. **Nitrogen Dioxide (NO_2)**
4. **Sulphur Dioxide (SO_2)**
5. **Carbon Monoxide (CO)**
6. **Ozone (O_3)**
7. **Ammonia (NH_3)**
8. **Lead (Pb)**

(*Crucial Note*: ***Carbon Dioxide [CO_2], Methane [CH_4], and Benzene are NOT included*** *among the 8 NAQI pollutants, though Benzene, Benzo(a)pyrene, Arsenic, and Nickel are included in the 12* ***National Ambient Air Quality Standards [NAAQS]***!)

• **Fly Ash, Acid Rain & Bharat Stage VI (BS-VI) Fuel Norms: Acid Rain** (rainwater with **pH < 5.6**) is caused by atmospheric oxidation of **SO_2 and NO_x** into H_2SO_4 and HNO_3 (causing *Marble Cancer* on the Taj Mahal); **Fly Ash** (a fine residue from coal-fired thermal power plants containing **Silica, Aluminium silicate, Calcium oxide, and toxic heavy metals like Arsenic, Lead, and Mercury**) is mandatorily utilized in Portland Pozzolana cement, bricks, and highway embankments; India leapfrogged directly from **BS-IV to BS-VI emission standards on April 1, 2020**, slashing fuel sulphur content from **50 ppm down to 10 ppm**.

7.2 Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties

• **Bioremediation & Phytoremediation Techniques:**

• **In-Situ Bioremediation: Bioventing** (supplying air/nutrients through wells to stimulate indigenous soil bacteria), **Biosparging** (injecting air under pressure below the water table), and **Bioaugmentation** (introducing specialized engineered microbial strains such as **Oilzapper** or **Oilivorous-S** developed by TERI, and *Pseudomonas putida* developed by **Dr. Ananda Mohan Chakrabarty** to degrade marine oil spills).

• **Ex-Situ Bioremediation: Landfarming**, **Biopiles**, **Composting**, and **Bioreactors**.

• **Global Hazardous Waste & Chemical Conventions (MoEFCC):**

• **Basel Convention (1989, in force 1992):** Controls **transboundary movements of Hazardous Wastes** and their disposal (includes plastic waste amendments).

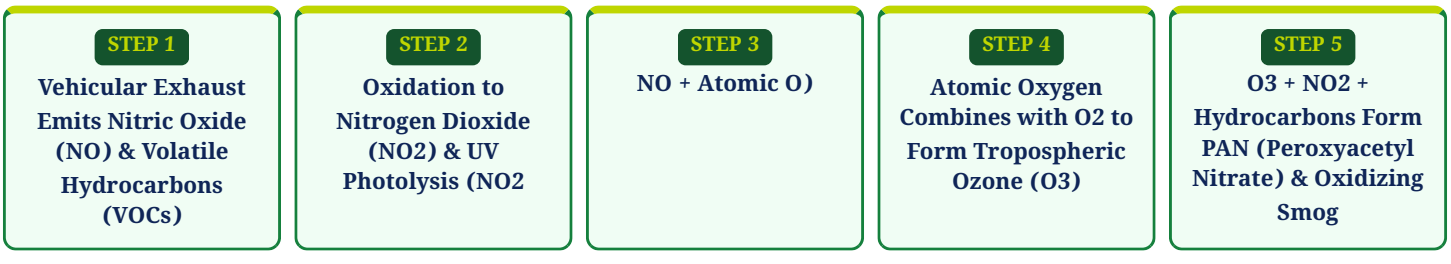
• **Rotterdam Convention (1998, in force 2004):** Mandates **Prior Informed Consent (PIC)** procedure for certain hazardous chemicals and pesticides in international trade.

• **Stockholm Convention (2001, in force 2004):** Eliminates or restricts the production and use of **Persistent Organic Pollutants (POPs)** (initially the **"Dirty Dozen"** such as DDT, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, PCBs, Dioxins, and Furans; later expanded to Endosulfan, Lindane, Dechlorane Plus, and UV-328).

• **Minamata Convention (2013, in force 2017):** Global treaty to protect human health and the environment from anthropogenic emissions and releases of **Mercury (Hg)** and mercury compounds.

7.3 Flowchart of Photochemical Smog Formation & Tropospheric Ozone Chemistry

Step-by-Step Conceptual Process Flowchart



7.4 Master Reference Table of Pollution-Induced Diseases & International Waste Conventions

Pollutant / Convention	Target Organ / Chemical Scope	Associated Disease / Mechanism (NCERT & MoEFCC)
Mercury (Hg / Methylmercury)	Central Nervous System	**Minamata Disease** (first detected in Minamata Bay, Japan, 1956 via contaminated fish); governed by **Minamata Convention (2013)**
Cadmium (Cd)	Bones & Kidneys	**Itai-Itai ("Ouch-Ouch") Disease** (painful skeletal softening and renal tubular dysfunction in Toyama, Japan)
Nitrate (NO_3^- > 45–50 mg/L in water)	Haemoglobin in infants	**Blue Baby Syndrome (Methaemoglobinaemia)** (Nitrate converts haemoglobin to *Methaemoglobin*, impairing oxygen transport)
Arsenic (As in aquifer water)	Skin, Lungs & Bladder	**Blackfoot Disease**, Hyperkeratosis, peripheral vascular gangrene (prevalent in West Bengal & Bihar Ganga-Brahmaputra plains)
Fluoride (F^- > 1.5 mg/L in water)	Tooth Enamel & Bones	**Dental & Skeletal Fluorosis** (*Knock-Knee Syndrome* and mottled teeth)
Coal Dust, Silica & Asbestos	Pulmonary Alveoli	**Pneumoconiosis (Black Lung Disease)**, **Silicosis**, and **Asbestosis / Mesothelioma**
Basel, Rotterdam & Stockholm ("BRS")	Transboundary Waste, PIC Chemicals & POPs	**Basel (1989)**: Hazardous Waste; **Rotterdam (1998)**: Prior Informed Consent; **Stockholm (2001)**: Persistent Organic Pollutants

Did You Know?: Why is **Ozone (O_3)** described in NCERT as **"Good up high, Bad nearby"**? In the **Stratosphere (15–35 km)**, the ozone shield acts as "Good Ozone" by absorbing lethal **UV-B and UV-C solar radiation** (preventing skin melanoma and **Snow Blindness** [corneal inflammation]); in the **Troposphere (surface level)**, ozone is a toxic **Secondary Pollutant** and greenhouse gas that damages plant stomata and human lung tissue!

Exam Trap Alert: Memorize the **8 pollutants of the National Air Quality Index (NAQI): PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3, and Pb**. In nearly every competitive exam, **CO_2 (Carbon Dioxide)** or **Methane (CH_4)** is placed as a distractor option—remember that **CO_2 is NOT part of NAQI**!

★ **Memory Trick:** Remember the **"BRS + M" Chemical Conventions** with **"B-Waste, R-Consent, S-POPs, M-Mercury"**: **B**asel = Hazardous **Waste**, **R**otterdam = Prior Informed **Consent**, **S**tockholm = **POPs** (Dirty Dozen), **M**inamata = **Mercury**!

Chapter 7 Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain	**Primary Pollutants (emitted directly from a source)**	Particulate Matter (PM_{10} and $PM_{2.5}$), Carbon Monoxide (CO—binds with haemoglobin ~200–250 times more strongly than oxygen to form stable **Carboxyhaemoglobin**), Carbon Dioxide (CO_2), Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x), Lead (Pb), and Volatile Organic Compounds (VOCs).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties	**Secondary Pollutants (formed in the atmosphere via chemical/ photochemical reactions among primary pollutants)**	Tropospheric (Surface) Ozone (O_3), Peroxyacetyl Nitrate (PAN), Sulphuric Acid (H_2SO_4), Nitric Acid (HNO_3), **and** Photochemical Smog**.
Flowchart of Photochemical Smog Formation & Tropospheric Ozone Chemistry	**Classical / Sulphurous Smog**	Occurs in **cool, humid winter climates** due to burning of sulphur-rich coal (Smoke + Fog + SO_2); chemically **Reducing Smog**.
Master Reference Table of Pollution-Induced Diseases & International Waste Conventions	**Photochemical Smog**	Occurs in **warm, dry, sunny climates** by the action of ultraviolet sunlight on unsaturated hydrocarbons (VOCs) and Nitrogen Oxides (NO_x) from vehicular exhaust, producing **Ozone (O_3), PAN, Acrolein, and Formaldehyde**; chemically **Oxidizing Smog**.
Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain	**National Air Quality Index (NAQI — "One Number, One Colour, One Description")**	Launched in **2014** by MoEFCC and CPCB covering **6 AQI Categories** (*Good* [0–50], *Satisfactory* [51–100], *Moderately Polluted* [101–200], *Poor* [201–300], *Very Poor* [301–400], *Severe* [401–500]) based on **8 Measured Pollutants
Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties	**PM_{10}**	(Particulate Matter ≤ 10 µm)
Flowchart of Photochemical Smog Formation & Tropospheric Ozone Chemistry	**$PM_{2.5}$**	(Fine Particulate Matter ≤ 2.5 µm)
Master Reference Table of Pollution-Induced Diseases & International Waste Conventions	**Fly Ash, Acid Rain & Bharat Stage VI (BS-VI) Fuel Norms**	Acid Rain **(rainwater with** pH < 5.6**) is caused by atmospheric oxidation of** SO_2 and NO_x **into** H_2SO_4 **and** HNO_3 **(causing *Marble Cancer* on the Taj Mahal);** Fly Ash **(a fine residue from coal-fired thermal power plants containing** Silica, Aluminium silicate, Calcium oxide, and toxic heavy metals like Arsenic, Lead, and Mercury**) is mandatorily utilized in Portland Pozzolana cement, bricks, and highway embankments; India leapfrogged directly from** BS-IV to BS-VI emission standards on April 1, 2020**, slashing fuel sulphur content from** 50 ppm down to 10 ppm**.
Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain	**In-Situ Bioremediation**	Bioventing **(supplying air/nutrients through wells to stimulate indigenous soil bacteria),** Biosparging **(injecting air under pressure below the water table), and** Bioaugmentation **(introducing specialized engineered microbial strains such as** Oilzapper **or** Oilivorous-S **developed by TERI, and *Pseudomonas putida* developed by** Dr. Ananda Mohan Chakrabarty** to degrade marine oil spills).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties	**Ex-Situ Bioremediation**	Landfarming, Biopiles, Composting, **and** Bioreactors**.
Flowchart of Photochemical Smog Formation & Tropospheric Ozone Chemistry	**Basel Convention (1989, in force 1992)**	Controls **transboundary movements of Hazardous Wastes** and their disposal (includes plastic waste amendments).
Master Reference Table of Pollution-Induced Diseases & International Waste Conventions	**Rotterdam Convention (1998, in force 2004)**	Mandates **Prior Informed Consent (PIC)** procedure for certain hazardous chemicals and pesticides in international trade.
Air Pollutants, National Air Quality Index (NAQI), Smog & Acid Rain	**Stockholm Convention (2001, in force 2004)**	Eliminates or restricts the production and use of **Persistent Organic Pollutants (POPs)** (initially the **"Dirty Dozen"** such as DDT, Aldrin, Dieldrin, Chlordane, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, PCBs, Dioxins, and Furans; later expanded to Endosulfan, Lindane, Dechlorane Plus, and UV-328).
Heavy Metal Toxicity Diseases, Bioremediation & International Waste Treaties	**Minamata Convention (2013, in force 2017)**	Global treaty to protect human health and the environment from anthropogenic emissions and releases of **Mercury (Hg)** and mercury compounds.

Chapter 7 Multi-Statement Exam Verification Drills

Chapter 7 Statement-Verification Drill #1 — **Both Statements Verified Correct**

Statement-I (Primary Pollutants (emitted directly from a source)): Particulate Matter (PM_{10} and PM_{2.5}), Carbon Monoxide (CO—binds with haemoglobin ~200–250 times more strongly than oxygen to form stable **Carboxyhaemoglobin**), Carbon Dioxide (CO_2), Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x), Lead (Pb), and Volatile Organic Compounds (VOCs).

Statement-II (Secondary Pollutants (formed in the atmosphere via chemical/photochemical reactions among primary pollutants)): Tropospheric (Surface) Ozone (O_3), Peroxyacetyl Nitrate (PAN), Sulphuric Acid (H_2SO_4), Nitric Acid (HNO_3), **and** Photochemical Smog**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7 Statement-Verification Drill #2 — Both Statements Verified Correct

Statement-I (Classical / Sulphurous Smog): Occurs in **cool, humid winter climates** due to burning of sulphur-rich coal (Smoke + Fog + SO_2); chemically **Reducing Smog**.

Statement-II (Photochemical Smog): Occurs in **warm, dry, sunny climates** by the action of ultraviolet sunlight on unsaturated hydrocarbons (VOCs) and Nitrogen Oxides (NO_x) from vehicular exhaust, producing **Ozone (O_3), PAN, Acrolein, and Formaldehyde**; chemically **Oxidizing Smog**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7 Statement-Verification Drill #3 — Both Statements Verified Correct

Statement-I (National Air Quality Index (NAQI — "One Number, One Colour, One Description")): Launched in **2014** by MoEFCC and CPCB covering **6 AQI Categories** (*Good* [0–50], *Satisfactory* [51–100], *Moderately Polluted* [101–200], *Poor* [201–300], *Very Poor* [301–400], *Severe* [401–500]) based on **8 Measured Pollutants

Statement-II (PM_{10}): (Particulate Matter ≤ 10 µm)

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7 Statement-Verification Drill #4 — Both Statements Verified Correct

Statement-I ($PM_{2.5}$): (Fine Particulate Matter ≤ 2.5 µm)

Statement-II (Fly Ash, Acid Rain & Bharat Stage VI (BS-VI) Fuel Norms): Acid Rain **(rainwater with** pH < 5.6**) is caused by atmospheric oxidation of** SO_2 and NO_x **into H_2SO_4 and HNO_3 (causing *Marble Cancer* on the Taj Mahal);** Fly Ash **(a fine residue from coal-fired thermal power plants containing** Silica, Aluminium silicate, Calcium oxide, and toxic heavy metals like Arsenic, Lead, and Mercury**) is mandatorily utilized in Portland Pozzolana cement, bricks, and highway embankments; India leapfrogged directly from** BS-IV to BS-VI emission standards on April 1, 2020**, slashing fuel sulphur content from** 50 ppm down to 10 ppm**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7 Statement-Verification Drill #5 — Both Statements Verified Correct

Statement-I (In-Situ Bioremediation): Bioventing **(supplying air/nutrients through wells to stimulate indigenous soil bacteria),** Biosparging **(injecting air under pressure below the water table), and** Bioaugmentation **(introducing specialized engineered microbial strains such as** Oilzapper **or** Oilivorous-S **developed by TERI, and *Pseudomonas putida* developed by** Dr. Ananda Mohan Chakrabarty** to degrade marine oil spills).

Statement-II (Ex-Situ Bioremediation): Landfarming**,** Biopiles**,** Composting**, and** Bioreactors**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 7 Statement-Verification Drill #6 — Both Statements Verified Correct

Statement-I (Basel Convention (1989, in force 1992)): Controls **transboundary movements of Hazardous Wastes** and their disposal (includes plastic waste amendments).

Statement-II (Rotterdam Convention (1998, in force 2004)): Mandates **Prior Informed Consent (PIC)** procedure for certain hazardous chemicals and pesticides in international trade.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8: Climate Change, Ozone Depletion, UNFCCC COP Summits & India's Net-Zero Panchamrit

Chapter Key Study Pillars — Chapter 8: Climate Change, Ozone Depletion, UNFCCC COP Summits & India's Net-Zero Panchamrit

Key Study Pillar 1
Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols

Key Study Pillar 2
Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29

Key Study Pillar 3
Master Table of Global Environmental Conventions, Protocols & Summits

8.1 Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols

• **Greenhouse Gases (GHGs) & Kyoto Protocol Basket (MoEFCC):**

• Naturally occurring **Water Vapour (H_2O)** is the single largest contributor to the **Natural Greenhouse Effect**, followed by **Carbon Dioxide (CO_2)** (largest *anthropogenic* driver), **Methane (CH_4)** (emitted from wetlands, paddy fields, enteric fermentation in cattle, coal mines, and landfills), **Nitrous Oxide (N_2O)** (fertilizers, nylon production, biomass burning), and **Fluorinated Gases**.

• **Seven Official Kyoto Protocol / UNFCCC Greenhouse Gases: CO_2, CH_4, N_2O, Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3—added in the Doha Amendment)**.

• **Global Warming Potential (GWP-100) & Atmospheric Lifetime:** Measured relative to **CO_2 (GWP = 1)**: **Methane (CH_4)** has a 100-year GWP of **~28–30** (short lifetime ~12 years), **Nitrous Oxide (N_2O)** has a GWP of **~265–273** (lifetime ~110–120 years), **HFCs** range from **140 to 14,800**, **PFCs** range from **6,500 to 9,200**, and **Sulphur Hexafluoride (SF_6)** has the **highest GWP of ~23,500** and an atmospheric lifetime of **3,200 years**!

• **Stratospheric Ozone Depletion, Vienna Convention (1985) & Montreal Protocol (1987):**

• **Polar Stratospheric Clouds (PSCs):** Over Antarctica during the polar winter vortex, Nitric Acid Trihydrate and ice crystals on **Polar Stratospheric Clouds** provide catalytic surfaces converting inactive chlorine reservoirs into active **Chlorine free radicals (Cl^\bullet)** via **Chlorofluorocarbons (CFCs), Halons, Carbon Tetrachloride, and Methyl Chloroform** (where a single chlorine atom can destroy up to **100,000 Ozone molecules**!).

• **Vienna Convention (1985) & Montreal Protocol (September 16, 1987 — World Ozone Day):** Universally ratified treaty phasing out **Ozone Depleting Substances (ODS)** such as CFCs and HCFCs.

• **Kigali Amendment to the Montreal Protocol (2016, in force January 1, 2019; ratified by India in 2021):** Phases down **Hydrofluorocarbons (HFCs)** by 80–85% by the late 2040s; note that **HFCs have ZERO Ozone Depleting Potential (ODP = 0)** because they contain no chlorine or bromine, so they were adopted as CFC substitutes, but they are **potent Greenhouse Gases** with thousands-fold Global Warming Potential!

8.2 Timeline from Stockholm *(1972)* & Rio Earth Summit *(1992)* to COP*28* & COP*29*

• **Stockholm Conference (1972) & Brundtland Commission (1987):** The 1972 UN Conference on the Human Environment established **UNEP (headquartered in Nairobi, Kenya)** and designated **June 5 as World Environment Day**; the 1987 Brundtland Report (**"Our Common Future"**) defined **Sustainable Development**.

• **1992 Rio Earth Summit (UNCED):** Produced **Agenda 21**, the **Rio Declaration**, **Forest Principles**, and the **Three Rio Sister Conventions**:

1. **UNFCCC** (*United Nations Framework Convention on Climate Change*)—supported scientifically by the **IPCC** (founded in 1988 by **WMO and UNEP**).

2. **UN Convention on Biological Diversity (CBD)**—which subsequently produced the **Cartagena Protocol on Biosafety (2000)** (regulating Living Modified Organisms [LMOs]), the **Nagoya Protocol on Access and Benefit-Sharing (2010)**, and the **Kunming-Montreal Global Biodiversity Framework (COP15, 2022)** featuring the **"30x30 Target"** (conserving **30% of terrestrial and marine areas by 2030**).

3. **UNCCD** (*UN Convention to Combat Desertification*, 1994—the **ONLY legally binding international agreement linking environment and development to sustainable land management**; COP14 was hosted in **New Delhi, India**, and COP16 in **Riyadh, Saudi Arabia** in December 2024).

• **UNFCCC Milestones — Kyoto (1997), Paris (2015), Glasgow (COP26), Sharm el-Sheikh (COP27), Dubai (COP28) & Baku (COP29):**

• **Kyoto Protocol (COP3, 1997, in force 2005):** Legally binding emission cuts for **Annex-I (Developed) countries** under **Common But Differentiated Responsibilities (CBDR)** via three market mechanisms: **Clean Development Mechanism (CDM)**, **Joint Implementation (JI)**, and **Emissions Trading**.

• **Paris Agreement (COP21, 2015):** Aims to hold global average temperature rise to **well below 2^°C above pre-industrial levels** and pursue efforts to limit it to **1.5^°C** via bottom-up **Nationally Determined Contributions (NDCs)**; also saw the launch of the **International Solar Alliance (ISA)** by **India and France** (headquartered in **Gurugram, Haryana**).

• **COP26 (Glasgow, UK, 2021):** India announced its historic **5-point 'Panchamrit' pledges** and **Mission LiFE** (*Lifestyle for Environment*):

1. Reach **500 GW of non-fossil fuel energy capacity by 2030**.

2. Meet **50% of energy requirements from renewable energy / non-fossil fuel sources by 2030** (*officially updated in India's August 2022 NDC to 50% cumulative electric power installed capacity from non-fossil fuel sources by 2030*).

3. Reduce total projected carbon emissions by **1 billion tonnes from 2021 to 2030**.

4. Reduce the **emissions intensity of India's GDP by 45% by 2030** over 2005 levels.

5. Achieve the target of **Net-Zero emissions by the year 2070**.

• **COP27 (Sharm el-Sheikh, Egypt, 2022):** Established the breakthrough **Loss and Damage Fund** for vulnerable developing countries.

• **COP28 (Dubai, UAE, 2023):** Completed the **First Global Stocktake (GST)**, operationalized the **Loss and Damage Fund** (initially hosted by the World Bank), called for **"transitioning away from fossil fuels in energy**

systems", and adopted the pledge to **triple global renewable energy capacity and double energy efficiency by 2030**.

• **COP29 (Baku, Azerbaijan, November 2024 — "Finance COP"):** Adopted the **New Collective Quantified Goal (NCQG)** on climate finance (mobilizing at least **USD 300 billion per year by 2035** for developing countries, scaling toward USD 1.3 trillion) and finalized **Article 6.4 global carbon market rules** (PIB).

• **India's National Action Plan on Climate Change (NAPCC, 2008):** Comprises **8 Core National Missions**: (1) National Solar Mission, (2) National Mission for Enhanced Energy Efficiency (NMEEE), (3) National Mission on Sustainable Habitat, (4) National Water Mission, (5) National Mission for Sustaining the Himalayan Ecosystem, (6) National Mission for a **Green India**, (7) National Mission for Sustainable Agriculture, and (8) National Mission on Strategic Knowledge for Climate Change.

8.3 Flowchart of Global Climate Governance Evolution *(1972 to 2024)*

Step-by-Step Conceptual Process Flowchart

STEP 1
1972 Stockholm (UNEP) & 1992 Rio Earth Summit (UNFCCC, CBD, UNCCD)

STEP 2
1997 Kyoto Protocol (CBDR Annex-I Binding Cuts) & 2015 Paris Agreement (1.5°C–2°C NDCs)

STEP 3
2021 COP26 Glasgow (India's 2070 Net-Zero Panchamrit & Mission LiFE)

STEP 4
COP27/28 Loss & Damage Fund & COP29 Baku (NCQG Climate Finance & Article 6 Carbon Markets)

8.4 Master Table of Global Environmental Conventions, Protocols & Summits

Convention / Protocol	Year Adopted	Core Environmental Mandate	Key Institutional / Exam Highlight (MoEFCC & PIB)
Vienna Convention & Montreal Protocol	1985 & 1987	Protection of Stratospheric **Ozone Layer** by phasing out **ODS (CFCs, Halons)**	**Kigali Amendment (2016)** phases down **HFCs** (which have **Zero ODP** but **High GWP**)
Cartagena & Nagoya Protocols (under CBD)	2000 & 2010	**Cartagena**: Biosafety of **LMOs (GMOs)**; **Nagoya**: **Access and Benefit-Sharing (ABS)** of genetic resources	**COP15 (Kunming-Montreal, 2022)** adopted the **30x30 Biodiversity Target**
CITES & CMS (Bonn Convention)	1973 & 1979	**CITES**: Regulates trade in endangered species; **CMS (Bonn)**: Conserves **Migratory Species**	**TRAFFIC** (founded 1976) is a joint wildlife trade monitoring network of **WWF and IUCN**
Kyoto Protocol (UNFCCC COP3)	1997 (Force: 2005)	Legally binding GHG reductions for **Annex-I countries** (**CBDR** principle)	Introduced **CDM, Joint Implementation (JI), and Certified Emission Reductions (CERs)**
Paris Agreement (UNFCCC COP21)	2015	Limit global warming to **well below 2^°C (ideally 1.5^°C)** via **NDCs**	**International Solar Alliance (ISA)** launched by India & France (**HQ: Gurugram**)
COP26 (Glasgow) & Updated India NDC	2021 & 2022	India's **Panchamrit**: **45% GDP emissions intensity cut by 2030**, **50% non-fossil power capacity by 2030**, **Net-Zero by 2070**	Launched **Mission LiFE** and **Coalition for Disaster Resilient Infrastructure (CDRI, HQ: New Delhi)**

Convention / Protocol	Year Adopted	Core Environmental Mandate	Key Institutional / Exam Highlight (MoEFCC & PIB)
COP28 (Dubai) & COP29 (Baku)	2023 & 2024	**COP28**: First Global Stocktake & Loss and Damage Fund; **COP29**: **NCQG USD 300B/yr by 2035** & Article 6 Carbon Markets	**COP30 (2025)** scheduled in **Belém, Brazil** (PIB)

Did You Know?: India has spearheaded **four major international environmental coalitions** headquartered in India or launched on global stages (PIB): (1) **International Solar Alliance (ISA, 2015, HQ: Gurugram)**, (2) **Coalition for Disaster Resilient Infrastructure (CDRI, 2019, HQ: New Delhi)**, (3) **LeadIT (Leadership Group for Industry Transition, with Sweden, 2019)**, and (4) **International Big Cat Alliance (IBCA, launched in April 2023, HQ: India)** to conserve the world's 7 **Big Cats** (*Tiger*, *Lion*, *Leopard*, *Snow Leopard*, *Cheetah*, *Jaguar*, *and Puma*)—of which **5 Big Cats are native to India** (all except **Jaguar and Puma**, which are native to the Americas)!

Exam Trap Alert: Distinguish carefully between the **two protocols of the Convention on Biological Diversity (CBD)**: the **Cartagena Protocol (2000)** deals with **Biosafety / Living Modified Organisms (LMOs)** resulting from modern biotechnology, whereas the **Nagoya Protocol (2010)** deals with **Access to Genetic Resources and the Fair and Equitable Sharing of Benefits (ABS)** (and the **Nagoya-Kuala Lumpur Supplementary Protocol** deals with liability and redress for LMOs).

★ **Memory Trick:** Remember the **2 Big Cats NOT found naturally in the wild in India** out of the 7 IBCA Big Cats with **"J-P = Jaguar and Puma (Americas)"**; the remaining **5 (Tiger, Lion, Leopard, Snow Leopard, and reintroduced Cheetah)** are all present in India!

Chapter *8* Comprehensive Analytical & Statutory Revision Matrix

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols	**Seven Official Kyoto Protocol / UNFCCC Greenhouse Gases**	CO_2, CH_4, N_2O, Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3—added in the Doha Amendment)**.
Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29	**Global Warming Potential (GWP-100) & Atmospheric Lifetime**	Measured relative to **CO_2 (GWP = 1)**: **Methane (CH_4)** has a 100-year GWP of **~28–30** (short lifetime ~12 years), **Nitrous Oxide (N_2O)** has a GWP of **~265–273** (lifetime ~110–120 years), **HFCs** range from **140 to 14,800**, **PFCs** range from **6,500 to 9,200**, and **Sulphur Hexafluoride (SF_6)** has the **highest GWP of ~23,500** and an atmospheric lifetime of **3,200 years**!
Flowchart of Global Climate Governance Evolution (1972 to 2024)	**Polar Stratospheric Clouds (PSCs)**	Over Antarctica during the polar winter vortex, Nitric Acid Trihydrate and ice crystals on **Polar Stratospheric Clouds** provide catalytic surfaces converting inactive chlorine reservoirs into active **Chlorine free radicals (Cl^\bullet)** via **Chlorofluorocarbons (CFCs), Halons, Carbon Tetrachloride, and Methyl Chloroform** (where a single chlorine atom can destroy up to **100,000 Ozone molecules**!).

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Master Table of Global Environmental Conventions, Protocols & Summits	**Vienna Convention (1985) & Montreal Protocol (September 16, 1987 — World Ozone Day)**	Universally ratified treaty phasing out **Ozone Depleting Substances (ODS)** such as CFCs and HCFCs.
Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols	**Kigali Amendment to the Montreal Protocol (2016, in force January 1, 2019; ratified by India in 2021)**	Phases down **Hydrofluorocarbons (HFCs)** by 80–85% by the late 2040s; note that **HFCs have ZERO Ozone Depleting Potential (ODP = 0)** because they contain no chlorine or bromine, so they were adopted as CFC substitutes, but they are **potent Greenhouse Gases** with thousands-fold Global Warming Potential!
Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29	**Stockholm Conference (1972) & Brundtland Commission (1987)**	The 1972 UN Conference on the Human Environment established **UNEP (headquartered in Nairobi, Kenya)** and designated **June 5 as World Environment Day**; the 1987 Brundtland Report (**"Our Common Future"**) defined **Sustainable Development**.
Flowchart of Global Climate Governance Evolution (1972 to 2024)	**1992 Rio Earth Summit (UNCED)**	Produced **Agenda 21**, the **Rio Declaration**, **Forest Principles**, and the **Three Rio Sister Conventions
Master Table of Global Environmental Conventions, Protocols & Summits	**UNFCCC**	(*United Nations Framework Convention on Climate Change*)—supported scientifically by the **IPCC** (founded in 1988 by **WMO and UNEP**).
Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols	**UN Convention on Biological Diversity (CBD)**	which subsequently produced the **Cartagena Protocol on Biosafety (2000)** (regulating Living Modified Organisms [LMOs]), the **Nagoya Protocol on Access and Benefit-Sharing (2010)**, and the **Kunming-Montreal Global Biodiversity Framework (COP15, 2022)** featuring the **"30x30 Target"** (conserving **30% of terrestrial and marine areas by 2030**).
Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29	**UNCCD**	(*UN Convention to Combat Desertification*, 1994—the **ONLY legally binding international agreement linking environment and development to sustainable land management**; COP14 was hosted in **New Delhi, India**, and COP16 in **Riyadh, Saudi Arabia** in December 2024).
Flowchart of Global Climate Governance Evolution (1972 to 2024)	**Kyoto Protocol (COP3, 1997, in force 2005)**	Legally binding emission cuts for **Annex-I (Developed) countries** under **Common But Differentiated Responsibilities (CBDR)** via three market mechanisms: **Clean Development Mechanism (CDM)**, **Joint Implementation (JI)**, and **Emissions Trading**.

Core Sub-Domain	Key Concept / Provision	Verified Analytical Parameters & Exam Distinctions (Ministry of Environment, Forest & Climate Change (MoEFCC))
Master Table of Global Environmental Conventions, Protocols & Summits	**Paris Agreement (COP21, 2015)**	Aims to hold global average temperature rise to **well below 2^°C above pre-industrial levels** and pursue efforts to limit it to **1.5^°C** via bottom-up **Nationally Determined Contributions (NDCs)**; also saw the launch of the **International Solar Alliance (ISA)** by **India and France** (headquartered in **Gurugram, Haryana**).
Greenhouse Effect, Global Warming Potential (GWP) & Ozone Depletion Protocols	**COP26 (Glasgow, UK, 2021)**	India announced its historic **5-point 'Panchamrit' pledges** and **Mission LiFE** (*Lifestyle for Environment*)
Timeline from Stockholm (1972) & Rio Earth Summit (1992) to COP28 & COP29	**COP27 (Sharm el-Sheikh, Egypt, 2022)**	Established the breakthrough **Loss and Damage Fund** for vulnerable developing countries.

Chapter *8* Multi-Statement Exam Verification Drills

Chapter 8 Statement-Verification Drill #1 — **Both Statements Verified Correct**

Statement-I (Seven Official Kyoto Protocol / UNFCCC Greenhouse Gases): CO_2, CH_4, N_2O, Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3—added in the Doha Amendment)**.

Statement-II (Global Warming Potential (GWP-100) & Atmospheric Lifetime): Measured relative to **CO_2 (GWP = 1)**: **Methane (CH_4)** has a 100-year GWP of **~28–30** (short lifetime ~12 years), **Nitrous Oxide (N_2O)** has a GWP of **~265–273** (lifetime ~110–120 years), **HFCs** range from **140 to 14,800**, **PFCs** range from **6,500 to 9,200**, and **Sulphur Hexafluoride (SF_6)** has the **highest GWP of ~23,500** and an atmospheric lifetime of **3,200 years**!

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8 Statement-Verification Drill #2 — **Both Statements Verified Correct**

Statement-I (Polar Stratospheric Clouds (PSCs)): Over Antarctica during the polar winter vortex, Nitric Acid Trihydrate and ice crystals on **Polar Stratospheric Clouds** provide catalytic surfaces converting inactive chlorine reservoirs into active **Chlorine free radicals (Cl^\bullet)** via **Chlorofluorocarbons (CFCs), Halons, Carbon Tetrachloride, and Methyl Chloroform** (where a single chlorine atom can destroy up to **100,000 Ozone molecules**!).

Statement-II (Vienna Convention (1985) & Montreal Protocol (September 16, 1987 — World Ozone Day)): Universally ratified treaty phasing out **Ozone Depleting Substances (ODS)** such as CFCs and HCFCs.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8 Statement-Verification Drill #3 — **Both Statements Verified Correct**

Statement-I (Kigali Amendment to the Montreal Protocol (2016, in force January 1, 2019; ratified by India in 2021)): Phases down **Hydrofluorocarbons (HFCs)** by 80–85% by the late 2040s; note that **HFCs have ZERO Ozone Depleting Potential (ODP = 0)** because they contain no chlorine or bromine, so they were adopted as CFC substitutes, but they are **potent Greenhouse Gases** with thousands-fold Global Warming Potential!

Statement-II (Stockholm Conference (1972) & Brundtland Commission (1987)): The 1972 UN Conference on the Human Environment established **UNEP (headquartered in Nairobi, Kenya)** and designated **June 5 as World Environment Day**; the 1987 Brundtland Report (**"Our Common Future"**) defined **Sustainable Development**.

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8 Statement-Verification Drill #4 — **Both Statements Verified Correct**

Statement-I (1992 Rio Earth Summit (UNCED)): Produced **Agenda 21**, the **Rio Declaration**, **Forest Principles**, and the **Three Rio Sister Conventions

Statement-II (UNFCCC): (*United Nations Framework Convention on Climate Change*)—supported scientifically by the **IPCC** (founded in 1988 by **WMO and UNEP**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8 Statement-Verification Drill #5 — **Both Statements Verified Correct**

Statement-I (UN Convention on Biological Diversity (CBD)): which subsequently produced the **Cartagena Protocol on Biosafety (2000)** (regulating Living Modified Organisms [LMOs]), the **Nagoya Protocol on Access and Benefit-Sharing (2010)**, and the **Kunming-Montreal Global Biodiversity Framework (COP15, 2022)** featuring the **"30x30 Target"** (conserving **30% of terrestrial and marine areas by 2030**).

Statement-II (UNCCD): (*UN Convention to Combat Desertification*, 1994—the **ONLY legally binding international agreement linking environment and development to sustainable land management**; COP14 was hosted in **New Delhi, India**, and COP16 in **Riyadh, Saudi Arabia** in December 2024).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Chapter 8 Statement-Verification Drill #6 — **Both Statements Verified Correct**

Statement-I (Kyoto Protocol (COP3, 1997, in force 2005)): Legally binding emission cuts for **Annex-I (Developed) countries** under **Common But Differentiated Responsibilities (CBDR)** via three market mechanisms: **Clean Development Mechanism (CDM)**, **Joint Implementation (JI)**, and **Emissions Trading**.

Statement-II (Paris Agreement (COP21, 2015)): Aims to hold global average temperature rise to **well below 2^°C above pre-industrial levels** and pursue efforts to limit it to **1.5^°C** via bottom-up **Nationally Determined Contributions (NDCs)**; also saw the launch of the **International Solar Alliance (ISA)** by **India and France** (headquartered in **Gurugram, Haryana**).

✓ **Exam Verification Key: Both Statement-I and Statement-II are factually accurate as per Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy.**

Solved Exam Practice Questions (MCQs)

Practice Question #1 Solved Exam MCQ

Q1. Who coined the term 'Ecosystem' in 1935 to describe the interactive system formed by biotic communities and their abiotic environment?
(A) Ernst Haeckel
(B) Arthur G. Tansley
(C) Eugene P. Odum
(D) Charles Elton
Ans: (B) | **Explanation:** Ernst Haeckel coined 'Ecology' (1866), while Sir Arthur G. Tansley coined 'Ecosystem' in 1935 (NCERT).

Practice Question #2 Solved Exam MCQ

Q2. Which of the following ecological pyramids is **ALWAYS UPRIGHT** in every ecosystem without any exception?
(A) Pyramid of Numbers
(B) Pyramid of Biomass
(C) Pyramid of Energy
(D) Both Pyramid of Numbers and Biomass
Ans: (C) | **Explanation:** Due to Lindeman's 10% energy transfer law and the Second Law of Thermodynamics, the Pyramid of Energy is always upright (NCERT).

Practice Question #3 Solved Exam MCQ

Q3. In an open marine/ocean ecosystem, what is the shape of the **Pyramid of Biomass**?
(A) Always Upright
(B) Inverted (because standing crop biomass of Phytoplankton is smaller than Zooplankton/Fishes)
(C) Linear
(D) Circular
Ans: (B) | **Explanation:** In marine ecosystems, the Pyramid of Biomass is inverted because microscopic phytoplankton have a lower standing biomass at any instant than the fishes feeding on them (NCERT).

Practice Question #4 Solved Exam MCQ

Q4. In the Nitrogen Cycle, which pair of chemoautotrophic soil bacteria is responsible for oxidizing **Ammonia (NH_3) into Nitrite (NO_2^-)** and subsequently **Nitrite (NO_2^-) into Nitrate (NO_3^-)**?
(A) Rhizobium and Azotobacter
(B) Nitrosomonas and Nitrobacter
(C) Pseudomonas and Thiobacillus
(D) Frankia and Nostoc
Ans: (B) | **Explanation:** *Nitrosomonas*/*Nitrosococcus* oxidize ammonia to nitrite, and *Nitrobacter* oxidizes nitrite to nitrate, whereas *Pseudomonas* performs denitrification (NCERT).

Practice Question #5 Solved Exam MCQ

Q5. Which of the following biogeochemical cycles is classified as a **Sedimentary Cycle** whose primary reservoir resides in the Earth's crust rather than the atmosphere?
(A) Carbon Cycle
(B) Nitrogen Cycle
(C) Phosphorus Cycle
(D) Hydrological Cycle
Ans: (C) | **Explanation:** Phosphorus and Sulphur cycles are sedimentary cycles with crustal rock reservoirs and no significant gaseous respiratory exchange (NCERT).

Practice Question #6 Solved Exam MCQ

Q6. Which of the following statements correctly compares **Biological Oxygen Demand (BOD)** and **Chemical Oxygen Demand (COD)** in water quality testing?
(A) BOD measures both biodegradable and non-biodegradable organic matter, so BOD is always greater than COD
(B) COD measures only biodegradable organic matter, while BOD measures inorganic salts
(C) BOD measures oxygen consumed by aerobic microbes to oxidize biodegradable organic matter only, whereas COD measures chemical oxidation of both biodegradable and non-biodegradable organic matter (COD > BOD)
(D) High BOD indicates high Dissolved Oxygen (DO) and pure drinking water
Ans: (C) | **Explanation:** COD oxidizes both biodegradable and non-biodegradable organics, making COD numerically greater than BOD; high BOD indicates heavy organic sewage pollution and low DO (NCERT).

Practice Question #7 Solved Exam MCQ

Q7. Specialized negatively geotropic vertical roots bearing breathing pores (*Lenticels*) that emerge above waterlogged anaerobic mud in Mangrove plants (such as *Avicennia* and *Sonneratia*) are called:
(A) Haustoria
(B) Pneumatophores
(C) Velamen roots
(D) Mycorrhizae
Ans: (B) | **Explanation:** Pneumatophores are aerial respiratory roots developed by halophytic mangroves in oxygen-deficient coastal mudflats (NCERT).

Practice Question #8 Solved Exam MCQ

Q8. Which two strict quantitative criteria were formulated by Norman Myers to designate a region as a global **Biodiversity Hotspot**?
(A) At least 500 endemic mammals and 50% forest cover
(B) At least 1,500 species of vascular plants as endemics AND loss of at least 70% of its original primary vegetation
(C) Presence of coral reefs and at least 10 National Parks
(D) Inclusion in the UNESCO World Heritage List and Ramsar List
Ans: (B) | **Explanation:** A Biodiversity Hotspot must host ≥ 1,500 endemic vascular plant species (0.5\% of global total) and have lost ≥ 70\% of its primary native vegetation (NCERT).

Practice Question #9 Solved Exam MCQ

Q9. Which of the following Indian Biosphere Reserves is **NOT** currently included in the **UNESCO Man and the Biosphere (MAB) World Network of Biosphere Reserves**?
(A) Panna Biosphere Reserve
(B) Khangchendzonga Biosphere Reserve
(C) Agasthyamalai Biosphere Reserve
(D) Cold Desert Biosphere Reserve (Himachal Pradesh)
Ans: (D) | **Explanation:** Out of 18 Biosphere Reserves in India, 12 are in UNESCO's WNBR; Manas, Dibru-Saikhowa, Dehang-Debang, Cold Desert, Kachchh, and Seshachalam are the 6 domestic reserves outside the UNESCO network (MoEFCC).

Practice Question #10 Solved Exam MCQ

Q10. Which two Indian Ramsar wetlands are **CURRENTLY** listed on the **Montreux Record** (register of wetlands facing ecological threat due to anthropogenic changes)?
(A) Chilika Lake and Keoladeo National Park
(B) Keoladeo National Park (Rajasthan) and Loktak Lake (Manipur)
(C) Sundarbans Wetland and Wular Lake
(D) Sambhar Lake and Ashtamudi Wetland
Ans: (B) | **Explanation:** Keoladeo National Park and Loktak Lake are currently on the Montreux Record; Chilika Lake was removed in 2002 after hydrological restoration (MoEFCC).

Practice Question #11 Solved Exam MCQ

Q11. Which Indian state currently possesses the **highest number of Ramsar Sites** (Wetlands of International Importance)?
(A) Uttar Pradesh
(B) Tamil Nadu
(C) Maharashtra
(D) Odisha
Ans: (B) | **Explanation:** Tamil Nadu ranks first in India with 18 Ramsar Sites, followed by Uttar Pradesh with 10 Ramsar Sites (PIB).

Practice Question #12 Solved Exam MCQ

Q12. Which National Park in Manipur, situated on floating decomposing biomass mats called **'Phumdis'** inside Loktak Lake, is the **world's ONLY floating National Park** and the last natural refuge of the **Sangai (Brow-antlered Deer)**?
(A) Sirohi National Park
(B) Keibul Lamjao National Park
(C) Murlen National Park
(D) Balpakram National Park
Ans: (B) | **Explanation:** Keibul Lamjao National Park on Loktak Lake is the world's only floating National Park (MoEFCC).

Practice Question #13 Solved Exam MCQ

Q13. According to the **5th Cycle All-India Tiger Estimation** and PIB releases, what is India's estimated wild tiger population, and which state ranks first in tiger population?
(A) 2,967 tigers; Karnataka
(B) 3,682 tigers; Madhya Pradesh (785 tigers)
(C) 3,167 tigers; Uttarakhand
(D) 4,120 tigers; Maharashtra
Ans: (B) | **Explanation:** India hosts 3,682 wild tigers (>75% of the global total), led by Madhya Pradesh (785), Karnataka (563), and Uttarakhand (560) (PIB).

Practice Question #14 Solved Exam MCQ

Q14. According to the **first-ever Snow Leopard Population Assessment in India (SPAI)** released by MoEFCC in 2024, how many Snow Leopards were estimated in India, and which UT/State recorded the highest count?
(A) 516; Himachal Pradesh
(B) 718; Ladakh (477)
(C) 640; Uttarakhand
(D) 812; Sikkim
Ans: (B) | **Explanation:** The SPAI report estimated 718 Snow Leopards in India, with Ladakh recording the highest population (477), followed by Uttarakhand (124) (PIB).

Practice Question #15 Solved Exam MCQ

Q15. According to the **India State of Forest Report (ISFR 2023)** published by the Forest Survey of India, what is the **Total Forest and Tree Cover** of India as a percentage of its total geographical area?
(A) 21.76%
(B) 24.62%
(C) 25.17%
(D) 33.00%
Ans: (C) | **Explanation:** Per ISFR 2023, Total Forest and Tree Cover is **8,27,357 sq. km (25.17%)**, comprising **21.76% Forest Cover** (7,15,343 sq. km) and **3.41% Tree Cover** (1,12,014 sq. km) (FSI ISFR 2023).

Practice Question #16 Solved Exam MCQ

Q16. Under the **ISFR 2023** rankings, which state has the **largest Forest Cover by area**, and which state has the **highest Forest Cover as a percentage** of its geographical area?
(A) Arunachal Pradesh and Mizoram
(B) Madhya Pradesh and Mizoram (85.34%)
(C) Chhattisgarh and Lakshadweep
(D) Madhya Pradesh and Arunachal Pradesh
Ans: (B) | **Explanation:** Madhya Pradesh ranks first in total area under forest cover, while Mizoram (85.34%) ranks first among states in percentage forest cover (FSI ISFR 2023).

Practice Question #17 Solved Exam MCQ

Q17. According to **ISFR 2023**, which three states recorded the **maximum combined increase in Forest and Tree Cover** compared to the previous assessment?
(A) Andhra Pradesh, Telangana, Odisha
(B) Chhattisgarh, Uttar Pradesh, Odisha
(C) Madhya Pradesh, Maharashtra, Karnataka
(D) Assam, Mizoram, Tripura
Ans: (B) | **Explanation:** Chhattisgarh (+684 sq. km), Uttar Pradesh (+559 sq. km), and Odisha (+559 sq. km) registered the highest increase in combined Forest and Tree Cover in ISFR 2023 (FSI ISFR 2023).

Practice Question #18 Solved Exam MCQ

Q18. According to **ISFR 2023**, which Indian state has the **largest Mangrove Forest Cover** (~42.45% of India's total 4,992 sq. km of mangroves), followed by which state in second place?
(A) Odisha followed by Andhra Pradesh
(B) West Bengal followed by Gujarat
(C) Gujarat followed by Maharashtra
(D) Tamil Nadu followed by Odisha
Ans: (B) | **Explanation:** West Bengal ranks first (~42.45%) and Gujarat ranks second (~23.32%) in Mangrove cover (**FSI ISFR 2023**).

Practice Question #19 Solved Exam MCQ

Q19. Under the **Wildlife (Protection) Amendment Act, 2022**, the original 6 Schedules of the 1972 Act were rationalized into **4 Schedules**. Which Schedule now contains **Protected Plant Species**?
(A) Schedule I
(B) Schedule II
(C) Schedule III
(D) Schedule IV
Ans: (C) | **Explanation:** In the amended 2022 Act, Schedule I and II cover protected animals, **Schedule III covers Protected Plants**, and Schedule IV covers CITES-listed specimens (**MoEFCC**).

Practice Question #20 Solved Exam MCQ

Q20. Who serves as the ex-officio **Chairperson of the National Board for Wildlife (NBWL)** constituted under the Wildlife (Protection) Act, 1972?
(A) Union Minister of Environment, Forest and Climate Change
(B) Prime Minister of India
(C) Cabinet Secretary
(D) Director General of Forests
Ans: (B) | **Explanation:** The Prime Minister chairs the National Board for Wildlife (NBWL), whereas the Union Environment Minister chairs the NTCA (**MoEFCC**).

Practice Question #21 Solved Exam MCQ

Q21. The **National Green Tribunal (NGT)**, established under the NGT Act, 2010, has civil jurisdiction over 7 environmental laws, **EXCEPT** which of the following Acts?
(A) Water (Prevention and Control of Pollution) Act, 1974
(B) Environment (Protection) Act, 1986
(C) Biological Diversity Act, 2002
(D) Wildlife (Protection) Act, 1972 and Forest Rights Act, 2006
Ans: (D) | **Explanation:** The Wildlife (Protection) Act, 1972, the Indian Forest Act, 1927, and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 are kept outside NGT's jurisdiction (**MoEFCC**).

Practice Question #22 Solved Exam MCQ

Q22. Where is the headquarters of the **National Biodiversity Authority (NBA)**, established in 2003 under the Biological Diversity Act, 2002, located?
(A) New Delhi
(B) Dehradun
(C) Chennai
(D) Hyderabad
Ans: (C) | **Explanation:** The National Biodiversity Authority (NBA) is headquartered in Chennai, Tamil Nadu (**MoEFCC**).

Practice Question #23 Solved Exam MCQ

Q23. The **Genetic Engineering Appraisal Committee (GEAC)**, India's apex regulator for the environmental release of Genetically Modified Organisms (GMOs), is a statutory body functioning under which Act?
(A) Biological Diversity Act, 2002
(B) Environment (Protection) Act, 1986
(C) Seeds Act, 1966
(D) Food Safety and Standards Act, 2006
Ans: (B) | **Explanation:** GEAC was constituted under the 'Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms / Genetically Engineered Organisms or Cells, 1989' notified under the **Environment (Protection) Act, 1986** (MoEFCC).

Practice Question #24 Solved Exam MCQ

Q24. Which veterinary non-steroidal anti-inflammatory drug (NSAID) administered to cattle was identified as the primary cause of catastrophic renal (kidney) failure and >95% population crash in Indian **Gyps Vultures**?
(A) Paracetamol
(B) Diclofenac (along with Aceclofenac & Ketoprofen)
(C) Meloxicam
(D) Amoxicillin
Ans: (B) | **Explanation:** Veterinary Diclofenac (and Aceclofenac/Ketoprofen, banned in 2023) causes visceral gout and kidney failure in scavenging vultures, whereas **Meloxicam and Tolfenamic acid** are vulture-safe alternatives (MoEFCC).

Practice Question #25 Solved Exam MCQ

Q25. Which of the following atmospheric gases is **NOT** one of the **8 pollutants** measured to calculate India's **National Air Quality Index (NAQI)**?
(A) Carbon Monoxide (CO)
(B) Carbon Dioxide (CO_2)
(C) Ammonia (NH_3)
(D) Lead (Pb)
Ans: (B) | **Explanation:** The 8 NAQI pollutants are PM_{10}, PM_{2.5}, NO_2, SO_2, CO, O_3, NH_3, and Pb. Carbon Dioxide (CO_2) is NOT included in NAQI (MoEFCC).

Practice Question #26 Solved Exam MCQ

Q26. Which of the following is a **Secondary Air Pollutant** formed in the troposphere during **Photochemical Smog**?
(A) Sulphur Dioxide (SO_2)
(B) Carbon Monoxide (CO)
(C) Peroxyacetyl Nitrate (PAN) and Tropospheric Ozone (O_3)
(D) Fly Ash
Ans: (C) | **Explanation:** PAN, Tropospheric Ozone (O_3), Aldehydes, and Ketones are secondary oxidizing pollutants formed by sunlight acting on NO_x and VOCs (NCERT).

Practice Question #27 Solved Exam MCQ

Q27. Excessive **Nitrate (NO_3^-)** contamination in drinking water interferes with oxygen transport in infants' blood, causing which syndrome?
(A) Minamata Disease
(B) Itai-Itai Disease
(C) Blue Baby Syndrome (Methaemoglobinaemia)
(D) Blackfoot Disease
Ans: (C) | **Explanation:** Excess nitrate causes *Methaemoglobinaemia* (Blue Baby Syndrome), while Mercury causes Minamata, Cadmium causes Itai-Itai, and Arsenic causes Blackfoot Disease (NCERT).

Practice Question #28 Solved Exam MCQ

Q28. Match the international chemical/waste treaties correctly: (1) **Basel Convention**, (2) **Rotterdam Convention**, (3) **Stockholm Convention**, (4) **Minamata Convention**:
(A) 1-Hazardous Waste, 2-Prior Informed Consent (Chemicals), 3-Persistent Organic Pollutants (POPs), 4-Mercury
(B) 1-POPs, 2-Hazardous Waste, 3-Mercury, 4-Ozone
(C) 1-Mercury, 2-POPs, 3-Hazardous Waste, 4-Biosafety
(D) 1-Hazardous Waste, 2-POPs, 3-Prior Informed Consent, 4-Lead
Ans: (A) | **Explanation:** Basel (1989) regulates transboundary Hazardous Waste; Rotterdam (1998) mandates Prior Informed Consent (PIC); Stockholm (2001) targets POPs; Minamata (2013) targets Mercury (MoEFCC).

Practice Question #29 Solved Exam MCQ

Q29. Which of the following Greenhouse Gases covered under the Kyoto Protocol has the **HIGHEST 100-year Global Warming Potential (GWP ~23,500)** and an atmospheric lifetime of **3,200 years**?
(A) Carbon Dioxide (CO_2)
(B) Methane (CH_4)
(C) Nitrous Oxide (N_2O)
(D) Sulphur Hexafluoride (SF_6)
Ans: (D) | **Explanation:** Sulphur Hexafluoride (SF_6), used as an electrical insulator in high-voltage switchgear, has the highest GWP (~23,500) among Kyoto gases.

Practice Question #30 Solved Exam MCQ

Q30. The **Kigali Amendment (2016)** to the **Montreal Protocol** mandates the global phase-down of which class of compounds?
(A) Chlorofluorocarbons (CFCs) with high Ozone Depleting Potential
(B) Hydrofluorocarbons (HFCs) which have ZERO Ozone Depleting Potential but high Global Warming Potential
(C) Sulphur Dioxide from thermal power plants
(D) Single-use microplastics
Ans: (B) | **Explanation:** The Kigali Amendment phases down HFCs (used in air-conditioning and refrigeration), which have ODP = 0 but very high GWP (MoEFCC).

Practice Question #31 Solved Exam MCQ

Q31. Under the **Convention on Biological Diversity (CBD)**, which protocol adopted in **2000** specifically governs the safe transfer, handling, and use of **Living Modified Organisms (LMOs)** resulting from modern biotechnology?
(A) Nagoya Protocol
(B) Cartagena Protocol on Biosafety
(C) Kyoto Protocol
(D) Geneva Protocol
Ans: (B) | **Explanation:** The Cartagena Protocol (2000) governs Biosafety/LMOs, whereas the Nagoya Protocol (2010) governs Access and Benefit-Sharing (ABS) of genetic resources (MoEFCC).

Practice Question #32 Solved Exam MCQ

Q32. Under India's **'Panchamrit'** climate targets announced at **UNFCCC COP26 (Glasgow)** and updated in its **2022 NDC**, by which year has India committed to achieving **Net-Zero emissions**, and by how much will it reduce the **emissions intensity of its GDP by 2030** (from 2005 levels)?
(A) Net-Zero by 2050; 33–35% reduction
(B) Net-Zero by 2070; 45% reduction by 2030
(C) Net-Zero by 2060; 50% reduction by 2030
(D) Net-Zero by 2047; 40% reduction by 2030
Ans: (B) | **Explanation:** India pledged Net-Zero emissions by **2070**, a **45% reduction in GDP emissions intensity by 2030** (over 2005 levels), and **50% cumulative electric power installed capacity from non-fossil fuel sources by 2030** (PIB).

Practice Question #33 Solved Exam MCQ

Q33. The **International Big Cat Alliance (IBCA)**, launched by India in April 2023 to conserve the world's 7 **Big Cats**, covers Tiger, Lion, Leopard, Snow Leopard, Cheetah, Jaguar, and Puma. Which **TWO** of these 7 Big Cats are **NOT naturally found in India**?
(A) Snow Leopard and Cheetah
(B) Jaguar and Puma
(C) Clouded Leopard and Caracal
(D) Lion and Leopard
Ans: (B) | **Explanation:** Jaguar and Puma (Cougar) are native to the Americas; the other 5 Big Cats are found in India (PIB).

Practice Question #34 Solved Exam MCQ

Q34. Where were the **UNFCCC COP28 (2023)** and **COP29 (2024)** summits hosted respectively?
(A) Sharm el-Sheikh (Egypt) and Dubai (UAE)
(B) Dubai (UAE) and Baku (Azerbaijan)
(C) Glasgow (UK) and Belém (Brazil)
(D) Madrid (Spain) and Baku (Azerbaijan)
Ans: (B) | **Explanation:** COP27 was held in Sharm el-Sheikh (2022), **COP28 in Dubai, UAE (2023)**, **COP29 in Baku, Azerbaijan (2024)**, and COP30 in Belém, Brazil (2025) (PIB).

Practice Question #35 Solved Exam MCQ

Q35. What was the headline climate finance outcome adopted at **UNFCCC COP29 in Baku, Azerbaijan (November 2024)** under the **New Collective Quantified Goal (NCQG)**?
(A) Abolishing the Green Climate Fund
(B) Mobilizing at least USD 300 billion per year by 2035 for developing countries (replacing the previous USD 100 billion/year goal)
(C) Taxing all domestic agriculture at 20%
(D) Merging UNFCCC with WTO
Ans: (B) | **Explanation:** COP29 in Baku adopted the Baku Finance Goal (NCQG) committing developed countries to triple climate finance to at least **USD 300 billion annually by 2035** inside an overarching USD 1.3 trillion mobilization roadmap (PIB).

Extended Comparative & Analytical Practice Set (Questions *36* to *75*)

Practice Question #36 High-Yield Comparative MCQ

Q36. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Sundarbans Mangroves"?

(A) West Bengal
(B) Odisha (Brahmani-Baitarani delta)
(C) Tamil Nadu (Cauvery delta)
(D) Andhra Pradesh (Godavari estuary)

Correct Answer: (A) | **Explanation:** For **Sundarbans Mangroves** (Ecosystem Site), the verified State / Union Territory is **West Bengal**. Furthermore, Largest Tide-Dominated Mangrove Delta (~42% of India's mangroves). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #37 High-Yield Comparative MCQ

Q37. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Bhitarkanika Mangroves"?

(A) Tamil Nadu (Cauvery delta)
(B) Odisha (Brahmani-Baitarani delta)
(C) Andhra Pradesh (Godavari estuary)
(D) Gujarat (Kutch, Jamnagar)

Correct Answer: (B) | **Explanation:** For **Bhitarkanika Mangroves** (Ecosystem Site), the verified State / Union Territory is **Odisha (Brahmani-Baitarani delta)**. Furthermore, Second-largest contiguous mangrove ecosystem in India. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #38 High-Yield Comparative MCQ

Q38. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Pichavaram & Muthupet"?

(A) Andhra Pradesh (Godavari estuary)
(B) Gujarat (Kutch, Jamnagar)
(C) Tamil Nadu (Cauvery delta)
(D) Tamil Nadu & Lakshadweep

Correct Answer: (C) | **Explanation:** For **Pichavaram & Muthupet** (Ecosystem Site), the verified State / Union Territory is **Tamil Nadu (Cauvery delta)**. Furthermore, Backwater island mangrove network. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #39 High-Yield Comparative MCQ

Q39. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Coringa Mangroves"?

(A) Gujarat (Kutch, Jamnagar)
(B) Tamil Nadu & Lakshadweep
(C) TN, Kerala, Karnataka
(D) Andhra Pradesh (Godavari estuary)

Correct Answer: (D) | **Explanation:** For **Coringa Mangroves** (Ecosystem Site), the verified State / Union Territory is **Andhra Pradesh (Godavari estuary)**. Furthermore, Estuarine mangrove sanctuary. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #40 High-Yield Comparative MCQ

Q40. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Gulf of Kutch & Pirotan"?

(A) Gujarat (Kutch, Jamnagar)
(B) Tamil Nadu & Lakshadweep
(C) TN, Kerala, Karnataka
(D) Uttarakhand

Correct Answer: (A) | **Explanation:** For **Gulf of Kutch & Pirotan** (Ecosystem Site), the verified State / Union Territory is **Gujarat (Kutch, Jamnagar)**. Furthermore, Arid-zone mangroves & Fringing Coral Reef. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #41 High-Yield Comparative MCQ

Q41. With reference to Ecosystem Site and State / Union Territory, which of the following is accurately matched with "Gulf of Mannar & Lakshadweep"?

(A) TN, Kerala, Karnataka
(B) Tamil Nadu & Lakshadweep
(C) Uttarakhand
(D) Meghalaya (West Garo Hills)

Correct Answer: (B) | **Explanation:** For **Gulf of Mannar & Lakshadweep** (Ecosystem Site), the verified State / Union Territory is **Tamil Nadu & Lakshadweep**. Furthermore, Fringing Reef (Mannar) & Coral Atolls (Lakshadweep). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #42 High-Yield Comparative MCQ

Q42. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "1. Nilgiri (1986 — First)"?

(A) Uttarakhand
(B) Meghalaya (West Garo Hills)
(C) TN, Kerala, Karnataka
(D) Tamil Nadu

Correct Answer: (C) | **Explanation:** For **1. Nilgiri (1986 — First)** (Biosphere Reserve Name), the verified State(s) / UT is **TN, Kerala, Karnataka**. Furthermore, Yes (Year 2000). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #43 High-Yield Comparative MCQ

Q43. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "2. Nanda Devi"?

(A) Meghalaya (West Garo Hills)
(B) Tamil Nadu
(C) West Bengal
(D) Uttarakhand

Correct Answer: (D) | **Explanation:** For **2. Nanda Devi** (Biosphere Reserve Name), the verified State(s) / UT is **Uttarakhand**. Furthermore, Yes (2004). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #44 High-Yield Comparative MCQ

Q44. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "3. Nokrek"?

(A) Meghalaya (West Garo Hills)
(B) Tamil Nadu
(C) West Bengal
(D) Odisha (Mayurbhanj)

Correct Answer: (A) | **Explanation:** For **3. Nokrek** (Biosphere Reserve Name), the verified State(s) / UT is **Meghalaya (West Garo Hills)**. Furthermore, Yes (2009). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #45 High-Yield Comparative MCQ

Q45. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "4. Gulf of Mannar"?

(A) West Bengal
(B) Tamil Nadu
(C) Odisha (Mayurbhanj)
(D) Madhya Pradesh

Correct Answer: (B) | **Explanation:** For **4. Gulf of Mannar** (Biosphere Reserve Name), the verified State(s) / UT is **Tamil Nadu**. Furthermore, Yes (2001). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #46 High-Yield Comparative MCQ

Q46. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "5. Sundarbans"?

(A) Odisha (Mayurbhanj)
(B) Madhya Pradesh
(C) West Bengal
(D) Chhattisgarh & MP

Correct Answer: (C) | **Explanation:** For **5. Sundarbans** (Biosphere Reserve Name), the verified State(s) / UT is **West Bengal**. Furthermore, Yes (2001). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #47 High-Yield Comparative MCQ

Q47. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "6. Simlipal"?

(A) Madhya Pradesh
(B) Chhattisgarh & MP
(C) Andaman & Nicobar Islands
(D) Odisha (Mayurbhanj)

Correct Answer: (D) | **Explanation:** For **6. Simlipal** (Biosphere Reserve Name), the verified State(s) / UT is **Odisha (Mayurbhanj)**. Furthermore, Yes (2009). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #48 High-Yield Comparative MCQ

Q48. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "7. Pachmarhi & 8. Panna"?

(A) Madhya Pradesh
(B) Chhattisgarh & MP
(C) Andaman & Nicobar Islands
(D) Kerala & Tamil Nadu

Correct Answer: (A) | **Explanation:** For **7. Pachmarhi & 8. Panna** (Biosphere Reserve Name), the verified State(s) / UT is **Madhya Pradesh**. Furthermore, Yes (2009 & 2020). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #49 High-Yield Comparative MCQ

Q49. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "9. Achanakmar-Amarkantak"?

(A) Andaman & Nicobar Islands
(B) Chhattisgarh & MP
(C) Kerala & Tamil Nadu
(D) Sikkim

Correct Answer: (B) | **Explanation:** For **9. Achanakmar-Amarkantak** (Biosphere Reserve Name), the verified State(s) / UT is **Chhattisgarh & MP**. Furthermore, Yes (2012). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #50 High-Yield Comparative MCQ

Q50. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "10. Great Nicobar"?

(A) Kerala & Tamil Nadu
(B) Sikkim
(C) Andaman & Nicobar Islands
(D) Gujarat & Andhra Pradesh

Correct Answer: (C) | **Explanation:** For **10. Great Nicobar** (Biosphere Reserve Name), the verified State(s) / UT is **Andaman & Nicobar Islands**. Furthermore, Yes (2013). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #51 High-Yield Comparative MCQ

Q51. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "11. Agasthyamalai"?

(A) Sikkim
(B) Gujarat & Andhra Pradesh
(C) Assam (2), Arunachal (1), Himachal Pradesh (1)
(D) Kerala & Tamil Nadu

Correct Answer: (D) | **Explanation:** For **11. Agasthyamalai** (Biosphere Reserve Name), the verified State(s) / UT is **Kerala & Tamil Nadu**. Furthermore, Yes (2016). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #52 High-Yield Comparative MCQ

Q52. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "12. Khangchendzonga"?

(A) Sikkim
(B) Gujarat & Andhra Pradesh
(C) Assam (2), Arunachal (1), Himachal Pradesh (1)
(D) Ladakh

Correct Answer: (A) | **Explanation:** For **12. Khangchendzonga** (Biosphere Reserve Name), the verified State(s) / UT is **Sikkim**. Furthermore, Yes (2018). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #53 High-Yield Comparative MCQ

Q53. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "13. Kachchh (Largest) & 14. Seshachalam"?

(A) Assam (2), Arunachal (1), Himachal Pradesh (1)
(B) Gujarat & Andhra Pradesh
(C) Ladakh
(D) Uttarakhand

Correct Answer: (B) | **Explanation:** For **13. Kachchh (Largest) & 14. Seshachalam** (Biosphere Reserve Name), the verified State(s) / UT is **Gujarat & Andhra Pradesh**. Furthermore, Domestic (Non-MAB). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #54 High-Yield Comparative MCQ

Q54. With reference to Biosphere Reserve Name and State(s) / UT, which of the following is accurately matched with "15. Manas, 16. Dibru-Saikhowa, 17. Dehang-Debang, 18. Cold Desert"?

(A) Ladakh
(B) Uttarakhand
(C) Assam (2), Arunachal (1), Himachal Pradesh (1)
(D) Manipur (Loktak Lake)

Correct Answer: (C) | **Explanation:** For **15. Manas, 16. Dibru-Saikhowa, 17. Dehang-Debang, 18. Cold Desert** (Biosphere Reserve Name), the verified State(s) / UT is **Assam (2), Arunachal (1), Himachal Pradesh (1)**. Furthermore, Domestic (Non-MAB). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #55 High-Yield Comparative MCQ

Q55. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Hemis National Park"?

(A) Uttarakhand
(B) Manipur (Loktak Lake)
(C) Assam
(D) Ladakh

Correct Answer: (D) | **Explanation:** For **Hemis National Park** (National Park / Sanctuary), the verified State / UT is **Ladakh**. Furthermore, Indus & Zanskar Rivers. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #56 High-Yield Comparative MCQ

Q56. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Jim Corbett (Ramganga) NP"?

(A) Uttarakhand
(B) Manipur (Loktak Lake)
(C) Assam
(D) Madhya Pradesh

Correct Answer: (A) | **Explanation:** For **Jim Corbett (Ramganga) NP** (National Park / Sanctuary), the verified State / UT is **Uttarakhand**. Furthermore, Ramganga & Kosi Rivers. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #57 High-Yield Comparative MCQ

Q57. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Keibul Lamjao National Park"?

(A) Assam
(B) Manipur (Loktak Lake)
(C) Madhya Pradesh
(D) Kerala

Correct Answer: (B) | **Explanation:** For **Keibul Lamjao National Park** (National Park / Sanctuary), the verified State / UT is **Manipur (Loktak Lake)**. Furthermore, Manipur River basin. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #58 High-Yield Comparative MCQ

Q58. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Kaziranga & Raimona / Dihing Patkai"?

(A) Madhya Pradesh
(B) Kerala
(C) Assam
(D) Jammu & Kashmir

Correct Answer: (C) | **Explanation:** For **Kaziranga & Raimona / Dihing Patkai** (National Park / Sanctuary), the verified State / UT is **Assam**. Furthermore, Brahmaputra, Diphlu, Mora Dhansiri. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #59 High-Yield Comparative MCQ

Q59. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Kuno National Park"?

(A) Kerala
(B) Jammu & Kashmir
(C) Rajasthan (Jaisalmer/Barmer)
(D) Madhya Pradesh

Correct Answer: (D) | **Explanation:** For **Kuno National Park** (National Park / Sanctuary), the verified State / UT is **Madhya Pradesh**. Furthermore, Kuno River (Chambal tributary). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #60 High-Yield Comparative MCQ

Q60. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Silent Valley & Eravikulam NP"?

(A) Kerala
(B) Jammu & Kashmir
(C) Rajasthan (Jaisalmer/Barmer)
(D) Madhya Pradesh

Correct Answer: (A) | **Explanation:** For **Silent Valley & Eravikulam NP** (National Park / Sanctuary), the verified State / UT is **Kerala**. Furthermore, Kunthipuzha River (Silent Valley). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #61 High-Yield Comparative MCQ

Q61. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Dachigam National Park"?

(A) Rajasthan (Jaisalmer/Barmer)
(B) Jammu & Kashmir
(C) Madhya Pradesh
(D) Mizoram (85.34%)

Correct Answer: (B) | **Explanation:** For **Dachigam National Park** (National Park / Sanctuary), the verified State / UT is **Jammu & Kashmir**. Furthermore, Dagwan River. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #62 High-Yield Comparative MCQ

Q62. With reference to National Park / Sanctuary and State / UT, which of the following is accurately matched with "Desert National Park"?

(A) Madhya Pradesh
(B) Mizoram (85.34%)
(C) Rajasthan (Jaisalmer/Barmer)
(D) Chhattisgarh (+684 sq. km)

Correct Answer: (C) | **Explanation:** For **Desert National Park** (National Park / Sanctuary), the verified State / UT is **Rajasthan (Jaisalmer/Barmer)**. Furthermore, Arid Thar basin. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #63 High-Yield Comparative MCQ

Q63. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Largest Forest Cover by Area"?

(A) Mizoram (85.34%)
(B) Chhattisgarh (+684 sq. km)
(C) West Bengal (~42.45%)
(D) Madhya Pradesh

Correct Answer: (D) | **Explanation:** For **Largest Forest Cover by Area** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Madhya Pradesh**. Furthermore, Arunachal Pradesh. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #64 High-Yield Comparative MCQ

Q64. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Largest Forest + Tree Cover by Area"?

(A) Madhya Pradesh
(B) Mizoram (85.34%)
(C) Chhattisgarh (+684 sq. km)
(D) West Bengal (~42.45%)

Correct Answer: (A) | **Explanation:** For **Largest Forest + Tree Cover by Area** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Madhya Pradesh**. Furthermore, Arunachal Pradesh. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #65 High-Yield Comparative MCQ

Q65. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Highest Forest Cover by % (States)"?

(A) Chhattisgarh (+684 sq. km)
(B) Mizoram (85.34%)
(C) West Bengal (~42.45%)
(D) Arunachal Pradesh

Correct Answer: (B) | **Explanation:** For **Highest Forest Cover by % (States)** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Mizoram (85.34%)**. Furthermore, Arunachal Pradesh (79.04%). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #66 High-Yield Comparative MCQ

Q66. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Highest Gain in Forest + Tree Cover"?

(A) West Bengal (~42.45%)
(B) Arunachal Pradesh
(C) Chhattisgarh (+684 sq. km)
(D) Tropical Moist & Dry Deciduous Forests

Correct Answer: (C) | **Explanation:** For **Highest Gain in Forest + Tree Cover** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Chhattisgarh (+684 sq. km)**. Furthermore, Uttar Pradesh (+559 sq. km). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #67 High-Yield Comparative MCQ

Q67. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Largest Mangrove Cover"?

(A) Arunachal Pradesh
(B) Tropical Moist & Dry Deciduous Forests
(C) 1972 / 2022
(D) West Bengal (~42.45%)

Correct Answer: (D) | **Explanation:** For **Largest Mangrove Cover** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **West Bengal (~42.45%)**. Furthermore, Gujarat (~23.32%). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #68 High-Yield Comparative MCQ

Q68. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Largest Forest Carbon Stock"?

(A) Arunachal Pradesh
(B) Tropical Moist & Dry Deciduous Forests
(C) 1972 / 2022
(D) 1974

Correct Answer: (A) | **Explanation:** For **Largest Forest Carbon Stock** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Arunachal Pradesh**. Furthermore, Madhya Pradesh. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #69 High-Yield Comparative MCQ

Q69. With reference to Metric / Forest Parameter (FSI ISFR 2023) and Rank 1 State / UT, which of the following is accurately matched with "Champion & Seth (1968) Most Extensive Forest Type"?

(A) 1972 / 2022
(B) Tropical Moist & Dry Deciduous Forests
(C) 1974
(D) 1986

Correct Answer: (B) | **Explanation:** For **Champion & Seth (1968) Most Extensive Forest Type** (Metric / Forest Parameter (FSI ISFR 2023)), the verified Rank 1 State / UT is **Tropical Moist & Dry Deciduous Forests**. Furthermore, Tropical Thorn Forests. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #70 High-Yield Comparative MCQ

Q70. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "Wildlife (Protection) Act (Amended 2022)"?

(A) 1974
(B) 1986
(C) 1972 / 2022
(D) 2003

Correct Answer: (C) | **Explanation:** For **Wildlife (Protection) Act (Amended 2022)** (Act / Statutory Body / Movement), the verified Year is **1972 / 2022**. Furthermore, PM chairs NBWL; Environment Minister chairs NTCA. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #71 High-Yield Comparative MCQ

Q71. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "Central Pollution Control Board (CPCB)"?

(A) 1986
(B) 2003
(C) 2010
(D) 1974

Correct Answer: (D) | **Explanation:** For **Central Pollution Control Board (CPCB)** (Act / Statutory Body / Movement), the verified Year is **1974**. Furthermore, Appointed by Central Govt (under MoEFCC). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #72 High-Yield Comparative MCQ

Q72. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "Environment (Protection) Act (EPA)"?

(A) 1986
(B) 2003
(C) 2010
(D) 1973 & 1983

Correct Answer: (A) | **Explanation:** For **Environment (Protection) Act (EPA)** (Act / Statutory Body / Movement), the verified Year is **1986**. Furthermore, Central Govt (MoEFCC). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #73 High-Yield Comparative MCQ

Q73. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "National Biodiversity Authority (NBA)"?

(A) 2010
(B) 2003
(C) 1973 & 1983
(D) 1973 & 1985

Correct Answer: (B) | **Explanation:** For **National Biodiversity Authority (NBA)** (Act / Statutory Body / Movement), the verified Year is **2003**. Furthermore, Appointed by Central Govt (HQ: Chennai). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #74 High-Yield Comparative MCQ

Q74. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "National Green Tribunal (NGT)"?

(A) 1973 & 1983
(B) 1973 & 1985
(C) 2010
(D) Central Nervous System

Correct Answer: (C) | **Explanation:** For **National Green Tribunal (NGT)** (Act / Statutory Body / Movement), the verified Year is **2010**. Furthermore, Retired Supreme Court Judge / Chief Justice of HC. (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Practice Question #75 High-Yield Comparative MCQ

Q75. With reference to Act / Statutory Body / Movement and Year, which of the following is accurately matched with "Chipko & Appiko Movements"?

(A) 1973 & 1985
(B) Central Nervous System
(C) Bones & Kidneys
(D) 1973 & 1983

Correct Answer: (D) | **Explanation:** For **Chipko & Appiko Movements** (Act / Statutory Body / Movement), the verified Year is **1973 & 1983**. Furthermore, Sunderlal Bahuguna, Chandi Prasad Bhatt, Gaura Devi (Chipko); Pandurang Hegde (Appiko). (Source: Ministry of Environment, Forest & Climate Change (MoEFCC) & IUC Academy).

Rapid-Fire Last-Minute One-Liner Revision Capsule

1. **Ernst Haeckel (1866)** coined the term **Ecology**, and **Sir Arthur Tansley (1935)** coined the term **Ecosystem** (NCERT).

2. **Joseph Grinnell (1917)** coined the term **Ecological Niche**, while **Gause's Principle** states that no two species with identical niches can coexist indefinitely.

3. An **Ecotone** is a zone of transition between two ecosystems (e.g., **Mangroves, Estuaries, Grasslands**), exhibiting higher species diversity called the **Edge Effect**.

4. **Raymond Lindeman (1942)** formulated the **10% Law of Energy Transfer**, explaining why food chains rarely exceed 4 to 5 trophic levels (NCERT).

5. The **Pyramid of Energy** is **ALWAYS UPRIGHT** in every ecosystem without exception.

6. The **Pyramid of Biomass** is **Upright in Terrestrial ecosystems** (Forest/Grassland) and **Inverted in Aquatic/Marine ecosystems** (Ocean/Pond).

7. The **Pyramid of Numbers** in a **Single Large Tree ecosystem** supporting frugivorous birds and their parasites is **Inverted** (or spindle-shaped if predatory hawks are at the top).

8. **Biomagnification** requires a pollutant to be **long-lived, mobile, biologically active, and Fat-Soluble (Lipophilic)** (e.g., **DDT, Methylmercury, PCBs**) (NCERT).

9. **Lichens** (symbiotic mutualism of **Algae [Phycobiont] + Fungi [Mycobiont]**) are the **Pioneer Species in Xerarch (bare rock) primary succession** and are sensitive **Bio-indicators of Sulphur Dioxide (SO_2) air pollution**.

10. **Mycorrhizae** represent a **Mutualistic** association between **Fungi** and the roots of higher plants (such as *Pinus*).

11. **Nitrosomonas** oxidizes Ammonia (NH_3) into **Nitrite (NO_2^-)**, **Nitrobacter** oxidizes Nitrite into **Nitrate (NO_3^-)**, and **Pseudomonas** performs **Denitrification** ($NO_3^- \rightarrow N_2$).

12. **Phosphorus and Sulphur Cycles** are **Sedimentary Biogeochemical Cycles** stored in Earth's crustal rocks, whereas **Carbon and Nitrogen Cycles** are **Gaseous Cycles** (NCERT).

13. **Eutrophication** of lakes by Nitrate and Phosphate runoff triggers **Algal Blooms**, which **increase Biological Oxygen Demand (BOD)** and **deplete Dissolved Oxygen (DO)**.

14. **Chemical Oxygen Demand (COD)** is **always higher than BOD** because COD measures chemical oxidation of both biodegradable and non-biodegradable organic pollutants.

15. **Coral Polyps** live in obligatory mutualism with photosynthetic dinoflagellate algae called **Zooxanthellae**; thermal stress causes expulsion of Zooxanthellae, resulting in **Coral Bleaching**.

16. **Mangroves** survive in saline, oxygen-poor intertidal mudflats through **Pneumatophores** (breathing roots), **Stilt roots**, and **Vivipary** (seed germination on the parent tree).

17. The **MISHTI Scheme** (*Mangrove Initiative for Shoreline Habitats & Tangible Incomes*) was launched in 2023 to restore mangroves across **9 coastal states and 4 UTs** (PIB).

18. **Norman Myers (1988)** introduced **Biodiversity Hotspots**; there are **36 Hotspots globally** and **4 in India (Himalayas, Indo-Burma, Western Ghats & Sri Lanka, and Sundaland)**.

19. In the Andaman & Nicobar archipelago, the **Andaman Islands** belong to the **Indo-Burma Hotspot**, while the **Nicobar Islands** belong to the **Sundaland Hotspot** (MoEFCC).

20. **Cryopreservation** is an **Ex-Situ conservation** method that preserves gametes, embryos, and seeds in liquid nitrogen at **-196^°C** (NCERT).

21. India has **18 Biosphere Reserves**, of which **12 are recognized under UNESCO's Man and the Biosphere (MAB) World Network** (**Nilgiri** was the first in 1986; **Panna** was the 12th in 2020).

22. The **6 Indian Biosphere Reserves NOT in UNESCO's MAB list** are **Manas, Dibru-Saikhowa, Dehang-Debang, Cold Desert, Kachchh (largest), and Seshachalam**.

23. **Hemis National Park** (Ladakh) is India's **largest National Park**, **South Button Island NP** (Andaman & Nicobar) is the **smallest**, and **Jim Corbett NP** (1936, Uttarakhand) is the **oldest**.

24. **Keibul Lamjao National Park** on **Loktak Lake (Manipur)** is the **world's ONLY floating National Park**, characterized by floating **Phumdis** and the **Sangai deer**.

25. **Project Tiger** was launched on **April 1, 1973**; India now hosts **3,682 wild tigers** (>75% of the global population), with **Madhya Pradesh (785)** ranking #1 (PIB).

26. **Nagarjunasagar-Srisailam** (Andhra Pradesh) is India's **largest Tiger Reserve by area**, while **Jim Corbett** holds the **highest tiger population** among individual reserves.

27. **Guru Ghasidas-Tamor Pingla Tiger Reserve** in **Chhattisgarh** (notified in November 2024) is India's **56th Tiger Reserve** and the 3rd largest in area (PIB).

28. **Project Elephant** was launched in **1992**; **MIKE** (*Monitoring the Illegal Killing of Elephants*) is a **CITES** programme operating across 10 elephant landscapes in India.

29. India's first **Snow Leopard Population Assessment (SPAI 2024)** recorded **718 Snow Leopards**, with the highest count in **Ladakh (477)** (PIB).

30. **Gahirmatha Marine Sanctuary** (adjacent to Bhitarkanika Mangroves, Odisha) is the world's largest mass-nesting (**Arribada**) beach for **Olive Ridley Sea Turtles**.

31. The **Ramsar Convention on Wetlands** was signed on **February 2, 1971** in Iran; India has **85+ Ramsar Sites**, led by **Tamil Nadu (18)** and **Uttar Pradesh (10)** (PIB).

32. Only **TWO Indian Ramsar Sites** are currently on the **Montreux Record**: **Keoladeo National Park (Rajasthan)** and **Loktak Lake (Manipur)** (**Chilika Lake** was removed in 2002).

33. According to **ISFR 2023** (FSI), India's **Total Forest and Tree Cover** is **8,27,357 sq. km (25.17%)**, comprising **21.76% Forest Cover** and **3.41% Tree Cover**.

34. In **ISFR 2023**, the top 3 states in **Area-wise Forest Cover** are **Madhya Pradesh, Arunachal Pradesh, and Chhattisgarh**; the top 3 states in **Percentage Forest Cover** are **Mizoram (85.34%), Arunachal Pradesh (79.04%), and Meghalaya (76.00%)**.

35. In **ISFR 2023**, the top 3 states recording the **maximum gain in combined Forest and Tree Cover** are **Chhattisgarh (+684 sq. km), Uttar Pradesh (+559 sq. km), and Odisha (+559 sq. km)**.

36. According to **ISFR 2023**, India's total **Mangrove Cover** is **4,992 sq. km (0.15%)**, led by **West Bengal (~42.45%), Gujarat (~23.32%), and Andaman & Nicobar Islands**.

37. According to **ISFR 2023**, India's **Forest Carbon Stock** stands at **30.43 billion tonnes of CO_2 equivalent**, with **Arunachal Pradesh** holding the largest carbon stock.

38. The **Wildlife (Protection) Amendment Act, 2022** replaced the old 6 Schedules with **4 Schedules**: **Schedule I** (highest animal protection), **Schedule II** (lower animal protection), **Schedule III (Protected Plants)**, and **Schedule IV (CITES specimens)**.

39. The **Prime Minister of India** chairs the **National Board for Wildlife (NBWL)**, while the **Union Environment Minister** chairs the **National Tiger Conservation Authority (NTCA)** (MoEFCC).

40. The **Central Pollution Control Board (CPCB)** was constituted as a statutory body under the **Water (Prevention and Control of Pollution) Act, 1974** and later given powers under the **Air Act, 1981**.

41. The **Environment (Protection) Act, 1986** was enacted under **Article 253** after the 1984 Bhopal Gas Tragedy and provides the statutory basis for **GEAC, Eco-Sensitive Zones (ESZ), CRZ, and EIA**.

42. The **National Biodiversity Authority (NBA)** (headquartered in **Chennai**) was established under the **Biological Diversity Act, 2002**, with **Biodiversity Management Committees (BMCs)** preparing local **People's Biodiversity Registers (PBRs)**.

43. Under the **Forest Rights Act (FRA), 2006**, the **Gram Sabha** is the statutory authority to initiate the process of determining individual and community forest rights.

44. The **National Green Tribunal (NGT, 2010)** enforces 7 **environmental laws**, but has **NO jurisdiction over the Wildlife (Protection) Act, 1972 or the Forest Rights Act, 2006**.

45. The **8 Pollutants** included in India's **National Air Quality Index (NAQI)** are **PM_{10}, PM_{2.5}, NO_2, SO_2, CO, O_3, NH_3, and Pb** (**CO_2 and CH_4 are excluded**).

46. **Photochemical Smog** is an **Oxidizing Smog** formed in warm, sunny climates by **UV sunlight + NO_x + VOCs**, yielding **Tropospheric Ozone (O_3) and Peroxyacetyl Nitrate (PAN)** (NCERT).

47. **Minamata Disease** is caused by **Mercury (Hg)**, **Itai-Itai Disease** by **Cadmium (Cd)**, **Blue Baby Syndrome** by **Nitrates (NO_3^-)**, and **Blackfoot Disease** by **Arsenic (As)**.

48. The **Basel Convention (1989)** regulates transboundary **Hazardous Waste**, **Rotterdam (1998)** covers **Prior Informed Consent (PIC)** for chemicals, **Stockholm (2001)** eliminates **Persistent Organic Pollutants (POPs)**, and **Minamata (2013)** phases down **Mercury**.

49. The **Montreal Protocol (September 16, 1987)** successfully phased out **Ozone Depleting Substances (CFCs, Halons)**, and its **Kigali Amendment (2016)** phases down **HFCs** (which have **Zero ODP** but **High GWP**).

50. The **1992 Rio Earth Summit** gave birth to the **Three Rio Conventions: UNFCCC (Climate Change)**, **CBD (Biodiversity)**, and **UNCCD (Desertification)**.

51. Under the **CBD (1992)**, the **Cartagena Protocol (2000)** regulates **Biosafety of Living Modified Organisms (LMOs)**, and the **Nagoya Protocol (2010)** governs **Access and Benefit-Sharing (ABS)**.

52. The **Kunming-Montreal Global Biodiversity Framework (CBD COP15, 2022)** adopted the **"30x30 Target"** to conserve **30% of global land and ocean areas by 2030**.

53. The **Kyoto Protocol (1997)** covers 7 **Greenhouse Gases**: **CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3**, with **Sulphur Hexafluoride (SF_6)** having the highest GWP (~23,500).

54. **Blue Carbon** refers to organic carbon captured and stored by **coastal and marine ecosystems**—specifically **Mangroves, Tidal Salt Marshes, and Seagrass Meadows**.

55. India's **National Action Plan on Climate Change (NAPCC, 2008)** consists of **8 National Missions** (including the National Solar Mission and Green India Mission) (**MoEFCC**).

56. Under India's **Panchamrit** and **August 2022 Updated NDC**, India committed to **45% reduction in GDP emissions intensity by 2030** (over 2005 levels), **50% non-fossil electric power capacity by 2030**, **2.5–3.0 billion tonnes additional CO_2 forest sink by 2030**, and **Net-Zero by 2070** (**PIB**).

57. The **International Solar Alliance (ISA)** was co-founded by **India and France** at **COP21 (Paris, 2015)** and is headquartered in **Gurugram, Haryana**.

58. The **International Big Cat Alliance (IBCA)** was launched by India in **April 2023** to conserve 7 **Big Cats** (*Tiger*, *Lion*, *Leopard*, *Snow Leopard*, *Cheetah*, *Jaguar*, *Puma*).

59. **UNFCCC COP27** (Sharm el-Sheikh, 2022) created and **COP28** (Dubai, 2023) operationalized the **Loss and Damage Fund** alongside the **First Global Stocktake**.

60. **UNFCCC COP29** (Baku, Azerbaijan, November 2024) adopted the **New Collective Quantified Goal (NCQG)** of mobilizing **USD 300 billion per year by 2035** in climate finance for developing nations and finalized **Article 6.4 global carbon trading rules** (**PIB**).

IUC Academy *1-3-7-21* Day Spaced-Revision & Self-Assessment Tracker (www.iucacademy.com)

Chapter / Study Section	Day 1 (First Read)	Day 3 (Active Recall)	Day 7 (MCQ Drill)	Day 21 (Exam Ready)
1. Chapter 1: Fundamentals of Ecology, Ecosystems, Energy Flow & Biogeochemical Cycles	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
2. Chapter 2: Terrestrial & Aquatic Ecosystems — Mangroves, Coral Reefs, Wetlands & Estuaries	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
3. Chapter 3: Biodiversity, IUCN Red List, Hotspots & Conservation (In-Situ & Ex-Situ)	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
4. Chapter 4: National Parks, Tiger Reserves, Wildlife Projects & Ramsar Wetlands of India	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
5. Chapter 5: India State of Forest Report (ISFR 2023) & Forest Types of India	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
6. Chapter 6: Environmental Legislation, Statutory Bodies & Movements in India	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
7. Chapter 7: Environmental Pollution, Air Quality Index, Waste Management & Bioremediation	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
8. Chapter 8: Climate Change, Ozone Depletion, UNFCCC COP Summits & India's Net-Zero Panchamrit	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
9. Solved Exam Practice Questions (MCQs)	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
10. Extended Comparative & Analytical Practice Set (Questions 36–75)	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**
11. Rapid-Fire Last-Minute One-Liner Revision Capsule	☐ Completed (100% Concept Clarity)	☐ Flowchart & Tables Revised	☐ 75+ MCQs Solved (>85% Accuracy)	☐ **Final Rapid Recall Ready**