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APPSC GROUP 1 PRELIMS

SCIENCE AND TECHNOLOGY

PRELIMS VISUAL EDGE

FACTS • DATA • CONCEPTS



Dr Ravi Kumar Reddy

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PAPER II

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Scan to learn and revise

Science, technology and innovation

Related, but not interchangeable

Science, technology and innovation are closely linked, but they are distinct concepts with different purposes and outcomes.

SCIENCE

Builds explanations using observation, evidence and testing.



observe and measure

TECHNOLOGY

Applies knowledge, skills and tools to solve practical problems.



INNOVATION

A significantly new or improved product or process that is made available or put into use.



Knowledge ⟷ practical needs ⟷ implementation

Key differences

Discovery	Invention	Innovation
reveals something previously unknown.	creates a new device, method or process.	requires implementation, not merely an idea.

One connected example

Understanding the photovoltaic effect



→ designing a solar cell



→ putting a significantly improved solar-powered irrigation system into use.

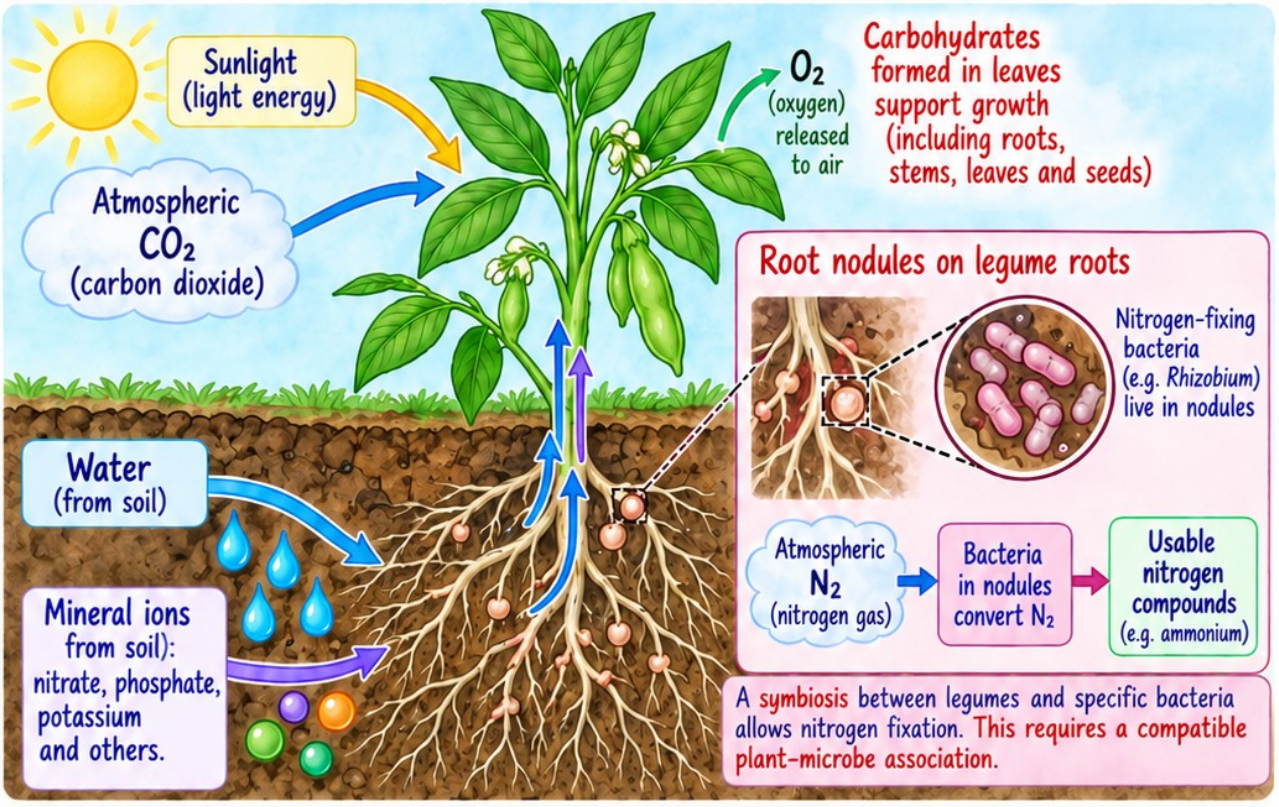


Key points to remember

1. Not every invention becomes an innovation.
2. Innovation may improve a product, service or process; it need not be new to the whole world.
3. Science and technology influence each other.

B18.023 | Science in agriculture | Card 1 of 3

Crops: where do their materials come from?



Key facts

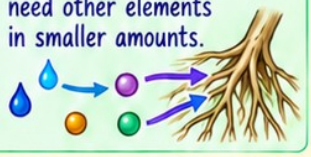
Most plant biomass carbon comes from air, not fertiliser.

Plants take in CO_2 from the air and use it to make carbohydrates, which provide the building blocks for growth.



Roots absorb water and mineral ions from the soil.

Water is needed for many processes and mineral ions such as nitrate (N), phosphate (P) and potassium (K) are essential nutrients, but plants also need other elements in smaller amounts.



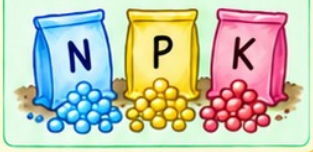
Manure and organic matter improve soils.

They add organic matter which helps soil structure, water retention and provides food and habitat for soil microbes. They also supply nutrients as they break down.



Fertilisers supply nutrients, not ready-made plant food.

Fertilisers provide mineral nutrients such as N, P and K in forms plants can absorb.



Water management

Drip or emitter irrigation near the root zone can reduce avoidable water losses (e.g. by evaporation and runoff) when well managed, especially in dry conditions. It does not always save water and is not suitable or necessary everywhere.



Limiting factors

Plant growth can be limited by light, water, nutrient supply or temperature. If one factor is in short supply, plant growth will be restricted, and an excess of another factor cannot fully compensate for a severe shortage.



Ramanujan and S.N.Bose: two kinds of counting

Srinivasa Ramanujan: number theory

- Integer partitions: ways of writing a positive integer as a sum of positive integers, ignoring order.
- Infinite series with remarkable identities.
- Continued fractions.
- Mock theta functions.

Integer partitions

A partition of a positive integer n is a way of writing n as a sum of positive integers, where order does not matter.

Example: all partitions of 4

Partition	As groups of dots
4	● ● ● ●
3 + 1	● ● ● ●
2 + 2	● ● ● ●
2 + 1 + 1	● ● ● ●
1 + 1 + 1 + 1	● ● ● ●

There are 5 partitions, so $p(4) = 5$.

3 + 1 and 1 + 3 count as the same partition.

With G.H. Hardy, Ramanujan developed an asymptotic formula for the growth of partition numbers.

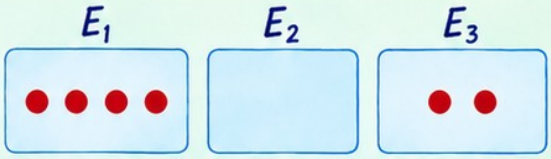
A pattern is not a proof for every input.

Satyendra Nath Bose:

- Treated light quanta (photons) as indistinguishable particles in Planck's radiation law.
- Einstein extended the idea to material particles, leading to Bose–Einstein statistics.

Quantum states and bosons

In Bose–Einstein statistics, identical bosons may occupy the same quantum state.



Bosons may share one quantum state.

Fermions and the exclusion principle

Identical fermions cannot share the same complete quantum state; each quantum state can be occupied by at most one fermion (with the same quantum numbers).

Exclusion does not mean they cannot occupy the same region of space.

Bose did not experimentally discover the Higgs boson.

Comparison: two kinds of counting

Ramanujan: unordered integer partitions

- Count ways to write an integer as a sum of positive integers, ignoring order.
- A problem in number theory.
- Partitions are mathematical combinations, not physical particles.

S.N. Bose: quantum occupation statistics

- Count ways identical bosons occupy quantum states.
- Particles are indistinguishable; multiple bosons can share a state.
- A physical model describing systems such as photons and, for material particles, Bose–Einstein statistics.

Both involve **counting**, but they are different problems: integer partitions count unordered sums of numbers, while Bose–Einstein statistics counts occupations of quantum states by identical particles.

Sources: The Trinity College Ramanujan Archive | Hardy–Ramanujan 1918 | S.N. Bose National Centre

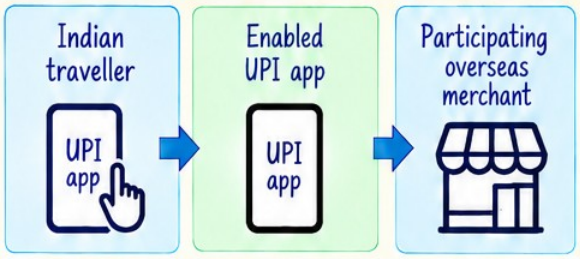
UPI abroad: two routes, not one common currency

Same technology, different ways to use

UPI can be used internationally through two separate mechanisms. This does not mean a single common currency. Payments still require currency conversion, compliance and confirmation of recipient details.

1 Overseas merchant acceptance

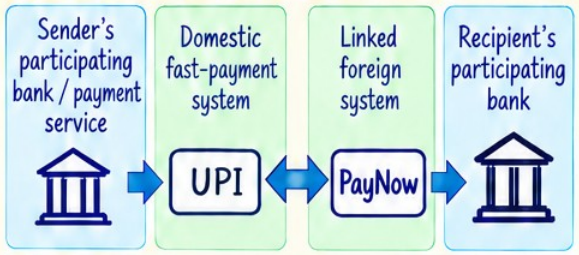
Indian travellers can pay at eligible overseas merchants using an enabled UPI app, where the merchant accepts UPI.



Result: Purchase and payment at an eligible overseas merchant.

2 Fast-payment system link

Participating banks or payment service providers can link India's fast-payment system with a foreign fast-payment system to enable cross-border remittances.



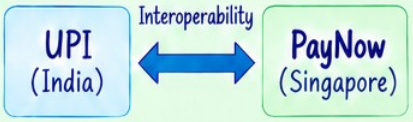
Result: Cross-border remittance to a recipient through participating institutions.

Availability depends on several factors

- Participating institutions (merchants, banks and payment services)
- Supported currencies (currency conversion is required)
- Permitted uses and compliance as per applicable regulations
- Applicable limits and conditions

Case example: India – Singapore UPI – PayNow link

India's UPI and Singapore's PayNow were linked and became operational on 21 February 2023. This enables cross-border payments and remittances between the two systems, through participating institutions.



This is an interoperability link between two fast-payment systems. It does not merge currencies and both sides follow their own rules.

Key distinctions

1 Cooperation agreement ≠ service live everywhere.

An agreement or link does not mean UPI is accepted at all merchants or available in all places.

2 Merchant acceptance ≠ every bank supports remittance.

Paying at overseas merchants is different from bank-to-bank cross-border remittances.

3 Shared payment interface ≠ common currency.

UPI and foreign systems allow interoperability for payments. They do not create a single common currency.

B19.043 | National Cyber Security Policy | Card 1 of 1

National Cyber Security Policy

Released 2 July 2013

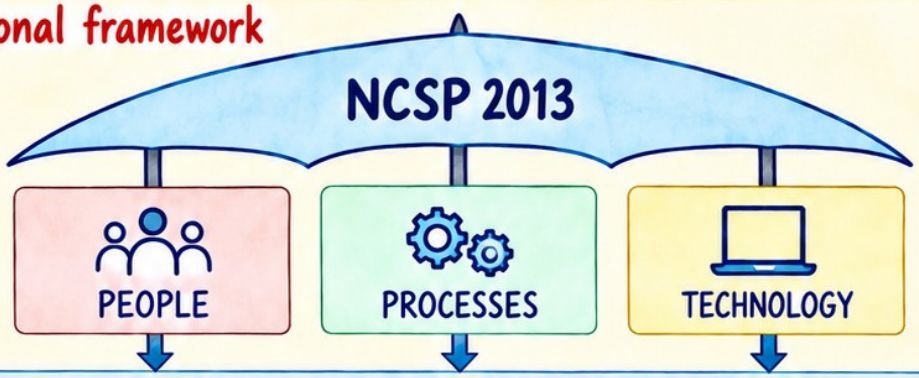
What is cybersecurity?

Cybersecurity protects the confidentiality, integrity and availability of information and information systems.

What is resilience?

Resilience maintains essential functions and recovers after disruption.

Functional framework



Policy priorities

- Secure information systems
- Critical infrastructure
- Incident response
- Research and skills
- Standards
- Cooperation

Related terms

Policy	Direction and priorities.
Strategy	Implementation approach to achieve the policy.
Statute / rules	Legal framework.
Directions	Specified operational obligations (e.g. to particular organisations).

Illustrative organisational risk cycle—not verbatim policy headings



Worked example: hospital (cyber incident)

Protect access controls and backups → Detect unusual activity → Isolate affected system → Restore tested backup → Review cause

MeitY Annual Report 2025-26

National Cyber Security Strategy formulated and under approval.

Formulated ≠ approved replacement policy.

Key points

- Risk cannot be reduced to zero.
- Prioritise by consequence and likelihood.

Sources: MeitY, National Cyber Security Policy 2013; MeitY Annual Report 2025-26.

Mars Orbiter Mission (Mangalyaan)

India's first mission to Mars orbit

The Mars Orbiter Mission, popularly called Mangalyaan, was launched by PSLV-C25 on 5 November 2013 and entered orbit around Mars on 24 September 2014. It was an orbiter, not a Mars lander or rover. India achieved Mars orbit on its first attempt at a Mars mission.

Objectives

Technological objectives

- Navigation over an interplanetary journey
- Communication across large distances
- Autonomous spacecraft functions
- A controlled manoeuvre to become bound to Mars

Scientific objectives

- Examine surface features
- Study thermal characteristics
- Study the atmosphere
- Mars Colour Camera produced both regional and broad planetary views from the elliptical orbit



Mangalyaan orbiter (not a lander or rover)

Conceptual illustration

Interplanetary journey and orbital capture

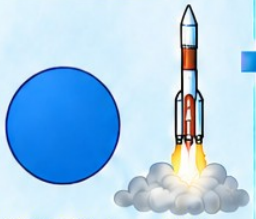
Interplanetary flight is not a straight-line chase after a planet's present position. Both Earth and Mars move around the Sun, so launch opportunities and trajectories must be timed for the future encounter.

On arrival, slowing relative to Mars is necessary for orbital capture; merely reaching its vicinity does not establish orbit.

Launch, cruise and capture are different stages

1. Launch from Earth

5 November 2013: launch



PSLV-C25 places MOM into an Earth orbit; spacecraft manoeuvres later begin the transfer to Mars.

2. Cruise to Mars

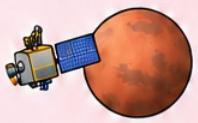
Earth-orbit preparation → interplanetary cruise



Both Earth and Mars move around the Sun. Launch opportunities are timed for the future encounter, not a straight-line chase.

3. Mars orbit insertion

24 September 2014: Mars orbit insertion



Capture burn: reduces velocity relative to Mars so that it becomes bound in an elliptical orbit.

4. After orbit insertion

Orbiter observations, not surface rover



Observations from the elliptical orbit using scientific payloads including a methane sensor and the Mars Colour Camera.

Mission duration

- Designed initially for six months.
- MOM operated for about eight years.
- After communication was lost following a long eclipse in April 2022, ISRO declared the spacecraft non-recoverable and at end of life in September 2022.
- It is not operational.

Key points to remember

- MOM did not land on Mars and was not a rover.
- The presence of a methane sensor was a scientific objective, not evidence that the mission discovered life or conclusively established a biological methane source.
- Interplanetary travel requires launch timing for the future encounter, and orbital capture needs a controlled manoeuvre to slow down relative to Mars.

India's nuclear weapons programme

Tests, doctrine, command and the nuclear triad

Overview

- India has a nuclear weapons programme with a history of nuclear tests and a publicly released doctrine.
- This must be distinguished from the civilian nuclear-power programme, which uses controlled nuclear reactions to generate energy and support other peaceful applications.

Nuclear-test history

May 1974
Pokhran-I
India's first nuclear test, conducted in Rajasthan.

11 and 13 May 1998
Pokhran-II series
A series of nuclear tests conducted in Rajasthan.

Nuclear doctrine (4 January 2003)

- Centres on credible minimum deterrence and a no-first-use posture.
- Deterrence aims to discourage an attack through the prospect of retaliation. It is a strategic policy, not a guarantee that conflict cannot occur.
- The published doctrine also retains the option of nuclear retaliation following a major chemical or biological attack against India or Indian forces.
- Thus an absolute 'no exceptions' summary is inaccurate.

Meaning of key terms

Nuclear deterrence	Discourages an attack through the prospect of retaliation. It is a strategic policy, not a guarantee that conflict cannot occur.
No-first-use (NFU)	A stated posture of not using nuclear weapons first, with the published qualification that allows retaliation following a major chemical or biological attack against India or Indian forces.

Command and control

Nuclear Command Authority
(authorises nuclear retaliation)

Political Council
Chaired by the Prime Minister
Political Council is the sole body authorised to order nuclear use.

Executive Council
Chaired by the National Security Adviser
Provides inputs and implements directives.

Distinct military command role
Strategic Forces Command
Distinct military role within these arrangements.

Nuclear triad

A nuclear triad refers to delivery capabilities associated with land, air and sea.

Land	Air	Sea
		
Land-based delivery systems	Air-based delivery systems	Sea-based delivery systems

The triad refers to delivery categories.
It does not mean three kinds of nuclear reaction.
Nuclear propulsion does not automatically mean nuclear armament.

Civilian nuclear-power programme



- Uses controlled nuclear reactions to generate electricity.
- Supports other peaceful applications.
- This is separate from the nuclear weapons programme.

Key distinctions for examination

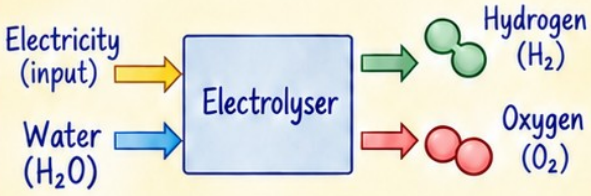
Tests vs civilian programme	Nuclear tests (Pokhran-I and Pokhran-II) are part of the weapons programme and are distinct from the civilian nuclear-power programme.
No-first-use	Must be read with the published qualification; it is not an absolute 'no exceptions' position.
Nuclear-powered vs nuclear-armed	Nuclear propulsion does not automatically mean nuclear armament.
Examination focus	Public doctrine, test history and delivery categories are sufficient foundations. Speculative stockpile counts, deployment locations and weapon-design details should not be treated as established examination facts.

Hydrogen: an energy carrier

Hydrogen is an energy carrier, not a primary source of energy.
It must be produced using a feedstock or a source of energy, such as water and electricity. It stores and transports energy in chemical form.

Producing hydrogen: Electrolysis

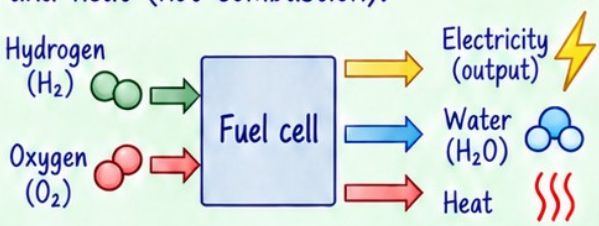
Electricity is used to split water into hydrogen and oxygen.



$$2H_2O \longrightarrow 2H_2 + O_2$$
(with electricity input)

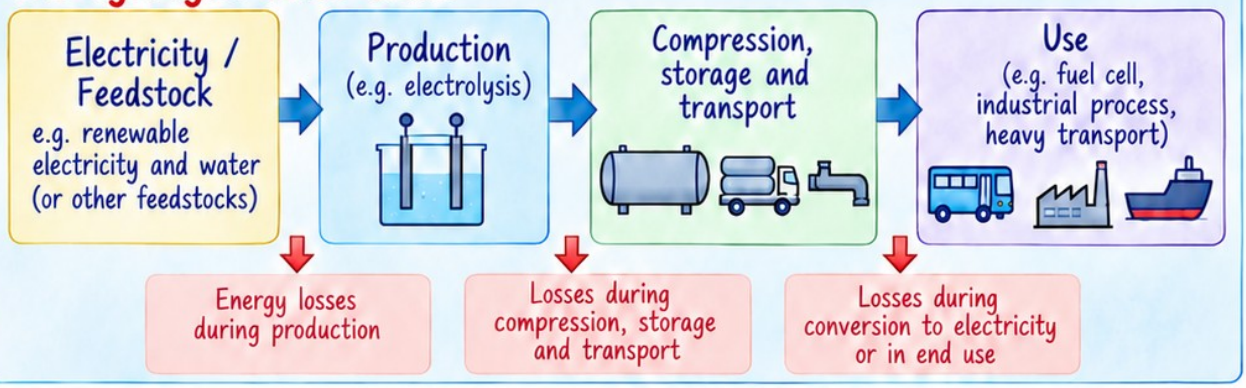
Using hydrogen: Fuel cell

Hydrogen and oxygen are converted electrochemically into electricity, water and heat (not combustion).



$$2H_2 + O_2 \longrightarrow 2H_2O$$
(releases energy as electricity and heat)

The hydrogen value chain



Key points

- Electrolytic hydrogen is not automatically "green". The environmental impact depends on the source of electricity and the emissions from production.
- India's framework for green hydrogen uses an emissions threshold and certification boundary, not the colour of hydrogen.
- Hydrogen has multiple uses, but it is not the best choice for every application. It is particularly useful where hydrogen is already a feedstock or in sectors that are hard to electrify, such as certain industrial processes and heavy transport.

Important considerations

- Pure hydrogen used in a fuel cell produces water at the point of use, but this does not mean zero lifecycle emissions. Emissions depend on the entire chain, especially the production stage.
- Converting electricity → hydrogen → electricity is not lossless. Direct electrification may be more efficient where it is practical.
- Handling hydrogen requires appropriate materials and safety infrastructure due to its physical properties.

Sources (short)

- Ministry of New and Renewable Energy (MNRE): Green Hydrogen Framework, Government of India.
- U.S. Department of Energy (US DOE): Hydrogen and Fuel Cells (overview resources).

Ecosystems:
living networks and physical conditions

What is an ecosystem?

An ecosystem is a community of organisms interacting with each other and with their physical and chemical surroundings.

Components of an ecosystem

Biotic components (living)

Producers



Build organic matter from inorganic inputs (usually sunlight).

Consumers



Eat other organisms to obtain energy and nutrients.

Decomposers



Break down dead matter and wastes into simpler substances.

Abiotic components (non-living)

Soil



Minerals and physical structure provide nutrients and habitat.

Water



Solvent and source of necessary chemicals.

Light



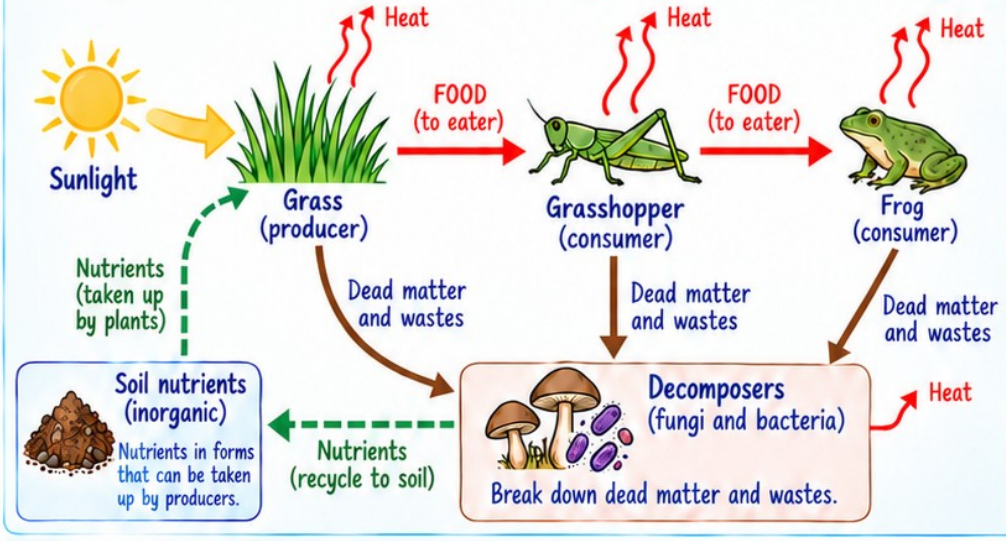
Main energy source for most producers.

Temperature



Influences organisms, processes and rates of reactions.

Example: food flow and nutrient cycling in a simple ecosystem



Feeding relationships

Food chain



A food chain shows one pathway of food flow from one organism to another.

Food web

Several interconnected feeding pathways

Omnivores

Some organisms feed at more than one trophic level.

Matter cycles; energy flows and dissipates as heat:
Decomposers receive material from all trophic levels.

Sources: NCERT Ecosystem; NOAA aquatic food webs.

CRZ and ESZ: read the applicable notification

The coast has different zones

High and low tide references and approved Coastal Zone Management Plans determine legal categories — not a guessed distance from today's waterline.



Four broad categories in mainland Coastal Regulation Zone (CRZ)

Ecologically sensitive and intertidal areas



Includes areas such as mangroves, dunes, tidal creeks and other ecologically sensitive and intertidal areas.

Developed urban areas



Already developed urban areas along the coast.

Relatively undisturbed and rural areas



Relatively undisturbed and rural coastal areas.

Coastal waters



Coastal waters up to the limit specified in the notification.

Different categories have different provisions. **CRZ is not one uniform no-construction strip.**

Mangroves, dunes, tidal creeks and fishing community livelihoods matter.

Which CRZ framework applies?

Updated CZMP under CRZ 2019 approved?

- **Yes** → Applicable CRZ 2019 framework.
- **Not yet** → CRZ 2011 provisions continue as specified in the notification.

Important points

- A plan approved in 2019 under CRZ 2011 is not automatically a CRZ 2019 plan.
- Plan approval ≠ project clearance.
- No single identical buffer can be assumed for every coast or protected area.

Eco-Sensitive Zones (ESZ): protective transition areas, commonly around protected areas.

ESZ are notified to create a transition area to protect the ecology of the larger protected area.

Prohibited activities

Certain activities may be prohibited.

Regulated activities

Certain activities may be regulated with conditions.

Promoted activities

Certain activities may be promoted.

The notification defines boundaries, features, monitoring and activity conditions.
ESZ does not automatically ban every village activity or require residents' removal.

The decision-making chain (site specific)

Applicable notification (CRZ or ESZ) → Approved Coastal Zone Management Plan (CZMP) or ESZ notification/plan → Relevant court orders (if any) → Site-specific decision based on facts, law and applicable provisions.

No single identical buffer can be assumed for every coast or protected area.

Source: MoEFCC CRZ 2019 notification; ESZ guidelines and notifications.

Biodiversity of Andhra Pradesh

Match the protected place to its habitat — not just its name

Eastern Ghats forests • dry scrub and grasslands • river valleys • wetlands • coastal habitats

Papikonda National Park



Godavari valley and Eastern Ghats forests

Sri Venkateswara National Park



Southern Eastern Ghats and Tirumala landscapes

Rajiv Gandhi / Rameswaram National Park



Proddatur; distinguish it from similarly named parks elsewhere

Habitat type	Key protected place(s)	Notes
Nallamala forests 	Nagarjunasagar–Srisailam Tiger Reserve (NSTR)	Current Andhra Pradesh reserve; Amrabad in Telangana is separate. Prey, connectivity, water and community relationships matter.
Estuarine mangroves 	Coringa and Krishna wildlife sanctuaries	Tidal creeks, sediment and salinity shape habitat.
Wetland and waterbird habitats 	Kolleru • Pulicat • Nellapattu	Water regime, food availability and undisturbed habitat matter.
Open grassland 	Rollapadu	Important blackbuck habitat. Historical Great Indian Bustard association is not proof of a flourishing current population.
Scrub habitat 	Sri Lankamalleswara	Associated with the rare Jerdon's courser; protect suitable scrub rather than replacing it indiscriminately.

Approach to conservation

Identify habitat  → Check legal designation  → Identify ecological pressure  → Assess management response 

Final caution: Use present state boundaries. Do not add Telangana's parks to an Andhra Pradesh total or equate every forest reserve with a national park.

Sources: Andhra Pradesh Forest Department • Wildlife Institute of India • NTCA

Disaster Management Act, 2005 and institutions

Key idea

Establishes a continuing system for reducing risk, preparing for emergencies, responding and recovering – not merely distributing relief after an event.

When does a hazard become a disaster?

A hazard becomes disastrous when its consequences seriously exceed the affected community's coping capacity.

Integrate with development

Prevention, mitigation and preparedness therefore belong inside development planning.

Institutional framework under the Act

National level

National Disaster Management Authority (NDMA)
Chaired by the Prime Minister
Formulates national policy and planning

State level

State Disaster Management Authority (SDMA)
Chaired by the Chief Minister
State-level coordination and planning

District level

District Disaster Management Authority (DDMA)
Chaired by the Collector / District Magistrate / Deputy Commissioner

Local authorities

Local implementation with elected local representation as provided by law

Other key institutions (complementary)

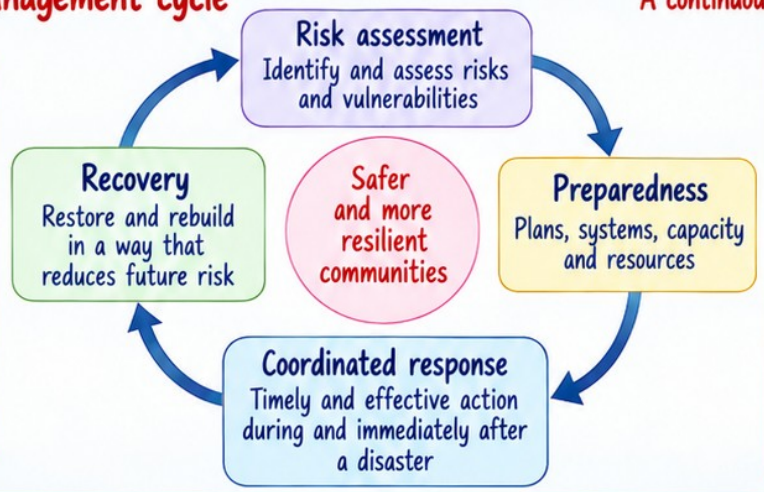
National Crisis Management Committee (NCMC)
Cabinet Secretary-led.
Addresses major crises with serious or national implications.

High-Level Committee (HLC)
Deals with specified national disaster-fund assistance.

National Institute of Disaster Management (NIDM)
Supports training, research and capacity development.

The disaster management cycle

A continuous cycle with feedback



Includes

- Prevention
- Mitigation
- Preparedness
- Response
- Recovery

These are linked and belong within development planning.

Key points

- A cycle with feedback, not a one-way ladder of commands.
- Ministries, executive committees and local authorities have complementary responsibilities.
- The NDMA is not itself a field rescue battalion.

2025 Amendment

Received assent on **29 March 2025**
Commenced on **9 April 2025**

- Strengthens national and state authorities' planning roles and disaster databases.
- Gives statutory recognition to the National Crisis Management Committee and High-Level Committee.
- Enables State Disaster Response Forces.

Urban disaster management (Section 41A)

- Enables states to constitute Urban Disaster Management Authorities for state capitals and municipal-corporation cities, excluding Delhi and Chandigarh.
- This is an enabling framework, not proof that every eligible city already has an operational authority.
- Urban plans should address interconnected risks such as flooding, heat, buildings and service disruption.

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