CLASSIFICATION, BIODIVERSITY, CONSERVATION

CLASSIFICATION

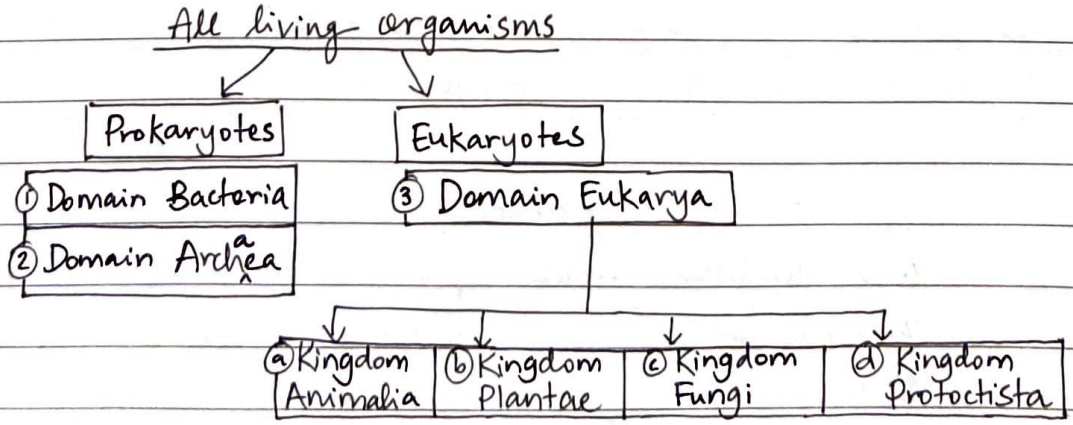
Species

① **Biological species:**
- a group of organisms with similar morphological (structural) features, physiological features (body functions), biochemical features (DNA base sequence of amino acid sequence in proteins).
- able to interbreed and produce fertile offspring.

② **Morphological species:**
- a group of organisms that have similar morphological features.

* this definition only used when:
→ not enough info on physiological & biochemical features.
→ not seen them interbreed.

③ **Ecological species:**
- a group of organisms living in the same area and have the same niche.
  └ the function of an organism in its environment.



Feature	Domain Bacteria	Domain Archaea	Domain Eukarya
① nucleus	x	x	✓
② DNA	→ circular → no histone proteins	→ circular → has histone proteins	→ linear → has histone proteins
③ plasmids	✓	✓	x
④ membrane-bound org	x	x	✓
⑤ cell wall	✓ peptidoglycan	✓ not peptidoglycan	some ✓ → plants: cellulose → fungi: chitin
⑥ ribosomes	✓ 70S	✓ 70s	✓ 80s in RER & cyto ✓ 70s in mito & chloro have similar small subunits
⑦ cell division	binary fission	binary fission	mitosis
⑧ cell membrane	phospholipid bilayer	phospholipid monolayer	phospholipid bilayer

	Kingdom Animalia	Kingdom Plantae	Kingdom Fungi	Kingdom Protoctista
① eukaryotic	✓	✓	✓	✓
② multi/unicellular	multicellular	multicellular	uni / multi cellular	mostly unicellular
③ tissues & organs	✓	✓	x	x
④ chloroplasts	x	✓	x	some ✓
⑤ nutrition	heterotrophic	autotrophic	heterotrophic	✓chloro auto / ✗chloro hetero
⑥ cell wall	x	✓ cellulose	✓ chitin	✓ some
⑦ vacuole	small, temporary	large, permanent	—	—
⑧ cilia/flagella	some in cells	mostly absent	—	✓ some

* Bacteria vs. Archaea:

① → membrane lipids: phospholipid bilayer vs. monolayer

② → ribosomal RNA: rRNA seq. in archaea similar to eukaryotic rRNA

③ → composition of cell wall: peptidoglycan vs. not peptidoglycan

④ → presence of histone proteins: ~~yes vs.~~ no vs. yes.

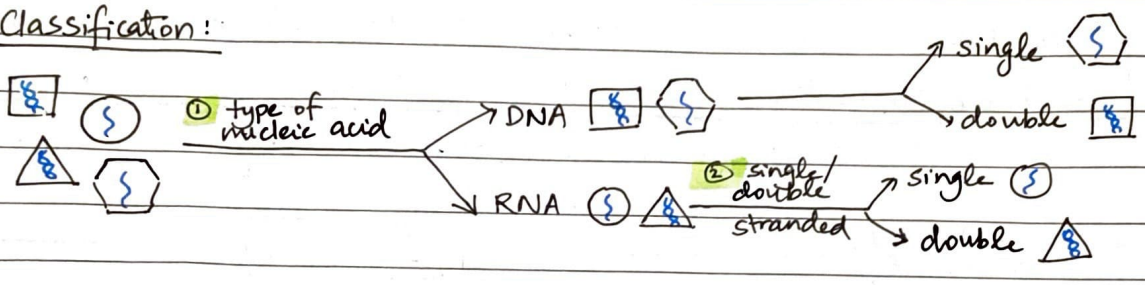
Viruses

→ Acellular (lack cell structures) — no cytoplasm, no nucleus, no cell surface membrane

→ Don't carry out living processes — don't respire, don't reproduce (have to enter host cell to replicate)

→ Basic structure  protein coat, nucleic acid (DNA / RNA)

Classification:



Hierarchical Classification

→ taxon = group

Classification of organisms in Eukarya domain into taxonomic hierarchy.

Domain	Did
Kingdom	King
Phylum	Philip
Class	Come
Order	Over
Family	For
Genus	Good
Species	Spaghetti?

BIODIVERSITY

→ can be assessed at 3 different levels:

① the number & range of different ecosystems and habitats.
② the number of species and their relative abundance.
③ the genetic variation between each species.

Population
- organisms of the same species
- in the same area
- at the same time

→ **Community**
- all the populations of the different species living in one area.

↓

Habitat
place where an organism lives, within an ecosystem.

Niche
the role/function of a species within an ecosystem.

Ecosystem
- a self-contained unit containing the community of interacting organisms and the environment they live in and interact with

biotic + abiotic factors
- biotic: living organisms
- abiotic: environment (sunlight, climate, soil, water, etc.)

① more habitats = more biodiversity
② higher no. of species = higher biodiversity ; more even distribution of species abundance = higher biodiversity.
③ more genetic variation = higher biodiversity

METHODS TO ASSESS DISTRIBUTION AND ABUNDANCE OF ORGANISMS IN AN AREA

→ **For immobile / sessile organisms – Quadrat Sampling**

- quadrat : square frame with variable size.
- place quadrat
- measure % distribution : count full squares / with more than half

→ **For mobile organisms – Lincoln Index : Mark-Release-Recapture**

~~- use net/pooter to capture as many organisms as possible~~
~~↳ capture in a human~~

① capture as many organisms as possible using net/pooter.
↳ shouldn't harm them

→ ② mark the organisms
↳ must not harm them
↳ must not increase/decrease chance of survival in wild
↳ shouldn't be easily removed

↓

③ release them into wild and allow them to mix with general population.

← ④ recapture after a few days (as many as possible, not just marked ones)

$$\text{Population size} = \frac{\text{First capture} \times \text{Second capture}}{\text{no. of marked individuals in recapture}}$$

— round up/down to get an integer

Sampling

Random
- sampled areas chosen randomly

Systematic
- sampled areas chosen non-randomly

Sampling

Random

done when:

→ area is uniform (no obvious differences)

→ no obvious pattern to species distribution (evenly spread out)

Placing quadrats randomly:

- divide the area using coordinates.
- use random no. generator to generate a coordinate.
- place quadrat on coordinate.
- at least 10 quadrats for reliability. and all quadrats same size for fair test.

Systematic

done when:

→ area not uniform

→ there is an obvious pattern in species distribution

a) **Line transect** → species distribution

- put a line
- identify any species that touches the line at specific intervals.

b) **Belt transect** → species number & abundance

- place quadrats at regular intervals
- count no. and abundance of species within each quadrat

SIMPSON'S INDEX OF DIVERSITY

→ calculates the biodiversity in one habitat.

↓ the number of species and their abundance

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n → total number of organisms in 1 species

N → total number of organisms of all species

D → btwn 0 and 1

- low biodiversity (0 - 0.49)
- high biodiversity (0.5 - 1)

CONSERVATION

→ protection and maintenance of biodiversity.

Causes of extinction of populations and species:

a) Climate change (unable to adapt to changing environment)
b) Competition*
c) Hunting by humans
d) Degradation and loss of habitats

* alien species: a species that moves into a new area and competes with (invasive species) the local species.

Reasons for the need to maintain biodiversity:

① moral & ethical reason → we are aware of damage we do ∴ responsibility to mitigate
② economic reason
  ↳ plants are source of drugs/medicine.
  ↳ ecotourism: national parks, coral reef
③ environmental reason
  ↳ forests absorb CO_2 to reduce greenhouse effect
  ↳ transpiration from trees humidify air
④ aesthetic reasons
  ↳ source of inspiration for artists
⑤ ecological reason → to protect food chains & food webs.

Methods of conservation

① Conserved areas: National parks, Marine parks
  ↳ protection of habitat/ecosystem
  ↳ ecotourism
  ↳ reduce damage caused by human activities

② Zoos
- ecotourism
- protection of endangered species
- research/study behaviours of animals = diet, breeding habits, habitat requirement } to reintroduce back into the wild
- education to raise awareness
- breeding programmes - frozen zoos, AI, IVF

③ Botanic gardens
- (same as zoos)
- research/study their behaviour = mineral requirement & soil type, breeding habits } to reintroduce

④ Seed banks : place where plant seeds are stored to conserve biodiversity
- storage of seeds in cool, dry area (cool - prevents enzyme activity; dry - prevents germination)
- collection of seeds from many diff species.
- collection of seeds from diff varieties within 1 species, to preserve variation

Limitations
- Some plants have seeds that cannot be dried and stored - embryo of plant frozen & stored.

⑤ Frozen zoos
- facility that stores genetic material from animals at very low temperature ($-196^{\circ}C$)
- Semen & sperm collected, stored in straws, and frozen.
  - allows storage of sperm from many varieties of the species.
  - less storage space required.
  - health history and traits are also recorded.
- harder to freeze eggs (high H_2O content may cause it to crystallise ∴ damage).
- So, sperm + egg fertilised → embryo; embryo stored frozen.
  - portable storage of many different species' genetic information.
  - cheaper & easier transport of genetic material.
  - prevents inbreeding depression.

Assisted Reproduction

Problems with captive breeding: (capturing endangered species, putting them in captivity, to breed).

- may not reproduce with each other.
  - ↳ not attracted
  - ↳ due to stress
- breeding closely related animals may lead to inbreeding depression.
- expensive & difficult to transport animals between different zoos.

Methods of assisted reproduction for conservation of endangered mammals:

① IVF (in vitro fertilisation)

↳ fertilisation of egg outside the female's body.

- female given fertility ~~eggs~~ hormones to produce eggs.
- needle is inserted into ovary to extract eggs.
- eggs kept in culture medium for short amount of time.
- semen extracted from male or from frozen zoo.
- semen and egg are mixed – fertilisation in a petri dish.
- several zygotes form and develop into embryos.
- embryos are placed in culture for several days / stored in frozen zoo.
- embryos are transferred/implanted into surrogate mothers.

② Embryo transfer

↳ used to avoid the risks of pregnancy for female.

- egg belonging to female of the vulnerable species is fertilised by the sperm of male of same species.
- zygote forms & develops into embryo.
- after fertilisation, embryo taken from uterus of female & transferred to surrogate female. (can be from another non-vulnerable species)
- embryo develops to full term and offspring is born.

③ Surrogacy

↳ surrogate = any female that becomes pregnant with the embryo from another female and carries the embryo full term.

- surrogate mothers require hormone treatment before they can receive an embryo, to ensure uterus is in right condition for embryo to embed.
- embryo might've been conceived by:
  - naturally
  - artificial insemination (semen from male injected into uterus of female).
  - IVF
- Surrogate female can be same/different species to biological mother of embryo, (but closely related species to ensure compatibility of embryo and uterus).

Reasons for controlling invasive alien species:

→ ecosystems are balanced: through evolution, native species become adapted to local environmental conditions. Non-native invasive species evolved elsewhere and have different adaptations, so the disrupt the balance of the ecosystem when introduced.

→ in new ecosystem, invasive species have few/none of the natural population controls that existed in their previous ecosystem (natural predators, parasites, competitors).

→ this leads to their rapid population growth.

→ this causes competition btwn invasive & native species for resources: food, light, water, mineral ions, space.

→ native species may be displaced or driven to extinction.

→ invasive species could be predators, causing massive decline in prey species

→ they can introduce new diseases to which native species lack natural immunity

→ cause decrease in biodiversity ⇒ lowers productivity & stability of ecosystem.

→ ecosystem becomes less able to recover from environmental change.

→ human health impacts: spread of novel diseases, irritants of skin / breathing system.
→ economic impacts: high cost to control invasive species, damage to agriculture & infrastructure.
→ disruption of human activities: blocked waterways by invasive plants

Role of international authorities in conservation

① IUCN (International Union for the Conservation of Nature)
- assesses conservation status of animal & plant species around the world.
- has its own classification system.
- species fall into several diff categories / levels depending on their population numbers, threats / risks to them.

② CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna)
- global agreement signed by >150 countries.
- controls the trade of endangered species and their associated products.
- categorises endangered & vulnerable species into 3 appendices, with diff trading regulations:

→ Appendix I: species that are endangered and face greatest risk of extinction.	all trade in the species and associated products is banned.
→ Appendix II: species not currently endangered / facing extinction, but will be unless trade closely controlled.	trade is only granted if an export permit has been issued by involved countries.
→ Appendix III: species included at request of the country that is regulating trade of the species & trying to prevent its overexploitation.	permits are required for regulated trade (permits are easier to come by for this appendix).

* when trade of an endangered species becomes illegal, its price / economic value ↑ this becomes major incentive for people to break the law.