Classification, biodiversity and conservation

A-Level Biology

Classifying living things

A **species** 物种 can be defined in more than one way:

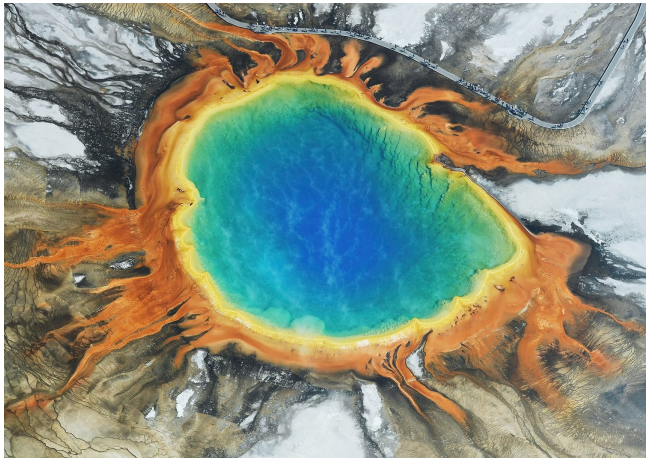
- the **biological** species concept — a group whose members can breed together to produce fertile offspring.
- the **morphological** species concept — a group whose members look alike.
- the **ecological** species concept — a group that fills the same role in its surroundings.

A museum insect collection: classification groups organisms by their shared features

The three domains

The largest groups in **classification** 分类 are three **domains** 域:

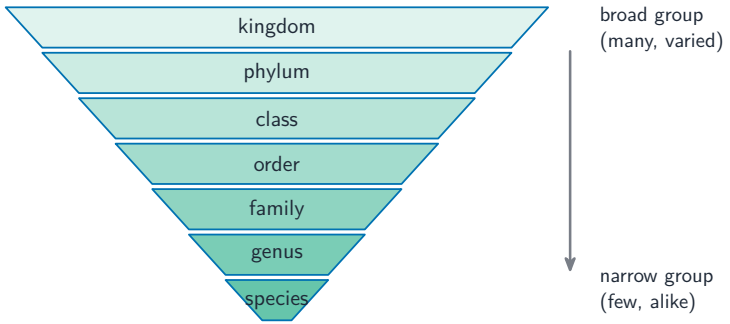
- **Archaea** 古菌 and **Bacteria** 细菌 — both are **prokaryotes** 原核生物 (no nucleus). They look similar but differ in their membrane lipids, their ribosomal RNA, and the make-up of their **cell walls** 细胞壁.
- **Eukarya** 真核生物 — all organisms whose cells have a nucleus.



Each coloured ring around this scalding spring is a different community of microbes living at a different temperature. Archaea like these — thriving where almost nothing else can — were the clue that they form a domain of their own, separate from ordinary bacteria

The taxonomic hierarchy

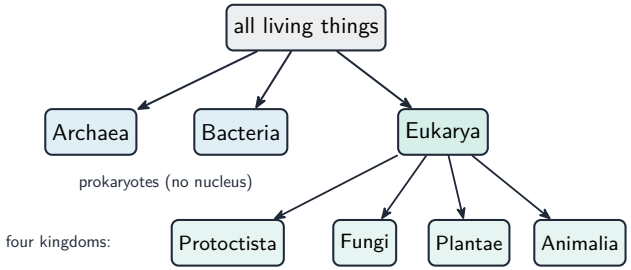
Inside the Eukarya domain, organisms are sorted into a **taxonomic hierarchy** 分类层级 — a set of smaller and smaller groups: **kingdom** 界, **phylum** 门, **class** 纲, **order** 目, **family** 科, **genus** 属 and species.



Each level of the taxonomic hierarchy is a smaller, more closely related group, ending at a single species

The Eukarya are split into four kingdoms:

- **Protoctista** 原生生物界 — mostly single-celled (such as *Amoeba*).
- **Fungi** 真菌界 — feed by absorbing food; have cell walls of chitin.
- **Plantae** 植物界 — make their own food by photosynthesis.
- **Animalia** 动物界 — feed on other organisms.



The three domains: Archaea and Bacteria are prokaryotes; the Eukarya split into four kingdoms

Viruses are not placed in these groups. They are classified by the type of **nucleic acid** 核酸 they contain (DNA or RNA) and whether it is **single-stranded** 单链 or **double-stranded** 双链.

Biodiversity

An **ecosystem** 生态系统 is all the living things in an area together with their non-living surroundings. A **niche** 生态位 is the particular role and place of a species within it.

A coral reef is a good picture of high biodiversity — many different corals, fish and other species living together:

*A **coral reef** is one of the most biodiverse habitats on Earth: many species of coral and fish share one small area*

Biodiversity 生物多样性 can be measured at three levels:

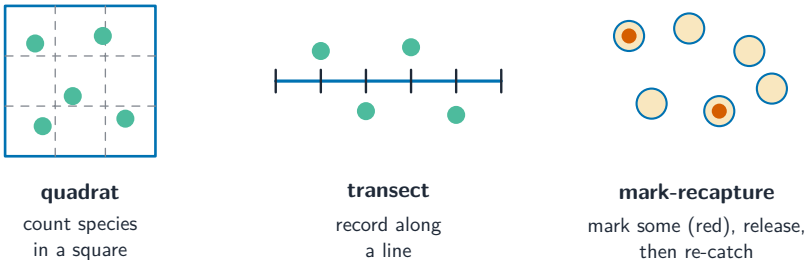
- the number and range of different ecosystems and **habitats** 栖息地.
- the number of species and their relative **abundance** 丰度 (how common each one is).
- the genetic variation within each species.

Biodiversity is measured at three levels: the range of ecosystems, the number of species, and the genetic variation within a species

Sampling an area

You cannot count every organism, so you take samples. **Random sampling** 随机取样 (choosing positions by chance) avoids bias and gives a fair picture. Useful methods are:

- **quadrats** 样方 — square frames placed to count or estimate the species inside them.
- **transects** 样带 — counting along a line across the area (a line transect records what touches the line; a belt transect counts within a strip).
- **mark-release-recapture** 标志重捕法 — for moving animals: catch, mark and release some, then later see what fraction of a new catch is marked (the Lincoln index).



Quadrats and transects sample fixed plants; mark-release-recapture estimates numbers of moving animals

To link the spread of a species to **biotic factors** 生物因素 (living) or **abiotic factors** 非生物因素 (non-living), you can use Spearman's rank or Pearson's **correlation** 相关性. To measure the diversity of an area as a single number, you use **Simpson's index of diversity** 辛普森多样性指数: a higher value means more diverse and usually more stable.

Worked example. 60 snails are caught, marked and released. Later, 80 snails are caught, of which 15 are marked. Estimate the population. The Lincoln index assumes the marked animals have **mixed back in evenly**, so the fraction marked in the second sample equals the fraction marked in the whole population:

$$N = \frac{\text{first sample} \times \text{second sample}}{\text{number marked in the second}} = \frac{60 \times 80}{15} = 320$$

So there are about **320** snails. The estimate is only as good as its assumptions, so state them: no births, deaths or migration between the two catches; the marks neither rub off nor make the animal easier for a predator to spot; and enough time is allowed for mixing. Break one and the estimate breaks with it - a mark that attracts predators lowers the recapture count and therefore **overestimates** the population.

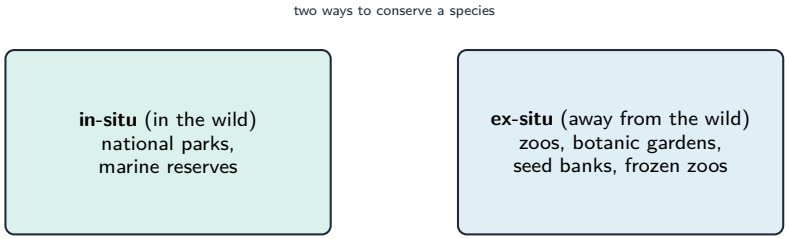
Conservation

A species can become **extinct** 灭绝 (die out completely) because of **climate change** 气候变化, competition (often from new species), hunting by humans, or the damage and loss of its habitats.

We try to protect biodiversity because other species give us food, medicines and materials, help keep ecosystems stable, and have value in themselves.

Ways to conserve species

- **zoos** 动物园 and **botanic gardens** 植物园 keep and breed **endangered species** 濒危物种.
- protected **conservation** 保护 areas, such as national parks and marine parks, keep habitats safe.
- 'frozen zoos' store frozen cells, eggs and sperm, and **seed banks** 种子库 store seeds for the future.



Conservation is either in-situ (protecting species in their own habitat) or ex-situ (keeping and breeding them away from the wild)

For rare mammals, **assisted reproduction** can boost numbers: **in vitro fertilisation** 体外受精 (IVF), **embryo transfer** 胚胎移植, and **surrogacy** 代孕 (another female carries the young).

Conservationists also control **invasive species** 入侵物种, which are brought in from elsewhere and out-compete native species.

Two organisations help worldwide: the IUCN, which lists how threatened each species is, and CITES, which controls the international trade in endangered animals and plants.

Exam tips

- Learn the **taxonomic hierarchy** (domain → kingdom → … → species) and the three domains; a species interbreeds to give **fertile** offspring.
- Measure biodiversity with **Simpson's index** (a higher value = more diverse) and explain why high biodiversity aids stability.
- Give **in-situ vs ex-situ** conservation methods with the advantage of each.