Classification & Biodiversity

A-Level Biology ▪ Topic 18

A-Level Biology

What we will cover

grouped by shared features

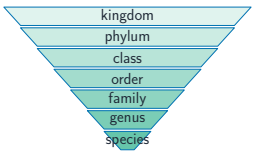
1 Classification

Species and the three domains

A **species** 种 is a group that can interbreed to give fertile offspring. The three **domains** 域 are Bacteria, Archaea and Eukarya – based on rRNA, not just cell type.

> Archaea look like bacteria under the microscope but are genetically closer to eukaryotes.

The taxonomic hierarchy



Smaller, more closely related groups:

kingdom → phylum → class → ··· → species

Eukarya's four kingdoms:
Protoctista 原生生物界,
Fungi 真菌界, **Plantae** 植物界,
Animalia 动物界.

2 Biodiversity

Biodiversity

Biodiversity 生物多样性 is measured at three levels:

- the range of **ecosystems** 生态系统 & **habitats** 栖息地
- the number of species & their **abundance** 丰度
- the genetic variation within a species

Sampling an area

Random sampling 随机取样 avoids bias:

- **quadrats** 样方 & **transects** 样带 – fixed plants
- **mark-release-recapture** 标志重捕法 – moving animals

Simpson's index 辛普森多样性指数 gives diversity as one number. Link a species' spread to **biotic** 生物因素 or **abiotic factors** 非生物因素 with a **correlation** 相关性 test – Spearman's rank or Pearson's.

quadrat
count species in a square

transect
record along a line

mark-recapture
mark some (red), release, then re-catch

3 Conservation

Conservation

two ways to conserve a species

in-situ (in the wild)	**ex-situ** (away from the wild)
national parks, marine reserves	zoos, botanic gardens, seed banks, frozen zoos

Species go **extinct** 灭绝 from climate change, hunting & habitat loss.

- **in-situ** 就地保护 – national & marine parks
- **ex-situ** 迁地保护 – zoos, **seed banks** 种子库

IUCN 世界自然保护联盟 lists threat; **CITES** 濒危物种贸易公约 controls trade.

Ways to conserve a species

in situ	protect the habitat – reserves, national parks, and legal protection for **endangered species** 濒危物种
ex situ	zoos, botanic gardens, and seed banks for plants
assisted reproduction	for rare mammals: **in vitro fertilisation** 体外受精, **embryo transfer** 胚胎移植, and surrogacy
why it helps	it raises numbers faster than natural breeding, and widens the gene pool by moving gametes rather than animals
invasive species 入侵物种	brought in from elsewhere, they out-compete natives – so control or removal is itself conservation
the limit	ex-situ populations lose genetic diversity and behaviours, so in situ is preferred wherever possible

A **coral reef** 珊瑚礁 is the standard example of high biodiversity: very many species sharing one small area, each in its own **niche** 生态位.

Worked example – the Lincoln index

60 snails marked; later 80 caught, 15 marked

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

The estimate is only as good as its assumptions, so state them:

- no births, deaths or migration between the two catches
- the marks stay on and do not harm the animal
- marked animals mix back in fully and are no easier to catch

Why conserve at all, and how

Other species give us food, medicines and materials, help keep ecosystems stable, and have value in themselves.

in situ 就地保护
protect them where they live: national parks, marine reserves, protected habitat

ex situ 迁地保护
move them somewhere safe: zoos, botanic gardens, seed banks, captive breeding

In situ keeps the species doing its job in the ecosystem; *ex situ* is the fallback when the habitat itself is gone.

Viruses sit outside the scheme

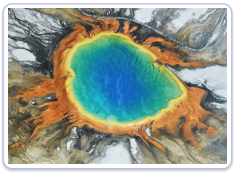
Viruses are not placed in any kingdom. They are classified instead by their **nucleic acid** 核酸:

DNA or RNA

single-stranded 单链 or double-stranded

They have no cells and cannot reproduce alone, so the usual test – can these two breed? – has nothing to work on.

The three domains



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

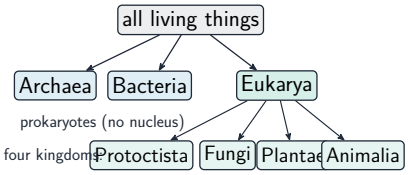
The three domains

Biodiversity, continued

ecosystem diversity → species diversity → genetic diversity (within a species)

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

The taxonomic hierarchy, continued



Archaea and Bacteria are prokaryotes; the Eukarya split into four kingdoms – **Protoctista** 原生生物界 (mostly single-celled, like *Amoeba*), **Fungi** 真菌界 (absorb their food, chitin cell walls), **Plantae** 植物界 (photosynthesise) and **Animalia** 动物界 (feed on other organisms).

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.

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.

4 Recap

Worked example – measuring biodiversity

Why can two woods with the same number of species have very different biodiversity?

- Species richness counts species but ignores how many of each there are.
- A wood where one species dominates is less diverse than one with even numbers.
- Simpson's index uses both richness and **evenness** 均匀度.
- $D = 1 - \sum(n/N)^2$, so higher D = more diverse.

Richness alone is not biodiversity – evenness matters too. Random sampling with quadrats avoids bias; a large N makes the estimate reliable.

Topic 18 – key takeaways

1. **Domains**
   Archaea, Bacteria, Eukarya
2. **Hierarchy**
   kingdom → phylum → ...→ species
3. **Biodiversity**
   ecosystems, species, genetic variation
4. **Conservation**
   in-situ vs ex-situ; IUCN & CITES

Check yourself

1. Name the three domains.
2. Which taxonomic level is the smallest?
3. Which method samples moving animals?
4. What does "in-situ" conservation mean?

Answers **1.** Archaea, Bacteria, Eukarya **2.** species **3.** mark-release-recapture **4.** protecting species in their own habitat