

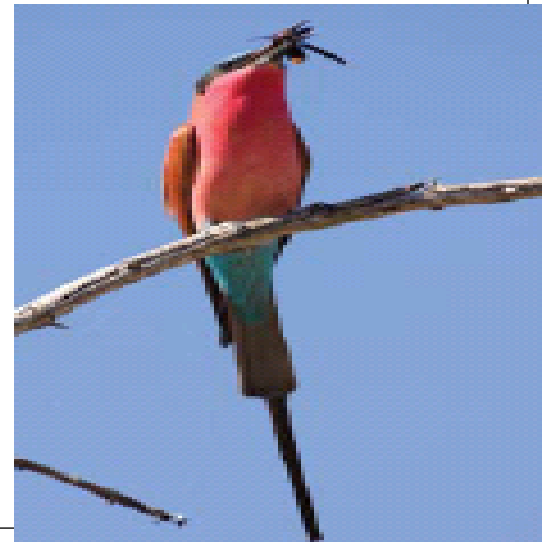
UNIT 2

ECOLOGY



Ecology?

- The branch of biological science that study the relationship between organisms and their environment as well as the relationship in between these organisms.



Why is it important that materials are recycled?

- Energy is continually lost as heat from the ecosystem and has to be replaced as light.
- Nutrients, however, are recycled.

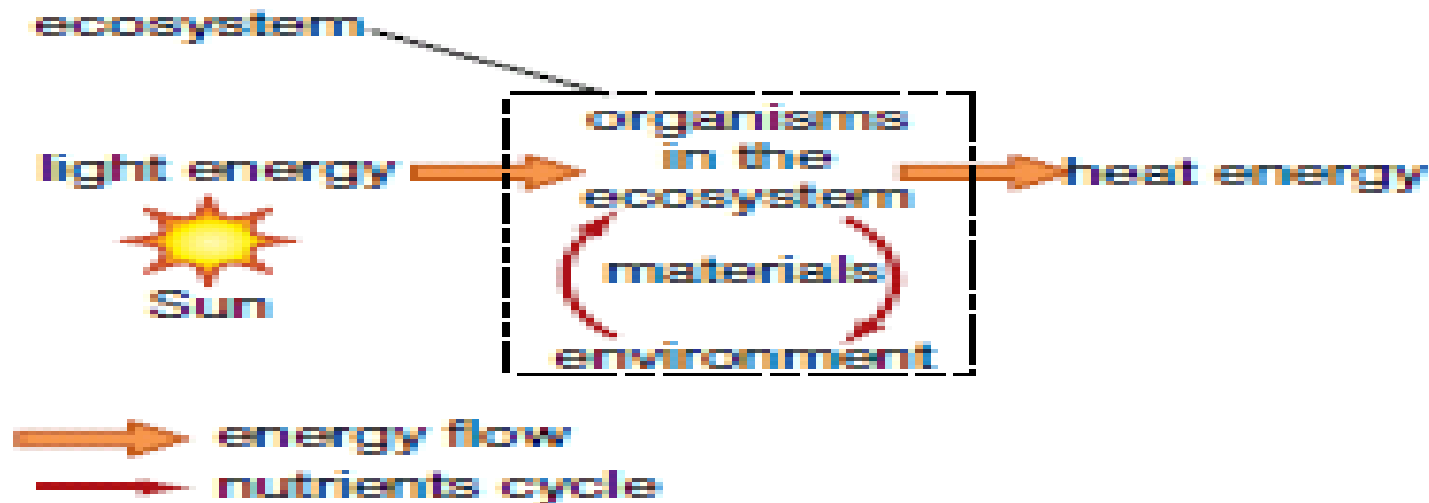
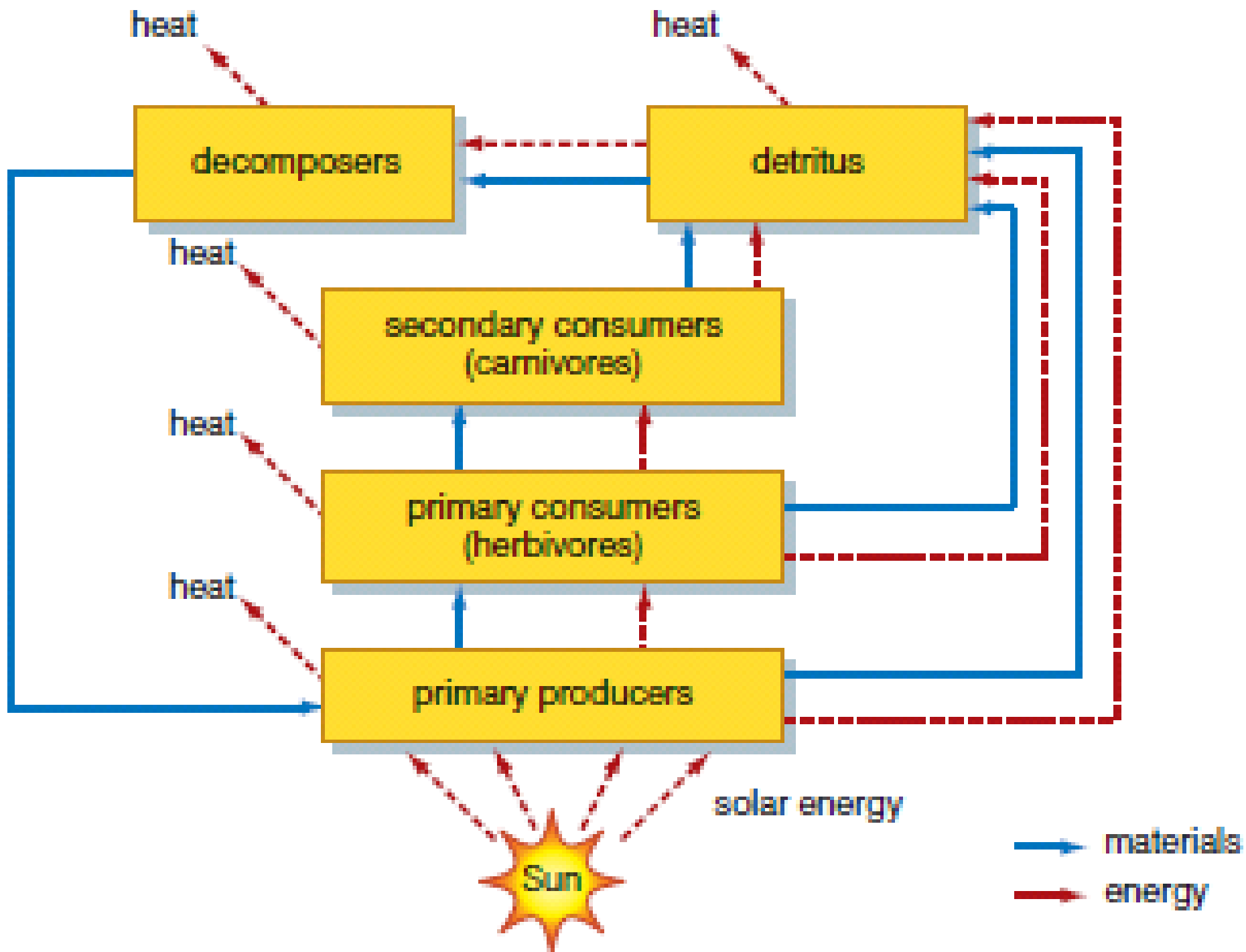


Figure 2.1 *The recycling of nutrients in an ecosystem.*

- There is a finite amount of each nutrient in an ecosystem and so the same atoms must constantly be re-used, over and over again.
- This happens at the ecosystem level and also globally.
- Ecosystems look unchanging, but they are in fact always changing.
- Materials are always being 'moved around' within an ecosystem.
- Nutrients are always being taken in by organisms and materials are lost when they breathe and excrete.

- What is a waste product to one organism becomes a vital nutrient to another.
- All the organisms in the ecosystem are interdependent and interact with their physical environment.
- Materials are moved around an ecosystem when organisms:
 1. Feed
 2. Excrete
 3. respire and breathe
 4. die and are decomposed

- The molecules that are moved around, particularly the organic molecules, store large amounts of energy in the bonds holding the atoms together.
- So, as materials are moved, energy is transferred also.
- The nutrients just keep on being recycled ...
- Decomposers (bacteria and fungi) are key in returning nutrients to the ecosystem.
- Important mineral elements such as **nitrogen** and **phosphorus** are returned to plants as a result of the action of decomposers.



- Decomposers feed by a method known as **saprobiotic** nutrition.
- Decomposers release many mineral elements, nitrogen, phosphorus and others from organic compounds in dead bodies.
- These are then absorbed from the soil by plants. However, carbon is released into the air as carbon dioxide when the decomposers respire - just as with all other organisms.
- Besides hydrolytic enzymes that break down complex organic molecules many micro-organisms have enzymes for other purposes.

- For example, many of the decomposers have an enzyme that releases the amino group from amino acids and converts it to ammonia.
- This is known as *ammonification* and is important in the nitrogen cycle.
- Ammonification is carried out by a range of bacteria and fungi as a way of obtaining energy from organic, nitrogen-containing compounds.



Figure 2.4 Fungi (moulds) decomposing bread using extracellular digestion

Main stages in the carbon cycle

- ❖ The main processes involved in cycling carbon through ecosystems are:
 - a) **photosynthesis** - the process that fixes carbon atoms from an inorganic source (carbon dioxide) into organic compounds (for example, glucose)
 - b) **feeding and assimilation** - feeding passes carbon atoms already in complex molecules to the next trophic level in the food chain where they are assimilated into (become part of) the body of that organism.

- C) **respiration** - this releases inorganic carbon dioxide from organic compounds
- D) **fossilisation** - sometimes living things do not decay fully when they die due to the conditions in the soil, and fossil fuels (for example, coal, oil and peat) are formed
- E) **combustion** - fossil fuels are burned, releasing carbon dioxide into the atmosphere

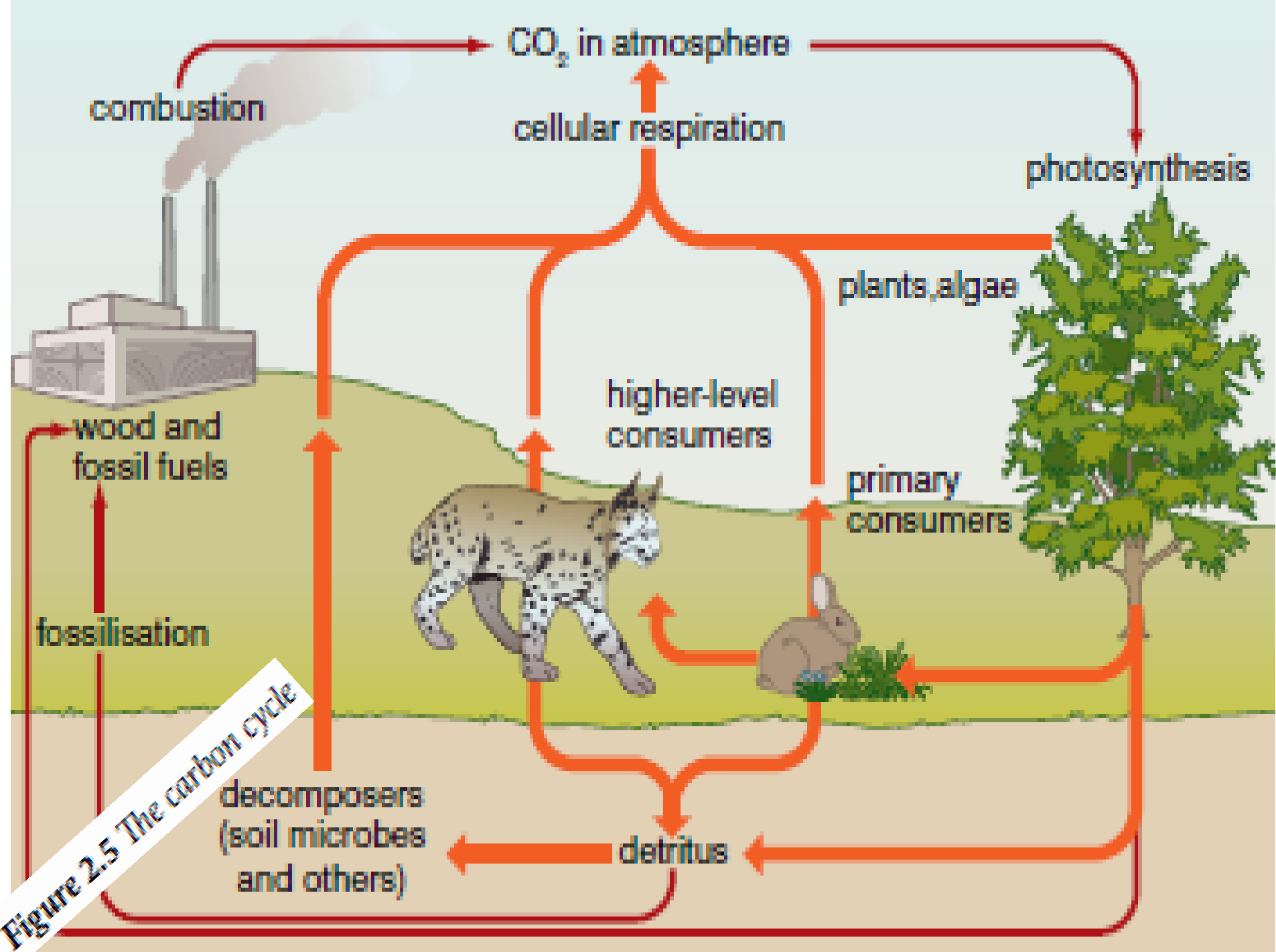


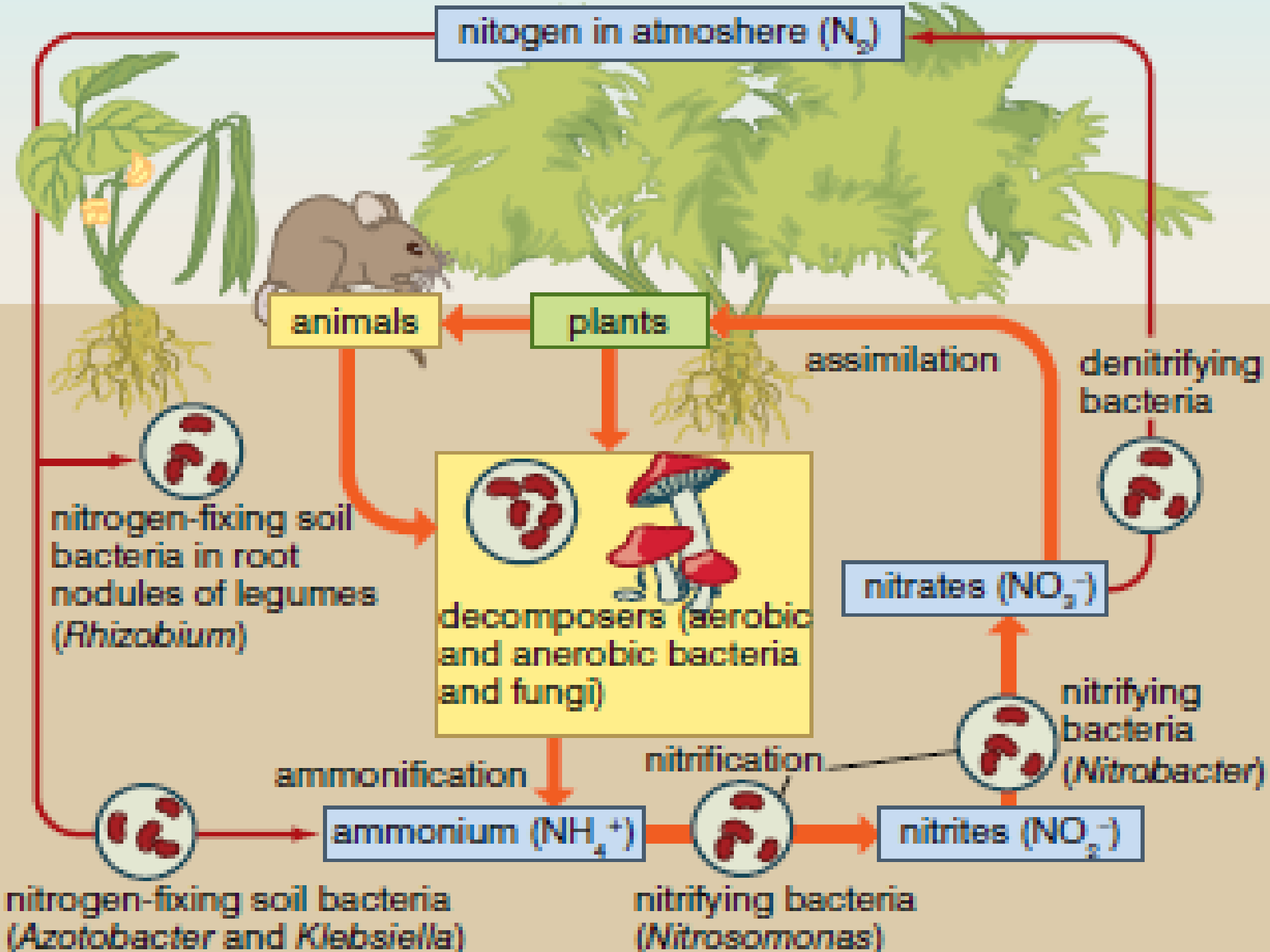
Figure 2.5 The carbon cycle

Main stages in the nitrogen cycle

- Nitrogen is present in proteins, amino acids, DNA, RNA (all kinds) and adenosine triphosphate (ATP) as well as ADP.
- Without nitrogen, organisms could not synthesise:
 - a) their genetic material (DNA)
 - b) their principal structural materials (proteins)
 - c) their principal energy transfer molecule (ATP)
- ❖ The main processes in the cycle are:
 - a. plants absorb nitrates from the soil
 - b. the nitrates are then used to form amino acids, which are used to synthesise proteins

- c . the plants are eaten by animals, the proteins digested and the amino acids absorbed and assimilated into animal proteins
- d. both plants and animals die, leaving a collection of dead materials (detritus) which contain the nitrogen still fixed in organic molecules; in addition, excretory products such as urea also contain nitrogen
- e. decomposers decay the excretory products and detritus, releasing ammonium ions (NH_4^+) into the soil; this process is often referred to as ammonification

f. nitrifying bacteria oxidise the ammonium ions to nitrates(NO_3^-) (which are taken up by the plants) in a process called **nitrification**; in this process there is an intermediate product called nitrite (NO_2^-)



- These processes recycle nitrogen that is already in biological molecules of one kind or another.
- But besides this, two other processes, *denitrification* and *nitrogen fixation*, decrease or increase, respectively, the amount of nitrogen in circulation.
- *Denitrifying bacteria* reduce nitrate to nitrogen gas that escapes from the soil.
- This decreases the total amount of nitrogen available to the plants, and, therefore, to all the other organisms also.

- Nitrogen-fixing bacteria 'fix' nitrogen gas into ammonium ions. This happens in two main situations:
 1. Nitrogen-fixing bacteria free in the soil (belonging to the genera *Azotobacter* and *Klebsiella*) reduce nitrogen gas into ammonium ions in the soil.
- These ammonium ions can be oxidised immediately into nitrates by nitrifying bacteria, adding to the amount of nitrogen available to the plants and, therefore, the other organisms also.

2. Nitrogen-fixing bacteria in nodules on the roots of legumes(belonging to the genus *Rhizobium*) form ammonium ions that are passed to the legumes and used by them to synthesise amino acids.

➤ The extra nitrogen only becomes available to other organisms when the legumes die and are decomposed.



Figure 2.7A Root nodules



Figure 2.7B The bacteria in a root nodule

How is phosphorus recycled?

- Phosphorus is present in organisms in the form of phosphates.
- a. phosphate is absorbed from the soil (or water) by plants
- b. these are passed along food chains to various herbivores and carnivores
- c. on death, their bodies are decomposed and phosphate ions are released from compounds like phospholipids, ATP, DNA and RNA and are returned to the soil or water

- d. phosphates also enter the soil (or water) as a result of the weathering of rocks and in the form of fertilisers, which, themselves, contain phosphates that have been obtained from rocks
- e. over millions of years, phosphate ions can leach into the seas and become part of newly forming sedimentary rock.

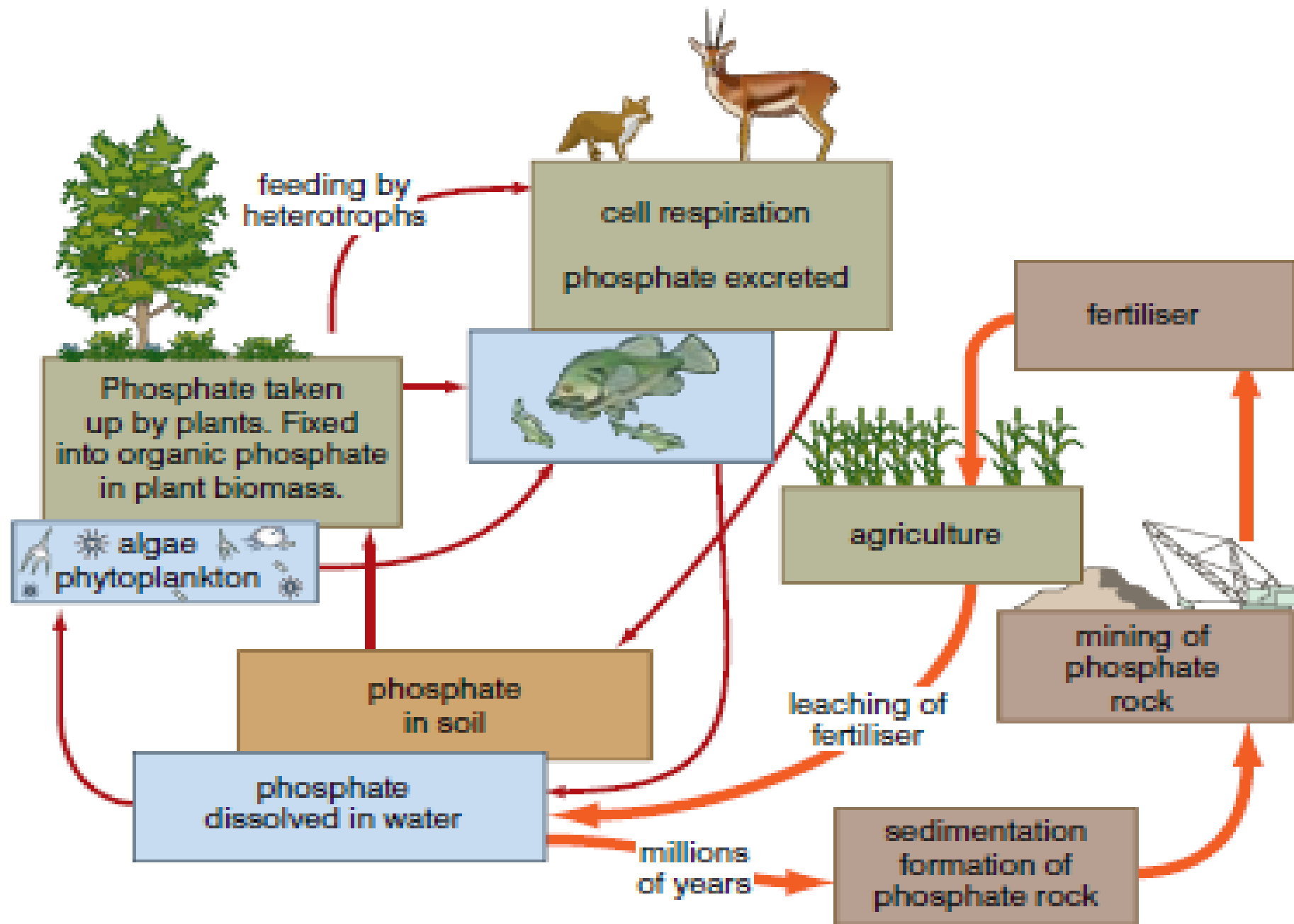


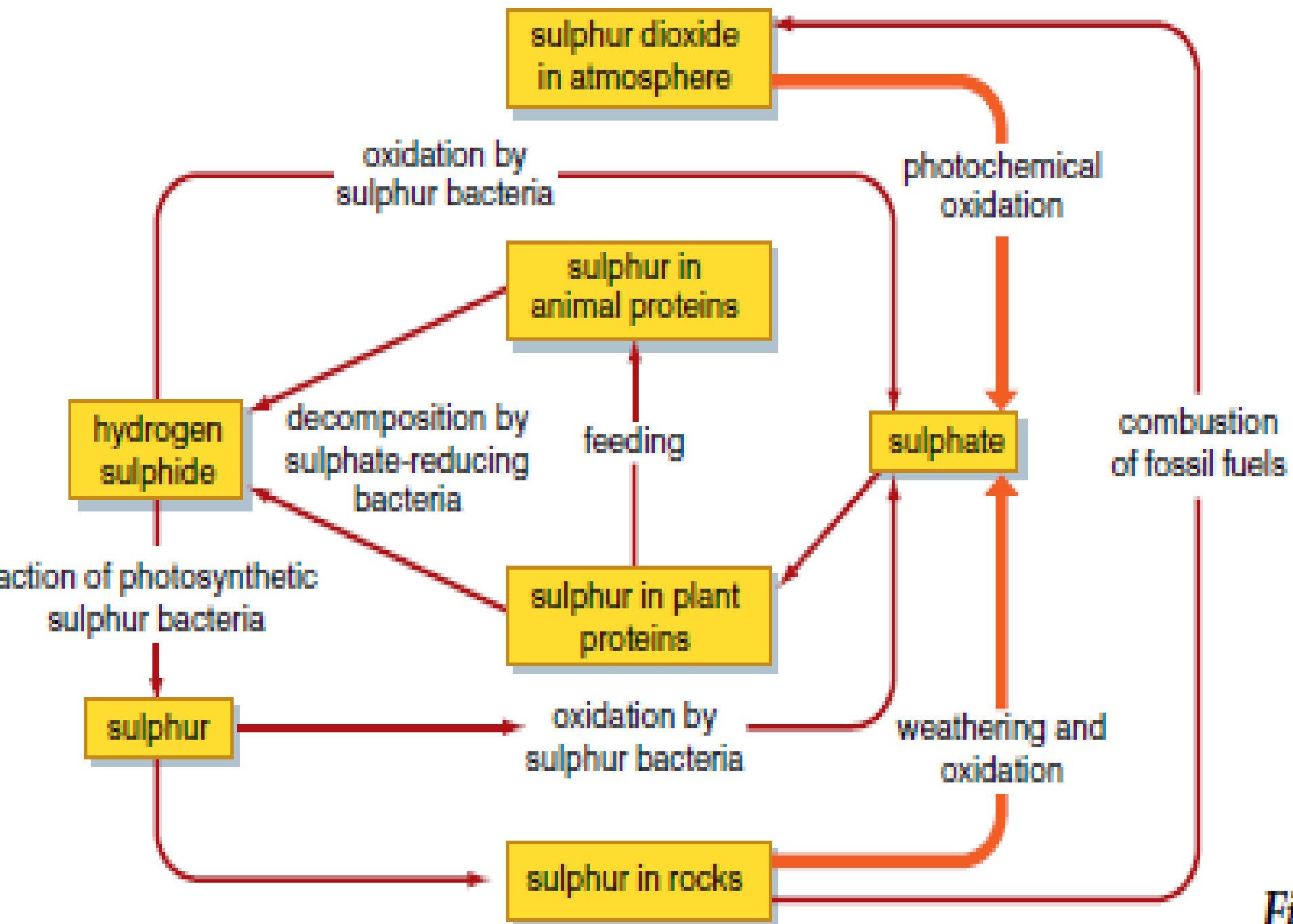
Figure 2.8 The phosphorus cycle

How is sulphur recycled?

- a. sulphate ions in the soil are taken up by plants and incorporated in plant tissue (many proteins include some sulphur-containing amino acids, such as methionine and cysteine)
- b. these are passed to animals by feeding and digestion
- c. on death of the plants and animals, sulphate-reducing bacteria release the sulphur in the proteins in the form of hydrogen sulphide (with the smell of 'bad eggs'); the most important genus of bacteria involved in this process is *Desulphovibrio*; this process requires anaerobic conditions

- d. in some aquatic environments the hydrogen sulphide is oxidised to sulphur by *photosynthetic sulphur bacteria*; this reaction is the equivalent of the photolysis of water in the photosynthesis of higher plants
- e. *sulphur bacteria*, mainly of the genus *Thiobacillus*, then oxidise the hydrogen sulphide (or sulphur) to sulphate (SO_4^{2-}), with sulphite (SO_3^{2-}) as an intermediate step; this is an oxygen-requiring process that needs aerobic conditions and makes sulphate ions available once again to be taken up by plant roots from the soil

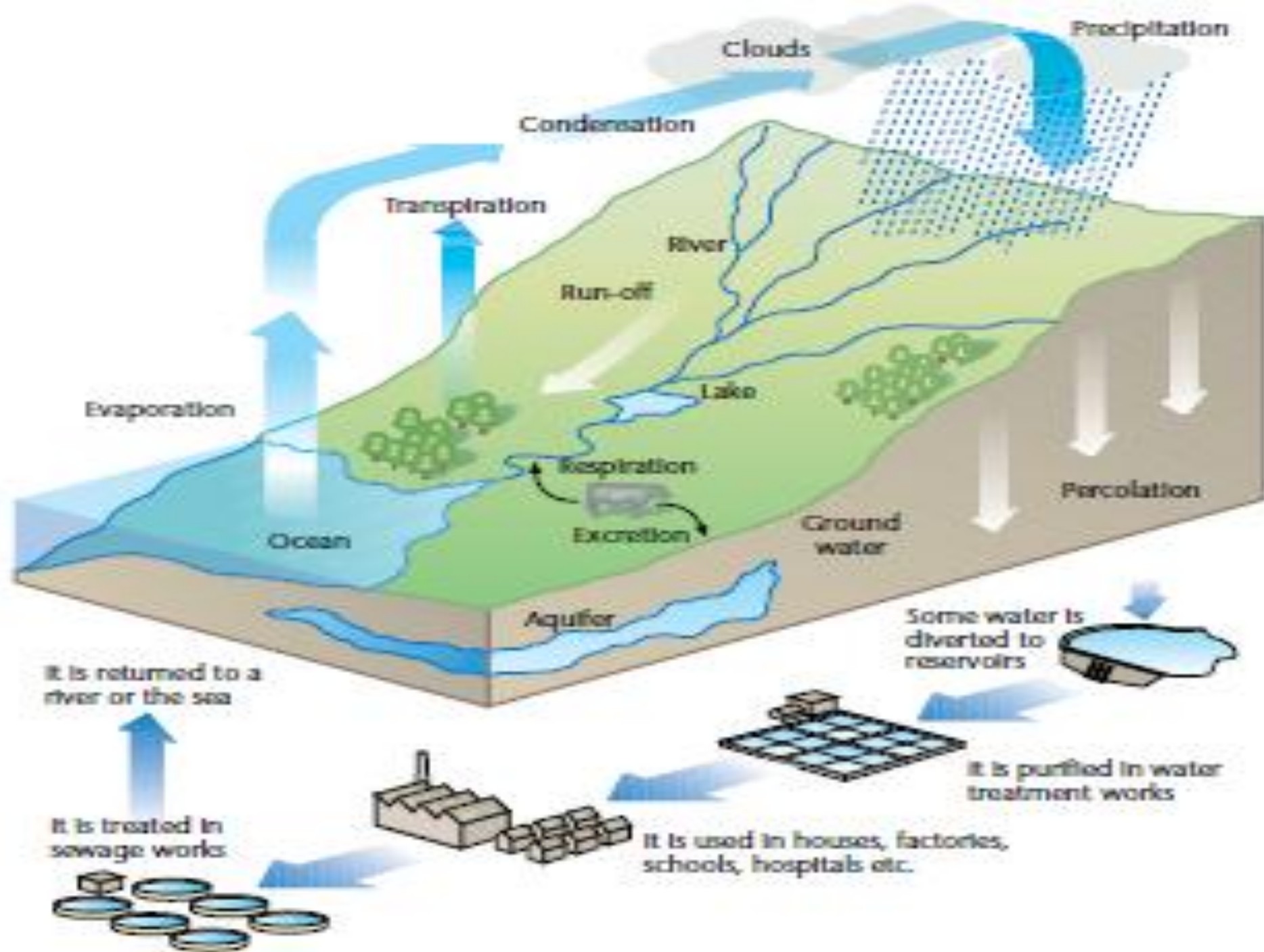
- f. sulphur can also become incorporated in rocks, including those that yield fossil fuels
- g. combustion of fossil fuels oxidises the sulphur to sulphur dioxide (SO_2); this is a serious pollutant of the atmosphere and a major contributor to the formation of acid rain
- h. in the atmosphere, the sulphur dioxide becomes further oxidised to sulphite and sulphate which dissolve in rainwater to form a mixture of sulphurous and sulphuric acid: acid rain



Water cycle

- ❖ Water is essential to all living organisms in all kinds of ways:
 - a) it makes up 70% of all cells
 - b) it is an essential requirement of photosynthesis
 - c) it is the basis of all transport systems in organisms
 - d) it provides a means of removing excretory products

- ✓ In addition, we use water in many ways in our daily lives:
 - A. to wash our clothes, our dirty dishes and our dirty selves
 - B. to flush away waste
 - C. to make products such as paper, steel and beer
 - D. to generate electricity using a range of devices that convert the motion of water into electrical energy
 - E. in a system, called 'hydroponics', to grow plants in a soil-free medium



2.2 Ecological succession

What is a succession?

- Succession —the replacement of one species by the others.
- They have developed from other previous systems by succession.
- Many of them began on completely bare ground.
- These extremely resilient organisms are able to colonize harsh environments and reproduce there. These are called **pioneer species**.



➤ The essence of succession are:

- a. Organisms colonise an area.
 - b. They change the abiotic (physical) conditions in the area.
 - c. The changed abiotic conditions allow other species to colonise the area.
 - d. The new species compete with the ones there before and become dominant.
 - e. They also then change the abiotic conditions, more species enter and the process continues.
- ✓ The various stages in a succession are called seres.
- ✓ Hydrosere & xerosere?

- As successive producers colonise the area, they create more and different habitats and niches for other organisms to occupy.
- As a consequence, succession usually involves an increase in the complexity of food webs.
- The final, most complex, state of a succession is the **climax community**

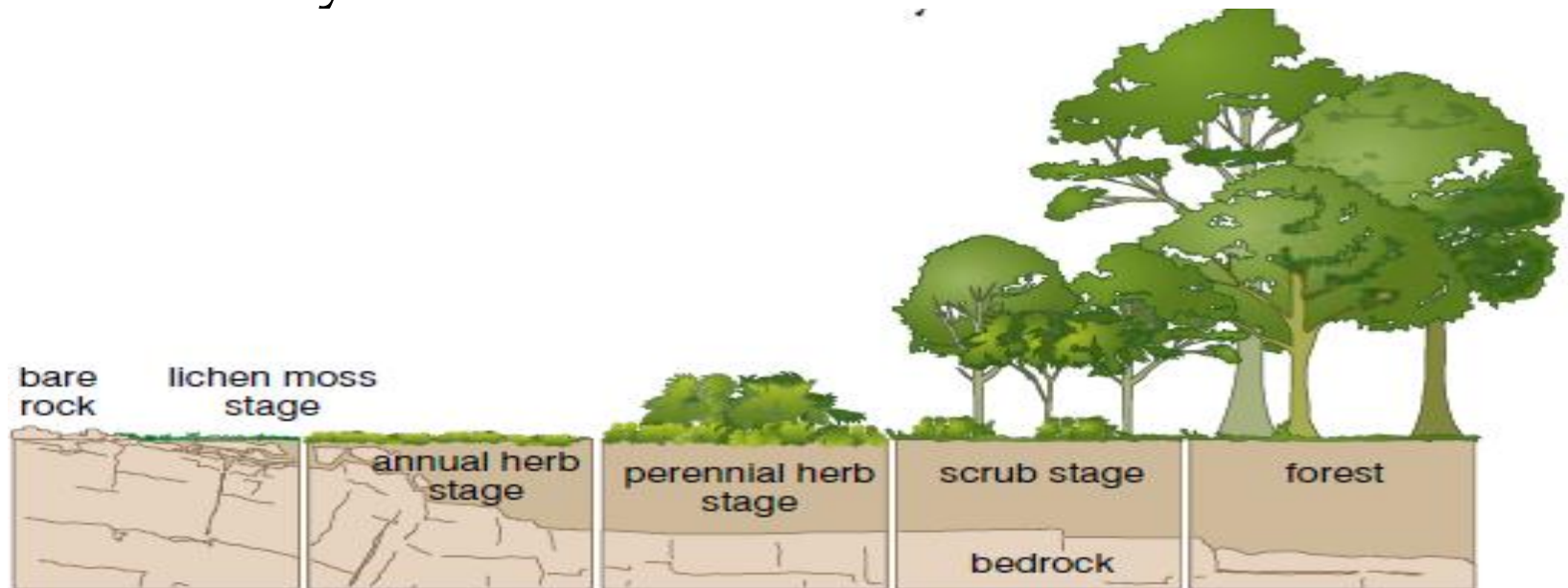


Figure 2.13 A succession from bare rock to a woodland climax

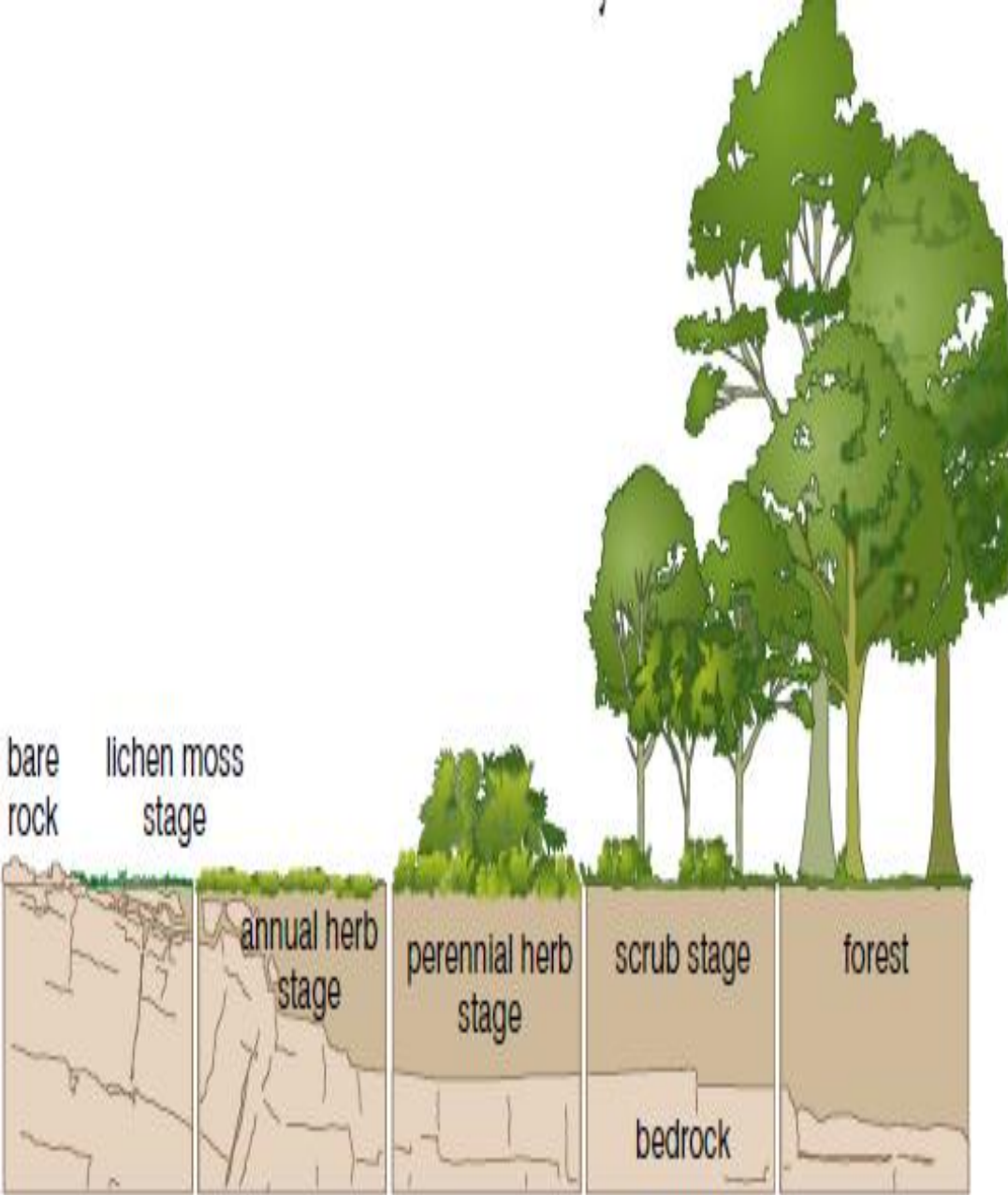


Figure 2.13 A succession from bare rock to a woodland climax

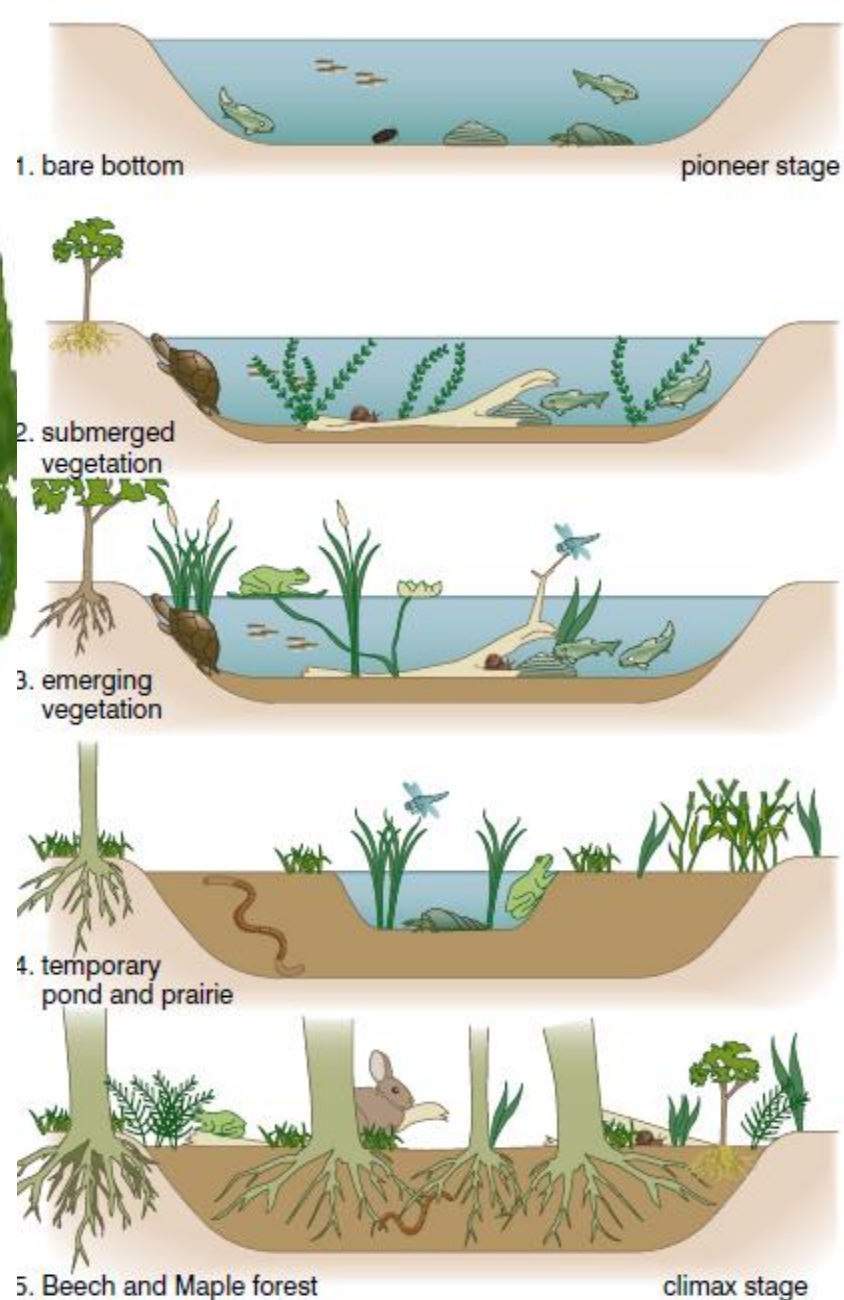
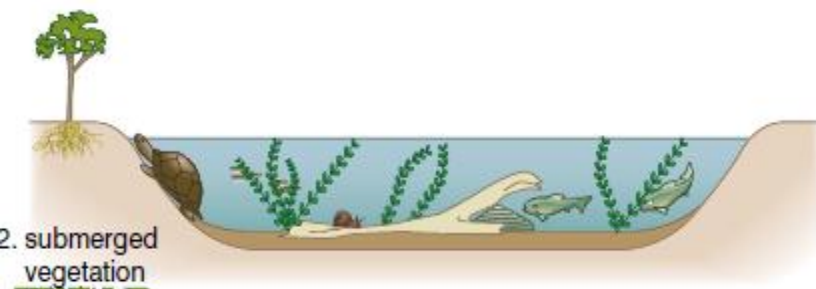


Figure 2.14 A succession from open water to woodland

- The increasing complexity of the plant community will create more and more ecological niches and so more animals will also enter the area.
- The species diversity will rise through the succession, until the climax is reached.
- The climax is the most complex community that can exist under the prevailing environmental conditions.

✓ The following trends occur in any succession:

- i. The total biomass of the community increases.
 - ii. The species diversity increases.
 - iii. The number of ecological niches increases.
 - iv. Food webs become more complex.
 - v. The community becomes more stable – can accommodate small changes/losses more easily.
- ✓ A woodland climax can arise through a totally different succession.
- ✓ A lake or pond can undergo a succession that results in the water being replaced by sediments allowing land plants to grow and giving rise to a succession that results in woodland.



Why do different areas have different climax communities?

- Forest climax communities in **Afar** do not become as complex as **Kafa** because of the climate.
- Because of this, they are said to be **climatic climax communities**
- Grassland in many areas would revert to woodland or forest if it were not grazed.
- The grazing animals nip off the growing points at the tips of young tree shoots, preventing them from growing

- Grasses grow from ground level, not from the tips of shoots, and so can regrow. These grasslands are grazing climaxes.
- Other factors that could influence the type of climax community formed include:
 - A. Temperature
 - B. precipitation (rainfall)
 - C. soil type
 - D. soil depth

- Where a succession starts from bare, previously uncolonised ground, or from a newly formed pond with no life, the succession is a **primary succession**.
- Sometimes, communities are destroyed by fire or by a farmer ploughing a field or by some other human intervention.
- When a new succession begins in such an area it is a **secondary succession**
- This may result in the same climax as was originally present or in a very different one.



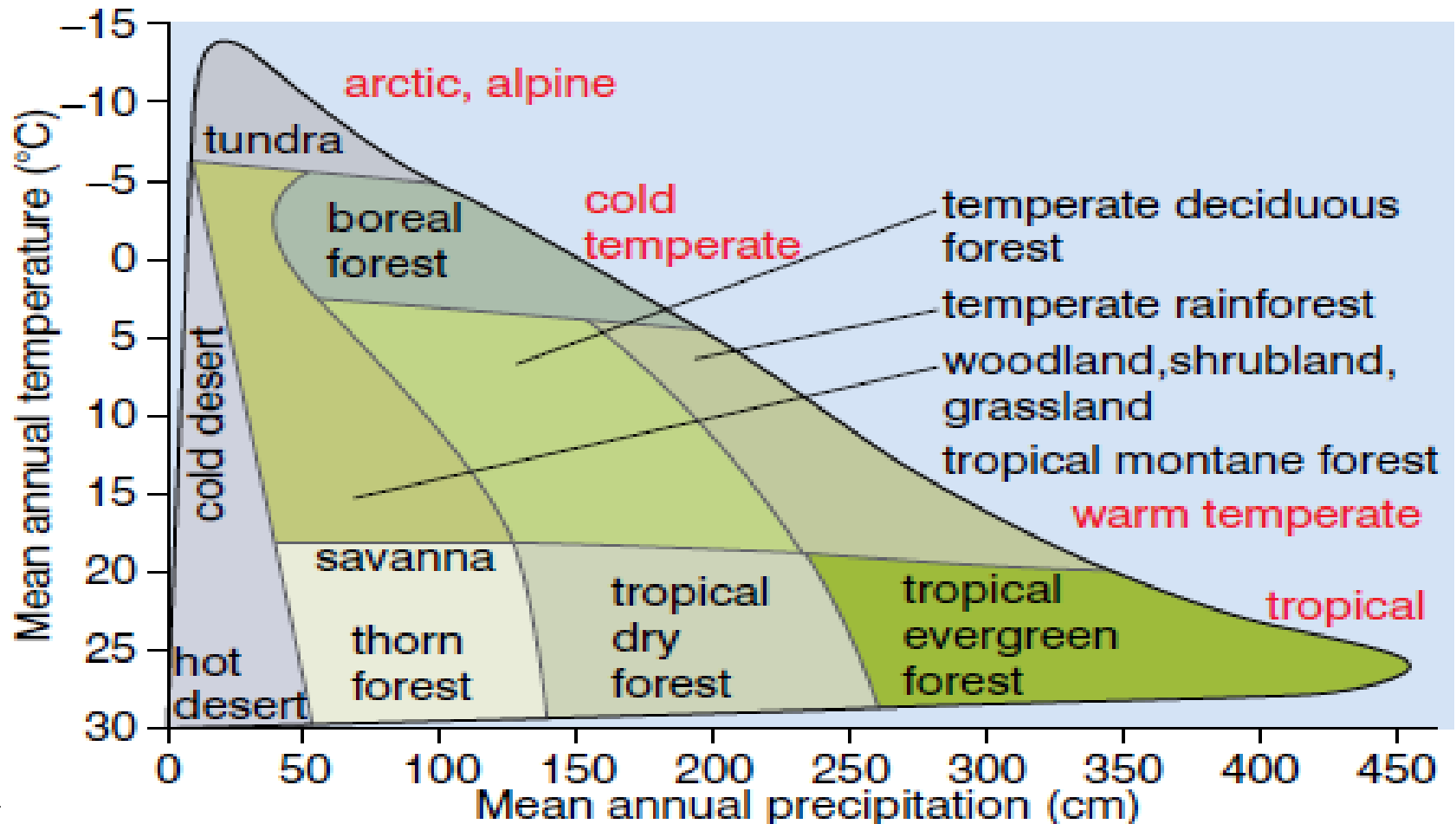
*photograph taken from Metehara area where volcano erupt before some hundred years ago —
primary succession ByYalew Mulissa*

- Secondary successions to the original climax are usually much quicker than primary successions because:
- a. the succession is not starting from bare rock/open water
 - b. there is a seed bank of many of the climax plant types available in remaining undamaged plants
 - c. the soil is already present

2.3 Biomes

- a climatically and geographically limited ecological area that consists of organisms that are adapted in similar ways.
- A biome is a geographical or regional area with:
 - i. a specific climate,
 - ii. a specific soil type, and
 - iii. specific animals and plants that are adapted in similar ways to the abiotic conditions within the area.
- Temperature and precipitation (rainfall) are the most significant climatic factors in determining biome type.

- ✓ **Biosphere** is all those parts of the Earth, including the Earth's crust, the seas and the atmosphere, where living organisms can be found
- ✓ **Biosphere** is divided into a number of **biomes**.



What types of biomes are there?

- There have been many classifications of the different biomes and scientists are still refining their ideas but we can classify the biomes into two main types:
 - A. Terrestrial - a biome consisting of an area of land
 - B. aquatic
- Each can then be further subdivided to give the distinct biomes.

Types of terrestrial biomes?

- A terrestrial biome is defined by temperature, rainfall, soil type, flora and fauna (plants and animals).

Biome	Precipitation	Temp.	Soil	Plants	Animals
Desert (hot)	Almost none	Hot	Poor	Sparse – succulents (like cactus), sage brush	Sparse – insects, arachnids, reptiles and birds
Desert (cold)	Almost none	Cold	Poor	Sparse – micro-organisms and some lichens	Sparse – polar bears, seals
Thorn forest (scrub)	Dry summer, rainy winter	Hot summer, cool winter	Poor	Shrubs, some woodland (like scrub oak)	Drought- and fire-adapted animals
Tundra	Dry	Cold	Permafrost (frozen soil)	Lichens and mosses	Migrating animals
Boreal forest (Taiga)	Adequate	Cool year-round	Poor, rocky soil	Conifers	Many mammals, birds, insects, arachnids, etc.
Temperate deciduous forest	Adequate	Cool season and warm season	Fertile soil	Deciduous trees	Many mammals, birds, reptiles, insects, etc.
Tropical montane forest	8–9 wet months, air always humid	Always warm	Fertile soil	Ferns, tree ferns, large deciduous trees, epiphytes	Many animals
Tropical rainforest	Very wet	Always warm	Poor, thin soil	Many plants, epiphytes common	Many animals





- There are several biomes to be found within Ethiopia.
- Wetter portions of the western highlands consist of tropical montane vegetation with dense, luxuriant forests and rich undergrowth.
- Drier sections at lower elevations of the western and eastern highlands contain tropical montane forest mixed with grassland.
- Temperate grasslands cover the higher altitudes of the western and eastern highlands.

- Tropical dry forest is found in the Rift Valley and eastern lowlands together with some dry grassland areas. Dry grassland also covers portions of the Denakil Plain.

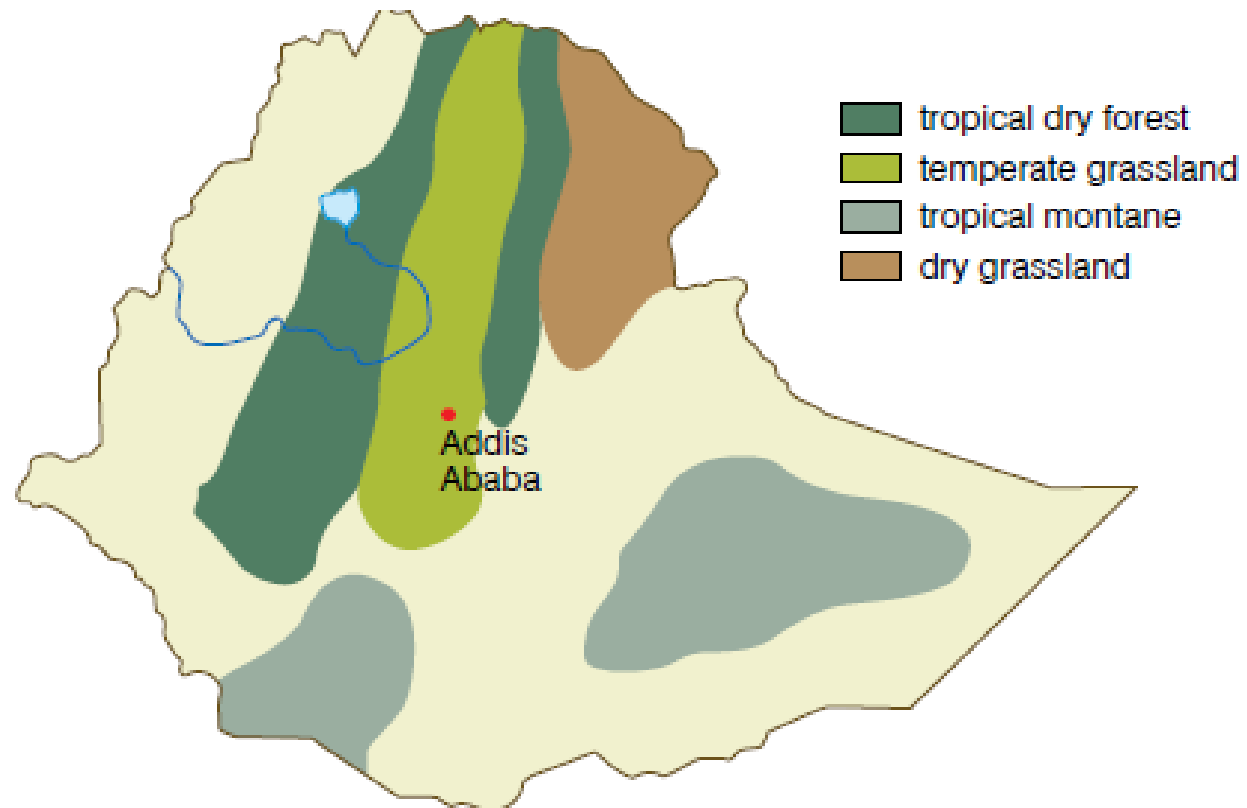


Figure 2.18 The main biomes in Ethiopia

What types of aquatic biomes are there?

- Aquatic biomes are subdivided into two main types:
 - a. marine biomes
 - b. freshwater biomes
- There are several biomes in each category

Table 2.2 *The main features of the aquatic biomes*

Biome	Salt content	Moving or standing	Other feature	Animals and plants
<i>Marine:</i>				
Oceanic, pelagic	High	Moving	The region of the ocean where light penetrates	Many fish, mammals and plankton
Oceanic, abyssal	High	Less movement	The region of the ocean where no light penetrates	Angler fish, sulphur bacteria at vents
Coral reef	High	Moving	Most diverse of all marine habitats. Has many strata like a rainforest.	Corals, many fish, many seaweeds
Estuarine	Intermediate	Extreme movement	Unique habitat due to mixing of saltwater and freshwater	Shore birds, fish, crabs, mangroves, kelps, sea grass
<i>Freshwater:</i>				
Ponds and lakes	Freshwater	Standing	Are stratified as top layer absorbs more heat and light	Large numbers of plankton, plants and animals in top layer
Streams and rivers	Freshwater	Moving	Water is highly oxygenated	Algae, plankton, plants and fish
Wetlands	Freshwater	Standing	Water is very nutrient rich	Many plants and animals – highest of all aquatic biomes

What is biodiversity?

➤ **Biodiversity** the extent to which an ecosystem contains different species.

the number of different species that are present in an ecosystem.

➤ Greater biodiversity makes an ecosystem less vulnerable.

➤ However, if only one or two individuals of a particular species are present in an ecosystem, they won't be contributing a great deal to the biodiversity of the ecosystem.

➤ An index of diversity can be calculated and this can be used to give a picture of the ecosystem as a whole.

- *index of diversity* is a number indicating an ecosystem's biodiversity.
- Here are 3 ecosystems. So to calculate index of diversity,

Species	Number of organisms of each species		
	Area 1	Area 2	Area 3
A	86	16	23
B	5	17	25
C	2	16	27
D	3	17	5
E	1	17	12
F	3	17	8

- One index of diversity is Simpson's index of diversity and is calculated from the formula:

$$d = \frac{N(N - 1)}{\sum n(n - 1)}$$

❖ In this formula,

- *d is the index of diversity,*
- *N is the total number of organisms in the area and*
- *n is the total number of organisms of each species.*

❖ **For area 1:**

$$d = (100 \times 99) / [(86 \times 85) + (5 \times 4) + (2 \times 1) + (3 \times 2) + (1 \times 0) + (3 \times 2)] = 1.348$$

❖ **For area 2:**

$$d = (100 \times 99) / [(16 \times 15) + (17 \times 16) + (16 \times 15) + (17 \times 16) + (17 \times 16) + (17 \times 16)] = 6.314$$

❖ **For area 3:**

$$d = (100 \times 99) / [(23 \times 22) + (25 \times 24) + (27 \times 26) + (5 \times 4) + (12 \times 11) + (8 \times 7)] = 4.911$$

➤ A low value for the index of diversity suggests an area dominated by one or just a few species.

- If there are more successful species with no species completely dominating the area, the value for the index of diversity will be higher.
- A low value for the index of diversity, suggesting only a few successful species, could be the result of a hostile environment with only a few organisms being really well adapted to that environment.
- Change in the environment would probably have quite serious effects.
- If those few species that can survive are seriously affected, then the whole ecosystem may be disrupted.



Figure 2.21 Tropical rainforest has a high species diversity



Figure 2.20 Lichens growing on bare rock

- Biodiversity isn't just about the numbers of different species and how well they are doing.
- It is also about the diverse ways in which these different species are found. So we must also consider:
 - a) the ecological diversity of each species - how many different ecological niches has it managed to colonise?
 - b) the genetic diversity of each species - is there just one strain of the species with essentially one set of genes (the gene pool) or are there several different (but related) gene pools because there are several different (but related) populations of the species living in different areas?

- So, biodiversity is a measure of the overall variability of life on the planet (or a local area) and it includes:
- a. the species richness and species diversity of the planet (or the local area)
 - b. the ecological variability of each species
 - c. the genetic variability of each species

How have humans influenced biodiversity?

- We humans have influenced our environment much more than any other species.
- The rate of this change has accelerated with the huge increase in our population and the development of our technology.
- We have reduced biodiversity in many ways, but two important activities have been:
 1. deforestation, and
 2. the impact of agriculture.



- Deforestation is usually carried out for one of two main reasons:
 - a. to clear land for human activities, such as mining, agriculture or house building, or
 - b. to obtain timber to make products such as paper, charcoal, furniture, or to use as a building material
- Tropical rainforest is one of the most complex and species-rich ecosystems in the world.
- Rainforest covers about 7% of the Earth's surface and contains 25% of the known species.

- Although many of the trees are very tall, the root systems are shallow and trees can easily fall.
- The shallow root systems grow in shallow, nutrient-poor soils.
- The soils are nutrient poor because many of the minerals from the soil remain 'locked up' in the huge trees.
- The only recycling of nutrients that occurs on a regular basis takes place when leaves fall.

- There is no accumulation of detritus as decomposers rapidly break down the leaves and release the mineral ions they contain.
- The roots take these up, leaving few mineral ions in the soil.
- As a result, when the forest is cleared for agriculture, crop yields are often poor after the first year and more forest must be cleared.
- Tropical rainforest is the most productive of natural land ecosystems

❖ Felling tropical rainforest has far-reaching effects.

1. There is a serious reduction in species diversity. Many ecological niches are destroyed when trees are felled and the species that fill these niches are lost. This reduces the biodiversity of the area.
2. There is a reduction in the rate at which carbon dioxide is removed from the atmosphere. In addition, if the trees are burned, then carbon dioxide is added to the atmosphere. The local and global cycling of carbon is therefore affected.

3. There is a reduction in the amount of nitrogen returned to the soil.
4. A secondary succession will take place. If the felled area is allowed to regenerate, then seeds of many species of plant from the shrub layer will germinate. Ordinarily, the shrub layer is limited because the canopy prevents much of the light from reaching lower levels.

Effects of agriculture on biodiversity

- The effects of large-scale agriculture often follow the same pattern.
- Large areas of land are given over to the production of just one crop plant, such as maize or another cereal.
- This inevitably brings a reduction in biodiversity for several reasons, including:
 - A. the area is dominated by just one species, drastically reducing the number of niches for other organisms to fill.

- B. organisms that might live there are regarded as pests, as they reduce the crop yield and so they are controlled by the use of pesticides, and
- C. hedgerows are removed to create bigger and more productive fields; this reduces still further the number of habitats and niches and, therefore, reduces the biodiversity of the area.

What is the status of biodiversity in Africa?

- Areas that have high plant species richness often also have high mammal species richness – and vice versa. The reason for this is not difficult to work out.
- The more different plants there are, the more different habitats and niches for animals (including mammals) there will be.

- There is one important exception. Parts of South Africa have a very high plant species richness, but do not have a correspondingly high mammal species richness.
- This is the Fynbos of South Africa.
- Fynbos has one of the highest concentrations of plant species anywhere in the world. But the plants grow on very nutrient poor soils. So there just isn't the protein in the plants to support a large number of mammals.
- Some other facts concerning African biodiversity include:

- A. a quarter (1229 species) of the world's approximately 4700 mammal species occur in Africa, including about 960 species in sub-Saharan Africa (SSA) and 137 species in Madagascar. The eastern and southern savannahs host large populations of mammals, including at least 79 species of antelope.
- B. more than a fifth of the approximately 10 000 bird species in the world are found in Africa; about 1600 bird species are endemic to SSA.

C. about 950 species of amphibians are found in Africa, making Africa (together with South America) the continent with the highest number of amphibians.

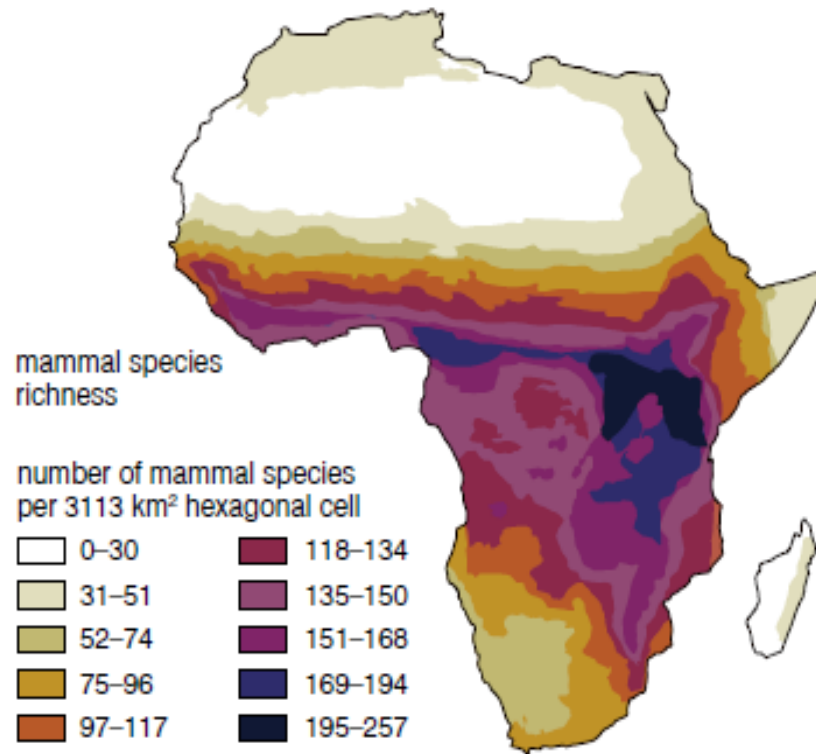


Figure 2.25A Mammal species richness in Africa

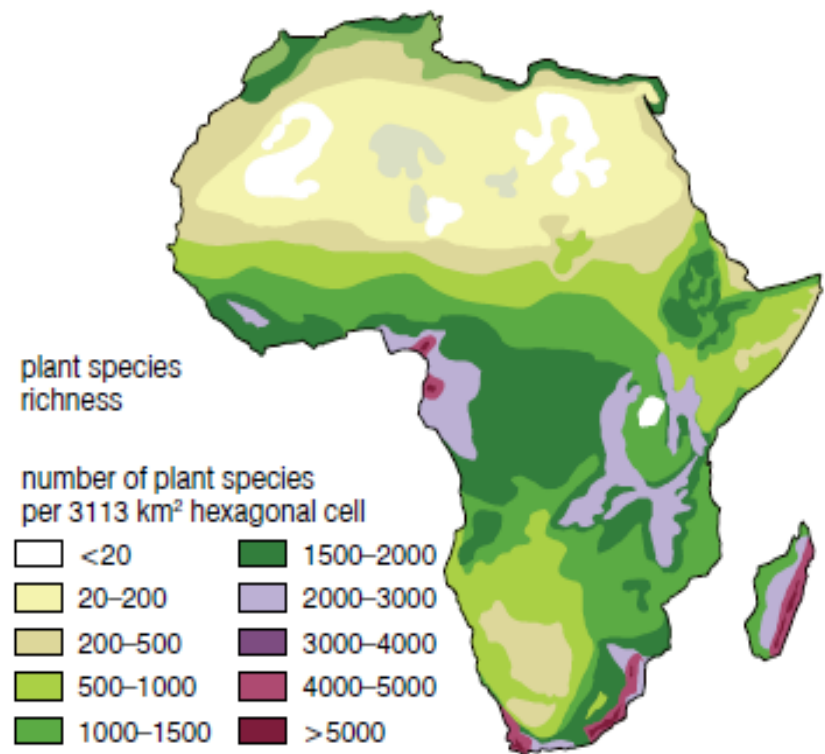


Figure 2.25B Plant species richness in Africa

Biodiversity in Ethiopia?

- Ethiopia is an important regional centre of biological diversity.
- The wide range in altitude and climate, the isolation of the highlands of Ethiopia, and the fact that there are so many different biomes present in the country, are some of the reasons for its high biodiversity.
- One estimate suggests that there are between 6500 and 6700 plant species in the country.
- This represents the fifth most diverse flora in Africa. About 10–12% of these plant species are endemic to Ethiopia (approximately 1150 plant species).

- Ethiopia is one of the 12 centres of origin (Vavilov centres) of cultivated crops.
- There are 11 cultivated crops, which have their centre of genetic diversity in Ethiopia. These are:

1. *Coffea arabica* — Coffee
2. *Eragrostis tef* — Tef
3. *Ensete ventriculatum* — Ensete
4. *Coccinia abyssinica* — Anchote
5. *Guizotia abyssinica* — Niger seed (Nug)
6. *Brassica carinata* — Ethiopian rape (Gomenzer)
7. *Carthamus tinctorius* — Safflower (Suf)
8. *Sorghum Spp.* — Sorghum
9. *Hordeum Spp.* — Barley
10. *Linum usitatissimum* — Linseed (Telba)
11. *Ricinus communis* — Castor bean (Gulo)



Figure 2.26 Different varieties of coffee in Ethiopia

- Ethiopia is also an important centre of genetic diversity of forage plants.
- About 46 legumes are endemic to Ethiopia.
- The high species richness creates many diverse ecological zones with many ecological niches for animals to fill.

Vertebrate group	Number of orders	Number of families	Number of genera	Number of species	Endemic to Ethiopia
Mammals	12	40	144	277	22
Birds	24	87	306	861	27
Reptiles	4	15	36	78	3
Amphibians	5	7	19	63	17
Fish	5	14	33	101	4

- In terms of the biodiversity of its avifauna (birds), Ethiopia is one of the most significant countries in mainland Africa.
- Again, Ethiopia's diverse ecology contributes to the tremendously diverse bird life.
- Over 861 species are found in Ethiopia.
- At present, 69 Important Bird Areas (which are also important for large numbers of other groups of animals) are identified by the Ethiopian Wildlife & Natural History Society (EWNHS).

- These include already existing protected areas and many other additional sites.
- Such protection is necessary as the diverse bird life of Ethiopia is threatened, along with the overall biodiversity of the country as a result of a number of practices.
- Some of the effects of these practices have been direct, others have been indirect.

Practices with direct effects on biodiversity

- a. **deforestation** – conversion of forests, woodlands and savannas to agricultural lands (for cultivation and grazing) and other land use systems reduce the area available to native species.
- b. **Fuel wood** collection and illegal logging.
- c. **overgrazing by stock animals** – reduces the availability of forage and woody plant species for other animals.
- d. **introduction of improved crop varieties** – reduce the genetic diversity of the particular crop plant as only the ‘improved’ variety is used.

- e. **overhunting (poaching)** – directly reduces the numbers of the species hunted
- f. **introduction of alien invasive species** – these often outcompete native species for the available resources, sometimes making native species locally extinct.

Prosopis glandulosa



Parthenium



Eucalyptus







Practices with indirect effects on biodiversity

1. **high population growth** – the more people there are, the bigger the demand for resources of all kinds, which puts pressure on land to be used for supporting humans, rather than other species.
2. **undervaluation of the biodiversity resources** – if biodiversity is not seen as important at all levels of government, then attempts to maintain biodiversity will not receive a high enough priority, this results in a lack of incentives for communities to conserve their local biodiversity.

3. **legal and institutional systems that promote unsustainable exploitation** – this results in big companies being able to make big profits from exploiting Ethiopian resources in a non sustainable way; the resources won't be there in the future as a result of these practices.
4. **disregard of traditional communal (range) land management systems** – traditional methods of land management conserved the species present and used them to support the community; these are at risk as more communities are encouraged to use more high-yielding, intensive practices.

Why is biodiversity loss a concern?

- In the years leading up to the millennium (2000) a global assessment of many aspects of biodiversity was made.
- It was called the Millennium Assessment (MA). The MA findings suggest that biodiversity loss contributes to:
 - a. worsening health
 - b. increasing insecurity of food supply
 - c. increasing vulnerability
 - d. lower material wealth
 - e. worsening social relations
 - f. less freedom for choice and action

Populations

- *A population is all the individuals of a particular species in a particular habitat at a particular time.*
- Populations are not static. Like ecosystems they are constantly changing.
- As the environment is modified (abiotic factors change) by plants present in an area, new species of plants colonise the area, establish themselves and outcompete the organisms that were there before and brought about the change.

Factors influencing population size

- There are three factors that directly affect numbers:
 1. natality – birth rate
 2. mortality – death rate
 3. migration – movement into (immigration) and out of (emigration) the area.
- Other factors influence mortality and natality.
- They influence how quickly a population increases in size or decreases in size.

- These factors can be divided into two main categories:
 - a. **biotic factors** – the effects of other organisms of the same species or of a different species.
 - b. **abiotic factors** – the effects of factors in the physical environment (light, temperature, carbon dioxide concentration, oxygen concentration, physical space, etc.)

➤ Some of the main biotic factors are:

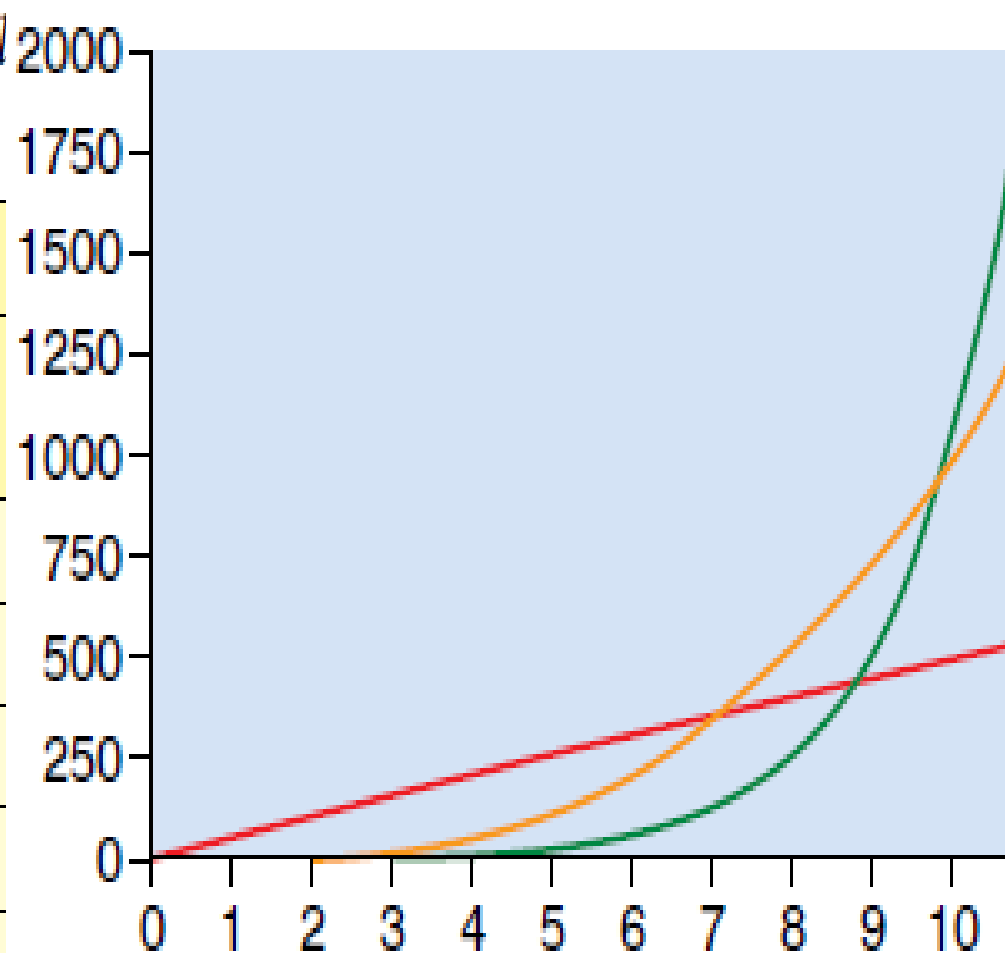
- a. **predation** – the presence of a carnivore (predator) or herbivore, in the case of plants.
- b. **disease** – infection by micro-organisms can reduce productivity and may be fatal.
- c. **intra-specific competition** – competition between members of the same species.
- d. **inter-specific competition** – competition between members of different species.

How do populations grow?

- All populations show the same pattern of growth.
 - After an initial 'establishing' phase, they show what is called exponential growth, until they are limited by the environment.
1. *Arithmetic growth*, the numbers increase by the same fixed amount in each time period.
 - This produces a uniform rate of growth over the time period.
 2. *exponential growth*, the population doubles in each time period, producing an ever increasing growth rate that is clearly not sustainable in nature.

Table 2.7 Arithmetic and exponential growth

Time period	Numbers in population	
	Arithmetic growth	Exponential growth
0	10	10
1	15	20
2	20	40
3	25	80
4	30	160
5	35	320
6	40	640
7	45	1280
8	50	2560



- Figure 2.38 shows populations increasing with:
- a slow rate of exponential growth (orange line)
 - a fast rate of exponential growth (green line)
 - arithmetic growth (red line)

- As a result of the combined influence of some or all of the biotic and abiotic factors, most populations develop through four main stages.

Table 2.8 The main phases of the growth curve

Phase	What is happening	Effect on population size
Lag	Population establishing itself; some organisms are not adapted to the environment and die, others reproduce.	Numbers remain low and static or increase slowly.
Log	All are adapted and reproduce rapidly due to plentiful resources.	Numbers increase rapidly.
Stationary	The carrying capacity is reached; the same numbers are dying as are produced in reproduction.	Numbers remain fairly constant; they fluctuate about a 'mean' level.
Decline	Nutrients exhausted, a new disease strikes or toxic excretory products accumulate.	Numbers decline rapidly.

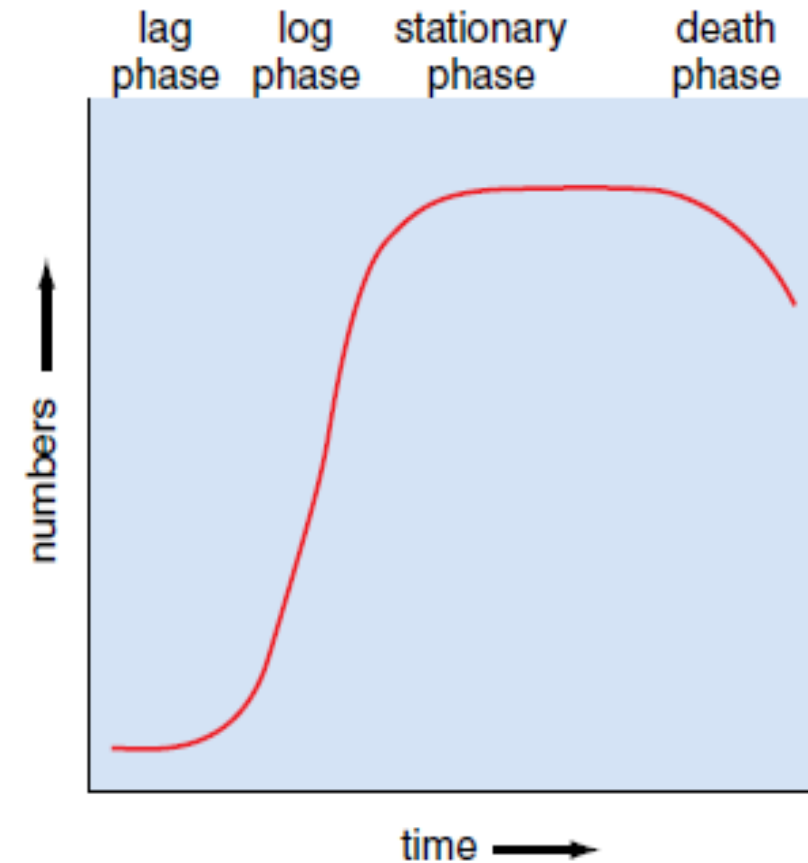


Figure 2.39 The main phases in a population growth curve

Human populations.

- We have come from a population of less than 5 million 10 000 years ago to a population of 6 800 000 000 (6.8 billion) at the end of 2009.
- The population has been increasing particularly quickly over the past two hundred years, because we have (generally) increased the quality and quantity of food available and we have decreased the impact of disease-causing organisms with improved sanitation and medical care.

- In countries with the highest population growth rates, the high growth rate is one factor in preventing or slowing development.
- The sheer weight of numbers makes it much more difficult to implement education programmes, health programmes, proper sanitation and all similar measures.
- ☞ **demographic transition** is a model that seeks to explain the transformation of countries from having *high birth* and *death rates* to *low birth* and *death rates*

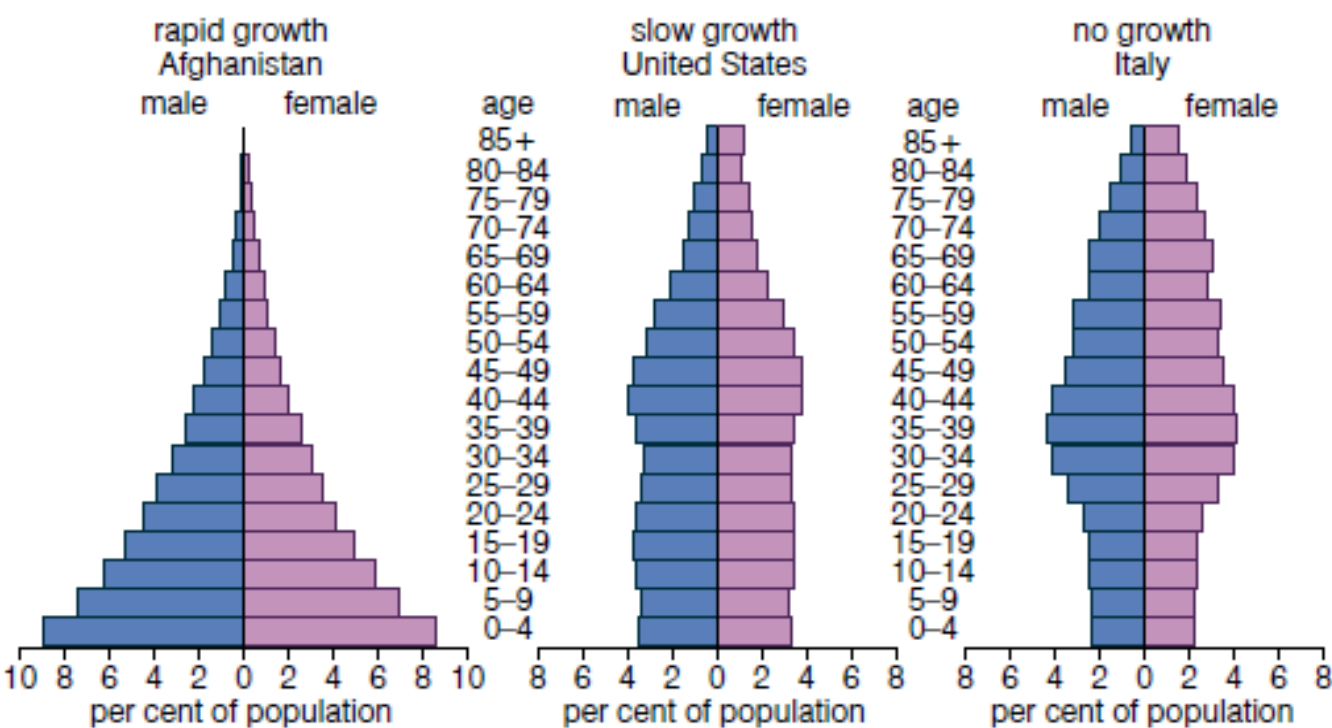


Figure 2.44 Age pyramids for Afghanistan, the USA and Italy

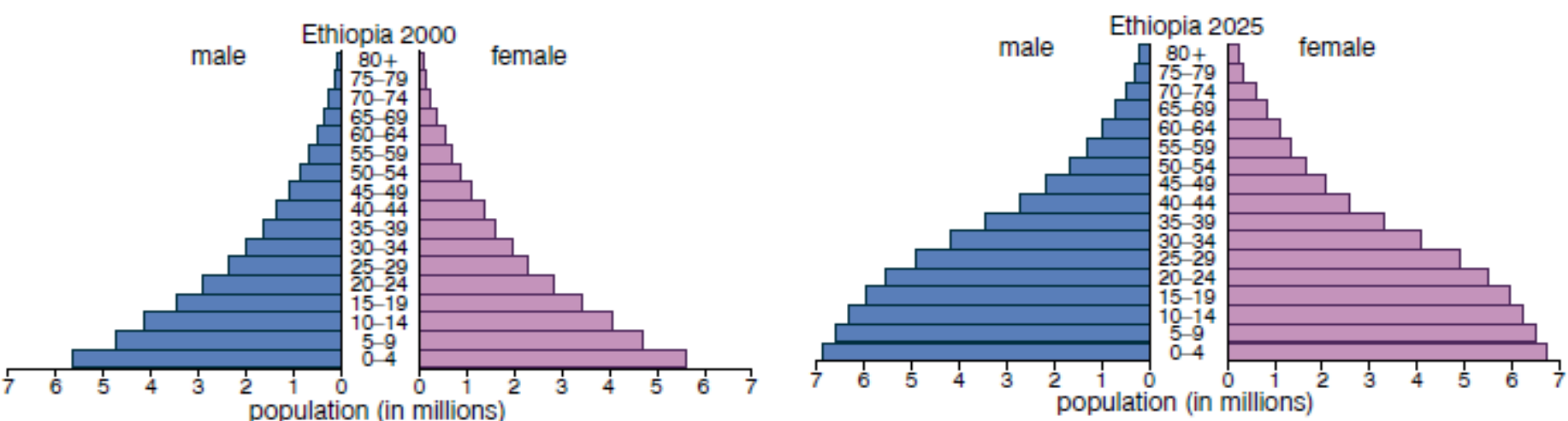


Figure 2.45A Ethiopia in 2000

Figure 2.45B Ethiopia in 2025

- Many countries now encourage some kind of population control.

Country	Way of reducing numbers born	Effect on population
China	In 1979 a policy was introduced which discouraged more than one child per family; an unwanted pregnancy is punished with a fine.	Population is still increasing but there has been a huge slowing of the rate of increase.
India	Only people with two or fewer children may serve in local government. Contraception has been introduced.	Population is still increasing, but rate of increase has been slowed.
Iran	Compulsory contraception courses for males and females before a marriage licence can be granted.	Rate of population increase has decreased from 4% in 1980 to 1.3% in 2008.
USA	Free contraception available as well as free sex education; priority is given to those who are poorest.	Population is stable and increasing only slightly.

How can we control?

- It is vital that the government makes available as many resources as possible to help local communities, particularly rural communities, with
 - a. sex education
 - b. access to contraception
 - c. general education to enable students to consider other options in their futures

- All of these will help in reducing the rapid population growth rate.
- In addition, help with the following will improve general health, which is usually associated with lower reproduction rates:
 - a. education about diet
 - b. resources to improve the quantity and quality of crops grown

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Xumureera

End of Unit 2



Ayyaana gaarii

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HAPPY

CHRISTMAS

Yalew M.