Chapter 21 – Ecology

Subject content:

Content

- Energy Flow
- Food Chains and Food Webs
- Carbon Cycle
- Effects of Man on the Ecosystem
- Environmental Biotechnology
- Conservation

Learning outcomes

- briefly describe the non-cyclical nature of energy flow
- explain the terms producer, consumer and trophic level in the context of food chains and food webs
- explain how energy losses occur along food chains, and discuss the efficiency of energy transfer between trophic levels
- describe and interpret pyramids of numbers and biomass
- describe how carbon is cycled within an ecosystem and outline the role of forests and oceans as carbon sinks
- evaluate the effects of
  - water pollution by sewage and by inorganic waste
  - pollution due to insecticides including bioaccumulation up food chains and impact on top carnivores
- outline the roles of microorganisms in sewage treatment as an example of environmental biotechnology
- discuss reasons for conservation of species with reference to the maintenance of biodiversity and how this is done, e.g. management of fisheries and management of timber production

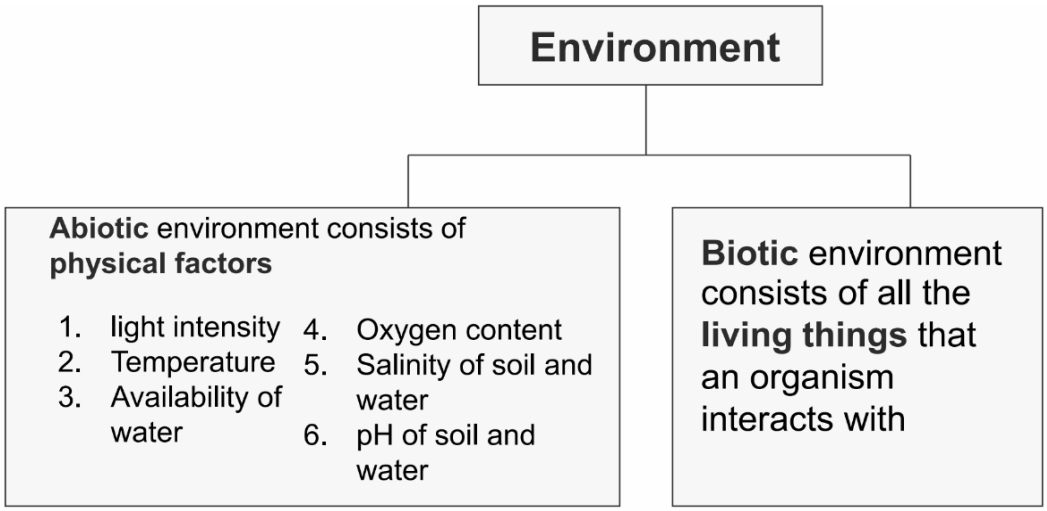
Use the knowledge gained in this section in new situations or to solve related problems.

Definitions

Term	Definition
Ecology	Interactions among organisms with one another + envt
Habitat	Place where organism lives + carries out activities
Population	Group of organisms of same species that live together in habitat
Community	Diff <u>populations</u> live with in same habitat
Ecosystem	<u>Community</u> of living organisms interacting with abiotic envt Self-supporting unit which has 1. constant energy source 2. food producers 3. food consumers 4. decomposers
Biosphere	Sum of all <u>ecosystems</u>
Producer	Carry out photosynthesis by using chlorophyll to absorb light energy and produce glucose in presence of carbon dioxide and water. Light energy is converted to chemical energy and stored in glucose molecules.
Consumer	Feed on other organisms to obtain energy in form of organic molecules
Decomposer	Break down organic matter from dead plants and animals into simpler substances
Food chain	Series of organisms through which energy is transferred in the form of food
Food web	Two or more food chains interlinked together
Trophic level	Position that organism occupies in food chain
Carbon sink	Nnatural or artificial reservoir that accumulates + stores carbon-containing chemical compound for indefinite period Stores more carbon than it releases into envt
Eutrophication	Water receives excess nutrients e.g. phosphates and nitrates, causing excessive growth of algae and water plants

21.1 Environment

Population → community → ecosystem → biosphere



21.2 Energy and Nutrient Flow

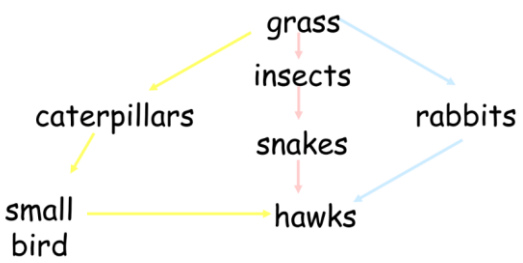
Type	Explanation	Examples
1. **Producer**	• Convert light energy from Sun → chemical energy in food • All food chains start with producers	Green plants Green algae
2. **Consumer**	• Obtain energy + nutrients by feeding • Types 1) Primary (herbivore) 2) Secondary (carnivore) 3) Tertiary (carnivore)	Animals
3. **Decomposer**	• Obtain energy by breaking down dead organisms, faeces, excretory products • Decomposition process: release inorganic nutrients (e.g. carbon, nitrogen) for nutrient cycling	Bacteria Fungi Earthworm

Food chain & food web

Food chain

grasses → grasshoppers → lizards → snakes

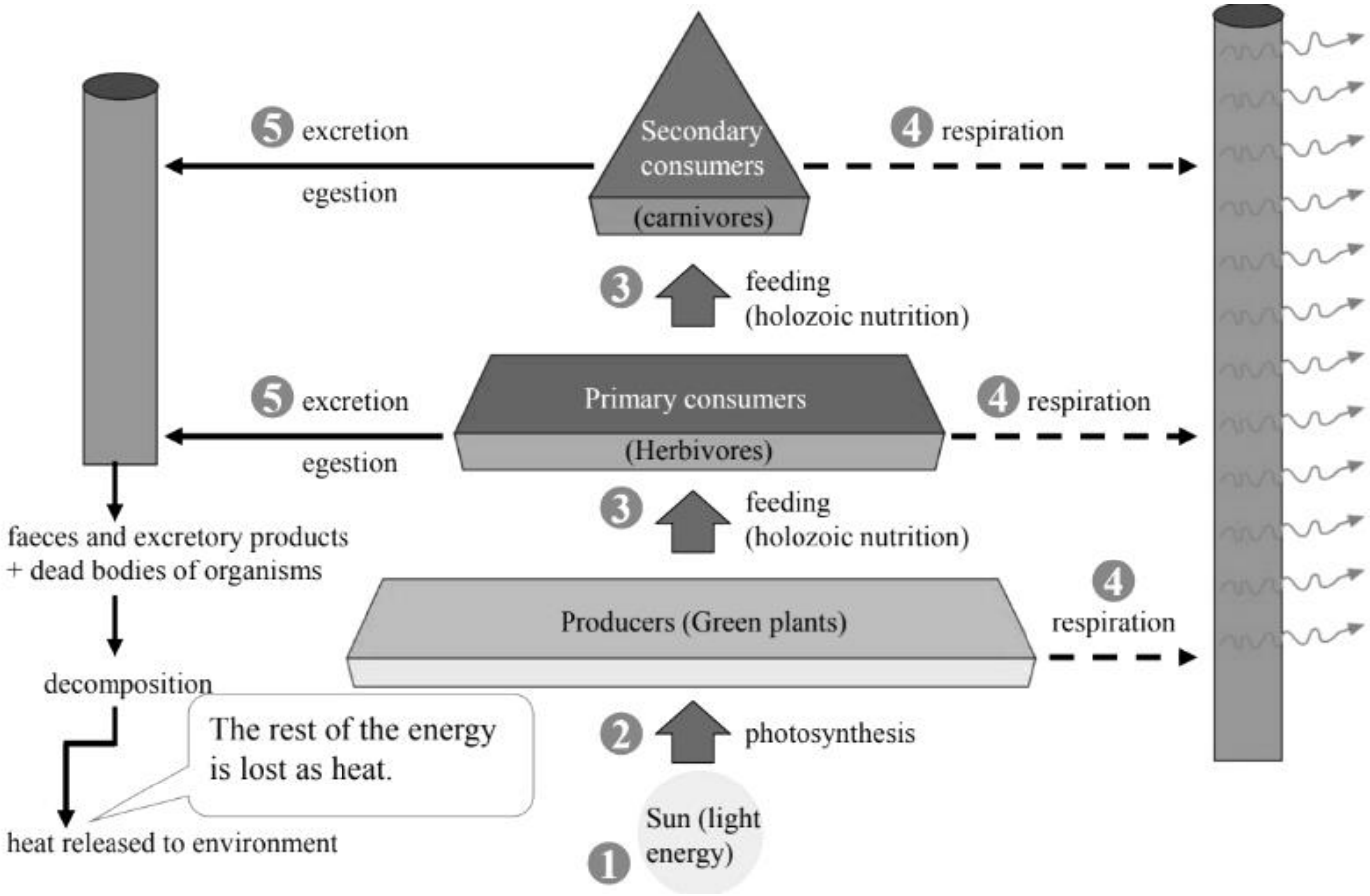
Food web



Short food chain: <u>more efficient</u> in energy transfer

- Large amt of energy (90%) lost at every trophic level
- Very small percentage of energy available in producers transferred to consumers → unable to support large no. of tertiary consumers

<u>Non-cyclic energy flow</u>



Energy flow

1. Sun: main energy source in ecosystem
2. Producer: convert light energy → chemical energy via photosynthesis
3. Energy in producers is passed from one trophic level to another via feeding

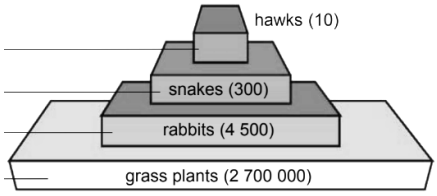
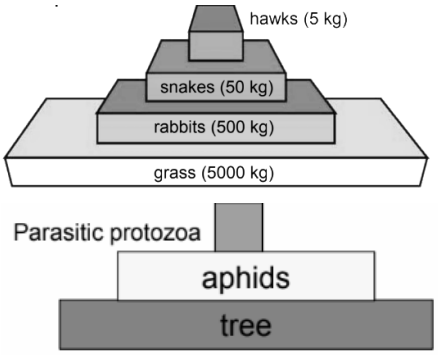
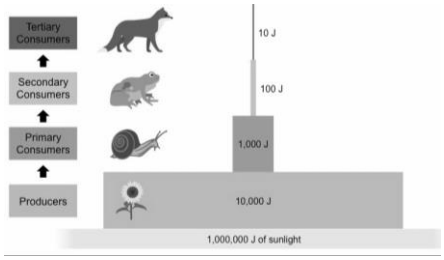
Energy loss

1. through respiration as heat
2. excretion and defecation
3. used for movement and transport
4. sunlight reflected off leaves instead of being used for photosynthesis

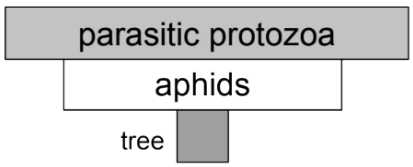
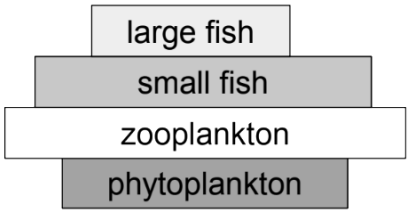
21.3 Ecological Pyramids

Types

1. **Pyramid of numbers**
2. **Pyramid of biomass**
3. **Pyramid of energy**

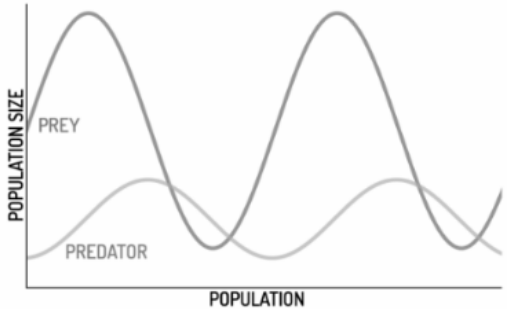
Numbers	Biomass	Energy
Compare <u>number</u> of organisms in each trophic level at a particular time	Compare <u>dry mass</u> of organisms in each trophic level at a particular time	Compare <u>total energy</u> in each trophic level over certain period of time
		

Exceptions:

<u>Inverted</u> pyramid of numbers	<u>Oddly-shaped</u> pyramid of biomass
● organisms are parasitic on organisms of another trophic level ● many small organisms feed on a large organism	● organism has high reproductive rate (e.g. phytoplankton > zooplankton, rate of reproduction is fast enough to replace those that were eaten)
	

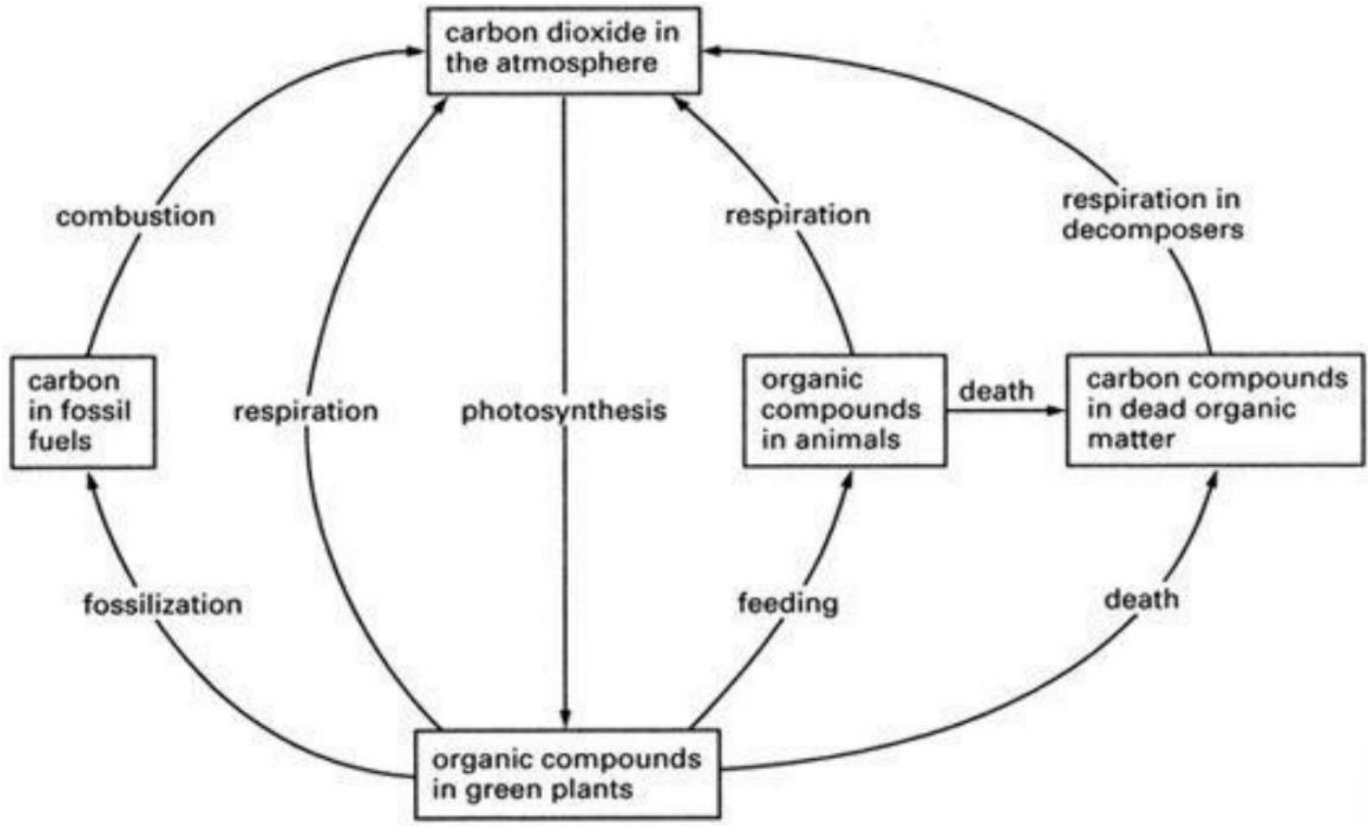
<u>Predator-prey relationship</u>

Prey population increase → predator population increase → decrease prey population



21.4 Nutrient Cycling

Carbon cycle



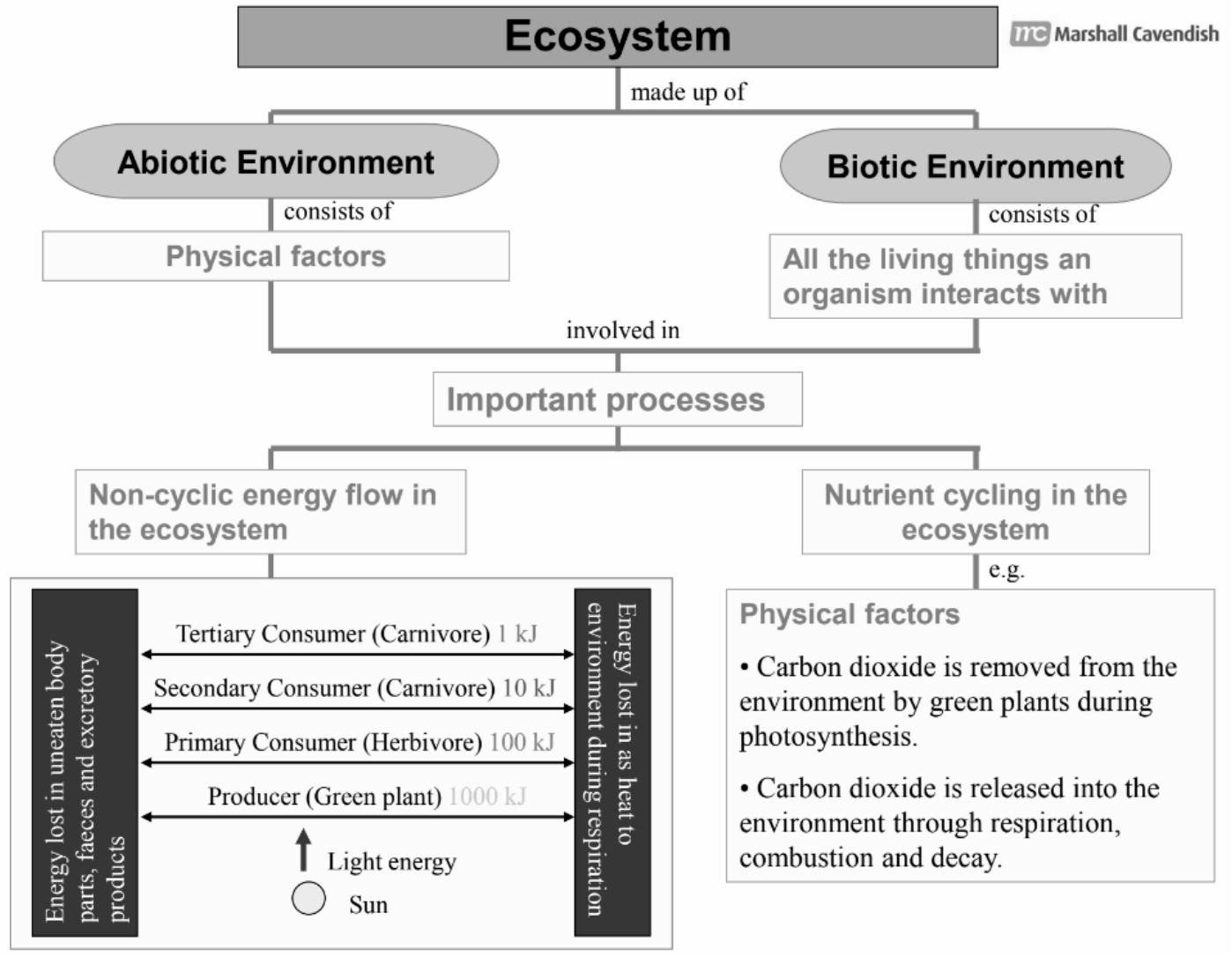
Remove CO_2	Release CO_2
1. Photosynthesis ● green plants: absorb CO_2 to synthesise glucose ● some glucose converted into proteins and fats **2. Feeding** ● animals: obtain C compounds by feeding on plants / other animals	**1. Respiration** ● plants and animals: oxidise glucose → release CO_2 **2. Decomposition** ● decomposers: break down dead organic matter → release CO_2 **3. Combustion** ● fossil fuels: C compounds in dead bodies of organisms ● combust fossil fuels → release CO_2

Imporance of carbon cycle:

1. Maintains <u>conc of carbon dioxide</u> in atm
2. Ensure continuous supply of carbon dioxide for <u>plants</u> to photosynthesise + <u>animals</u> feed on organic products of photosynthesis for energy & nutrients
3. <u>Energy</u> stored in carbon compounds formed from photosynthesis can flow from one organism to another through food chains in ecosystem

Carbon sink

Ocean	Forest
1. Phytoplankton photosynthesise using dissolved carbon dioxide + other elements to synthesise carbohydrates, lipids, proteins 2. Plankton combine calcium + dissolved carbonates → calcium carbonate protective coating 3. Carbon compounds buried in seabed → fossil fuels e.g. natural gas & oil	1. Green plants photosynthesise by absorbing atmospheric carbon dioxide 2. Carbon compounds stored in trees 3. Carbon stored in soil as dead organic matter 4. Remains of dead trees buried deep under ground + under high pressure and over millions of years → coal (fossil fuel)

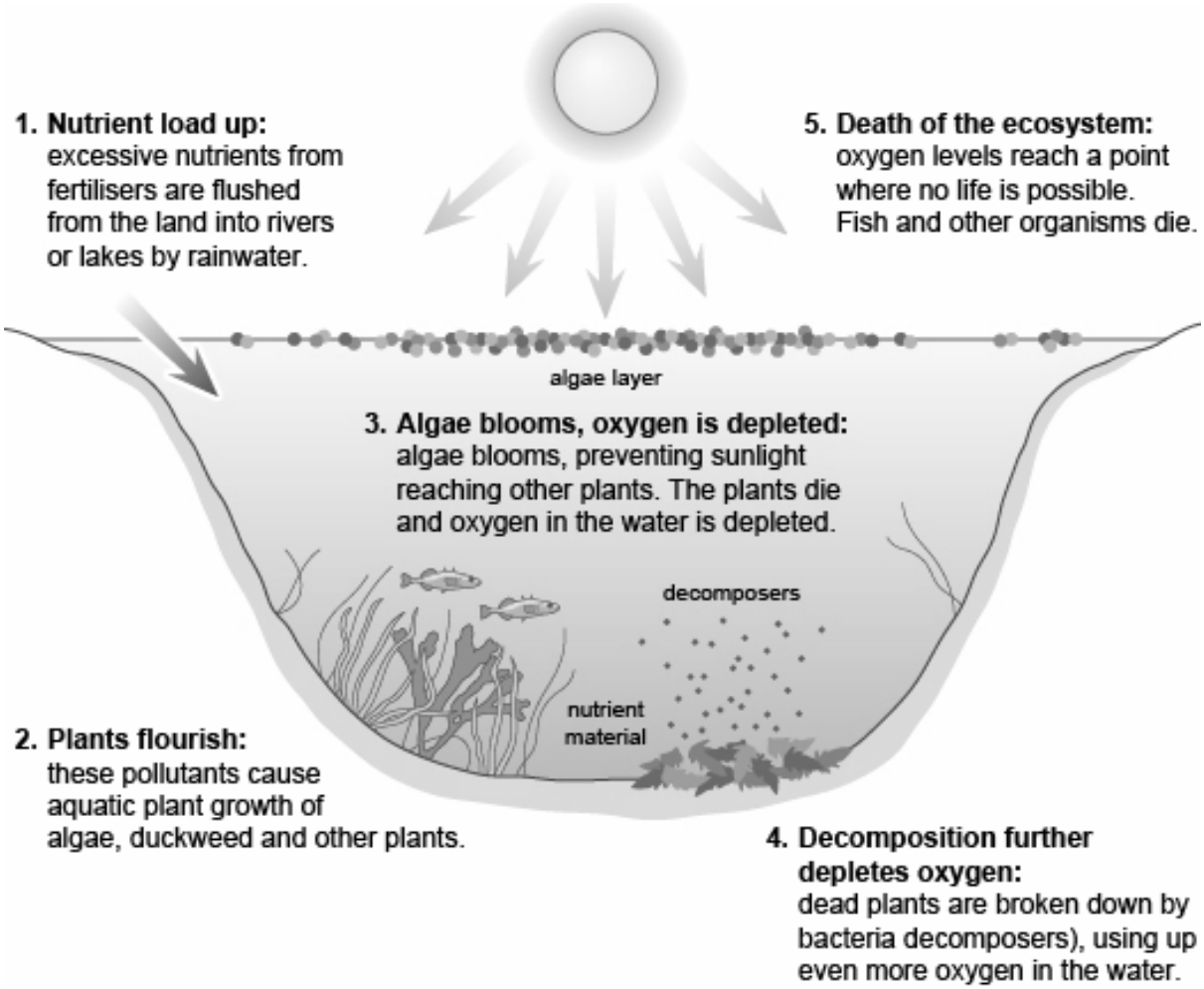


21.5 Human Impact on Ecosystem

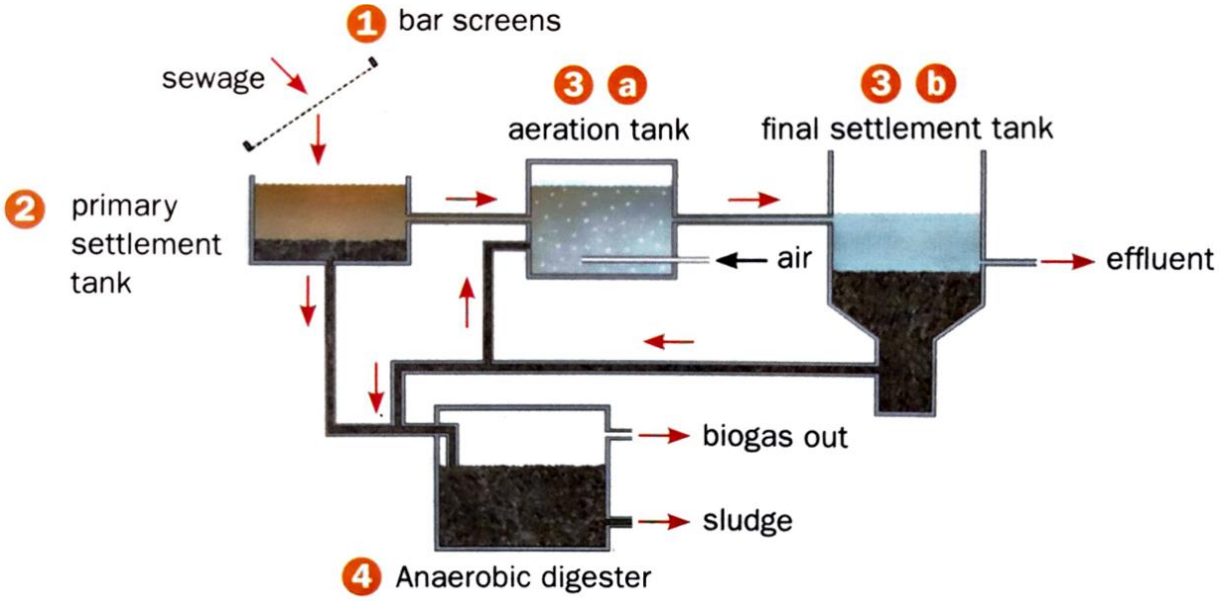
Water pollution by untreated sewage

Eutrophication

1. Large release of nitrates and phosphates from decomposition of sewage
   - Algae absorb nutrients + synthesise algal proteins & amino acids → growth / cell synthesis → rapid increase in population
   - Algae bloom → reduce light penetration into pond water
   - Pond producers X photosynthesise due to lack of sunlight → die
   - Decomposed by aerobic bacteria + fungi → deplete oxygen in water → fish die
2. Waste discharge: explosion in bacteria population in pond
   - compete with fish for oxygen → fish suffocate + die
3. Waste discharge: contain toxins → kill fish



Sewage treatment



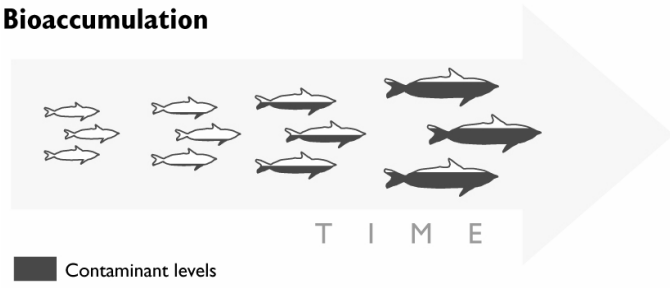
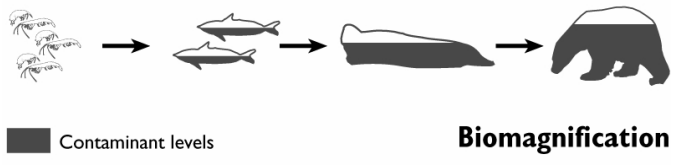
Feature	Description
1. Bar screens	• remove large course materials
2. Primary treatment	**Primary settlement tank** • solid suspensions settle to bottom of tank → primary sludge → anaerobic digester • top liquid → aeration tank
3. Secondary treatment	**Aeration tank** (activated sludge process) • liquid + aerobic microorganisms + oxygen → microorganisms absorb & breakdown organic pollutants

	Final settlement tank
	• microorganisms settle to bottom of tank → sludge
	  ○ some sludge → aeration tank for reuse
	  ○ exess sludge → anaerobic digester
	• clean water at top → discharged as effluent into water bodies

4. **Anaerobic digester**	• anaerobic bacteria decompose sludge (organic matter) → biogas (mainly methane)
	  ○ fuel to generate electricity
	• remaining solid material removed from tank
	  ○ fertiliser
	  ○ burnt in incinerator

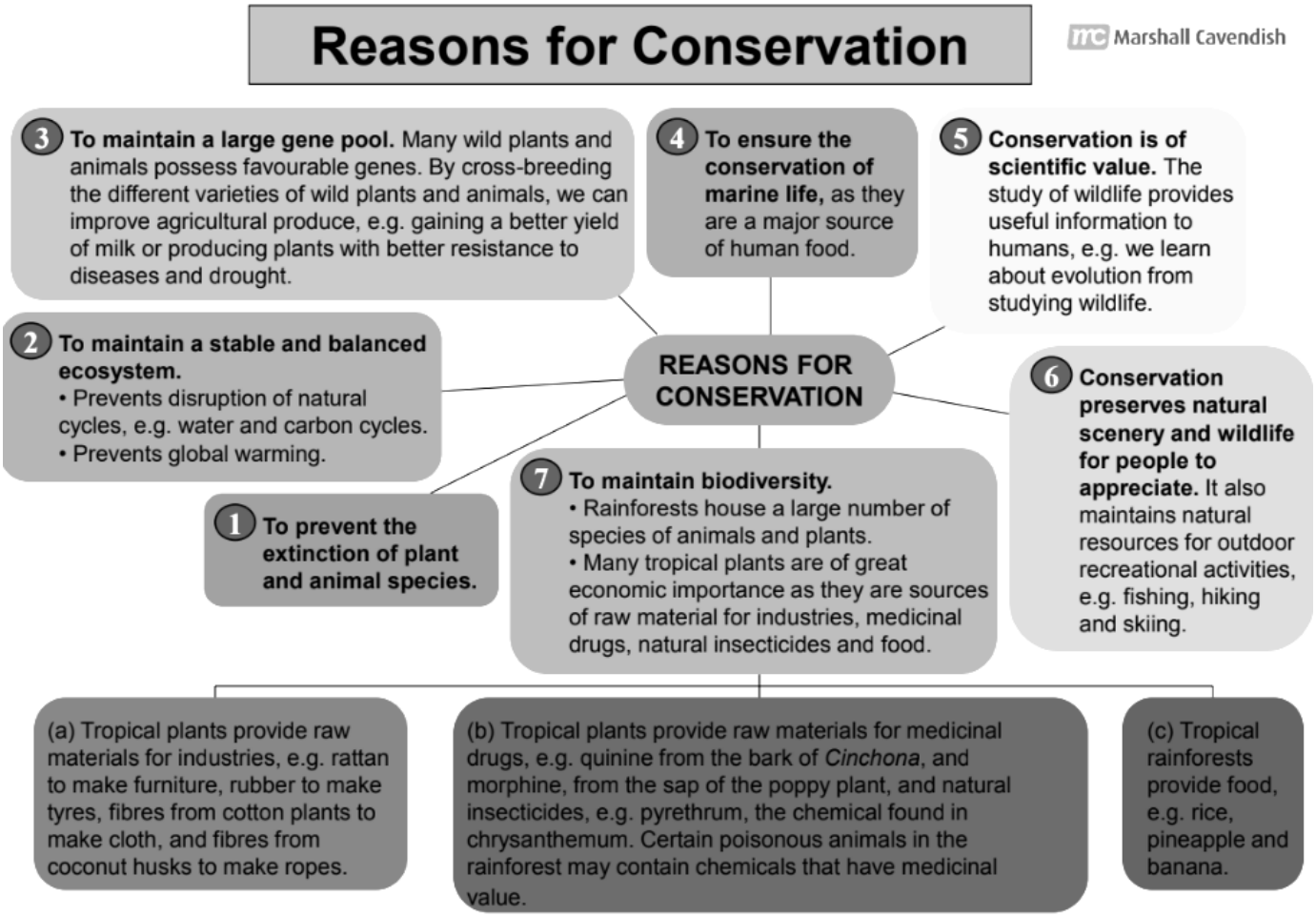
Pollution due insecticides

Example: dichlorodiphenyltrichloroethane (DDT)

Bioaccumulation	Biomagnification
	
In organism ● DDT is non-biodegradable: insoluble in water + not excreted + stored in fatty tissues of organism ● DDT X break down → accumulate → conc increase	Along food chain ● Secondary consumer feed on large no. of primary consumer to obtain enough energy → DDT passed down along food chain → accumulate → conc increase ● Certain conc reached: dangerous → symptoms manifested

21.6 Conservation

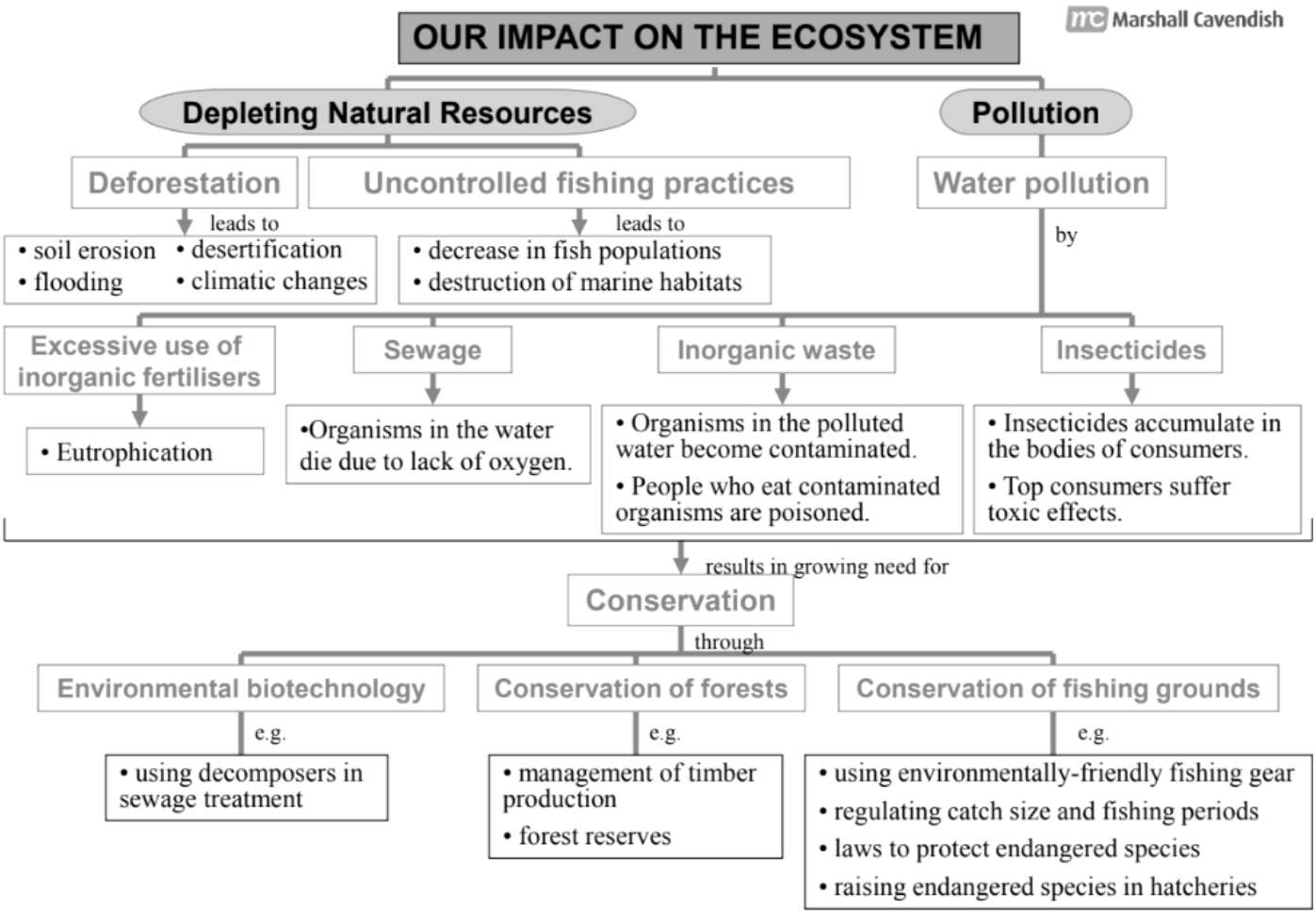
Reasons



1. Maintain <u>biodiversity</u> by preventing extinction of species
2. <u>Scientific research</u> e.g. learn about evolution from studying wildlife
3. <u>Economic</u> purposes
    - conservation of marine life which is major source of human food
    - tropical rainforests provide food
    - tropical plants provide raw materials for industries – e.g. rubber, rattan, cotton
4. Maintain <u>balanced and stable ecosystem</u> – prevent natural cycles disrupted + global warming
5. <u>Natural scenery and wildlife</u> for people to appreciate – e.g. fishing, hiking

Measures

Conserve	Methods
1. **Forests**	1) Prevent tree felling (indiscriminate cutting down of forest trees) 2) Manage production of timber ● trees felled for timber are cut down selectively & at regulated rate ● young trees not felled ● reforestation (new seedlings are planted to replace) 3) Designate land as forest reserve
2. **Fishing grounds**	1) Ban drift nets – indiscriminately trap all forms of marine life 2) Use nets with certain mesh size – young / immature fish not caught 3) Regulate entry of ships into fishing grounds 4) Limit period of fishing in fishing grounds 5) Ban harvesting / fishing of endangered species 6) Raise endangered species in hatcheries

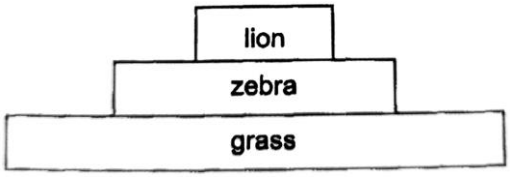


Typical questions

Multiple-choice questions

1 The diagram shows a pyramid of biomass for the food chain:

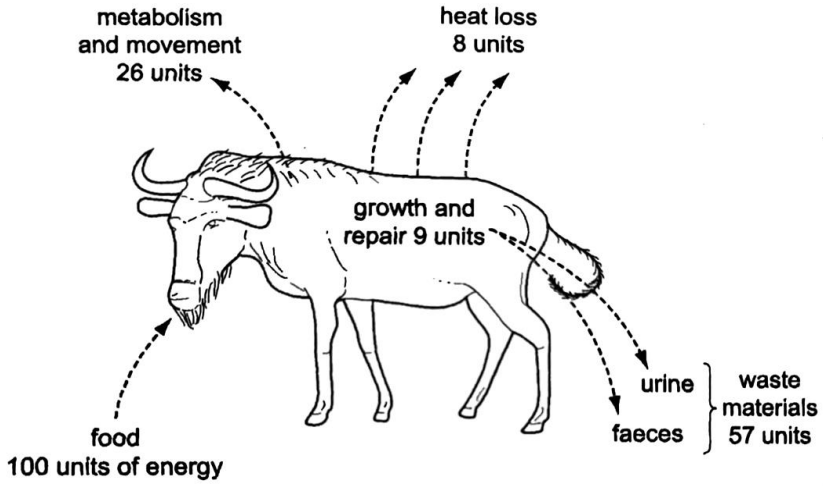
grass → zebra → lion



Which process causes loss of biomass from this food chain? (2011 P1 Q39)

A digestion
B growth
C photosynthesis
D respiration

2 The diagram shows how energy from food is used by an animal.

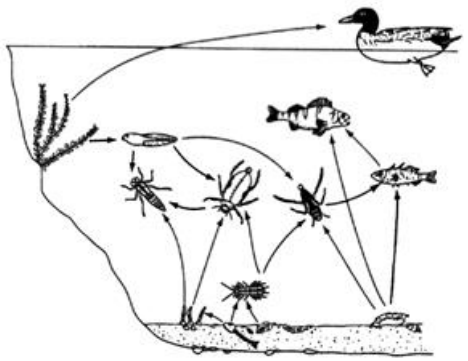


What percentage of this energy is available to consumers and decomposers?

(2012 P1 Q39)

A 91
B 66
C 34
D 9

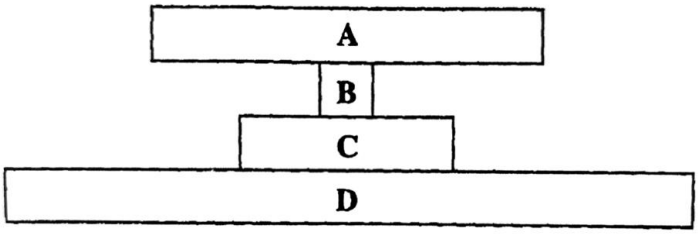
3 The diagram shows part of a food web in a freshwater pond.



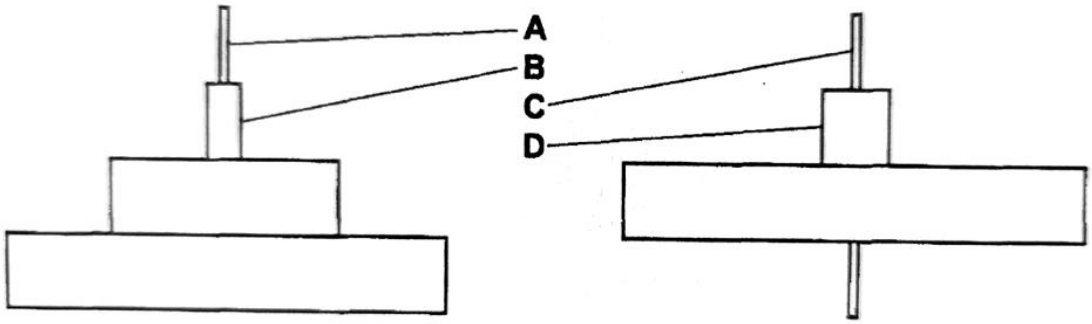
In this web, which is **not** correct? (2013 P1 Q39)

A One trophic level is herbivorous.
B Two trophic levels are producers.
C Three trophic levels are carnivorous.
D Four trophic levels are consumers.

4 The diagram shows a pyramid of numbers in an ecosystem on land.
Which organisms are smallest in body size? (2013 P1 Q40)



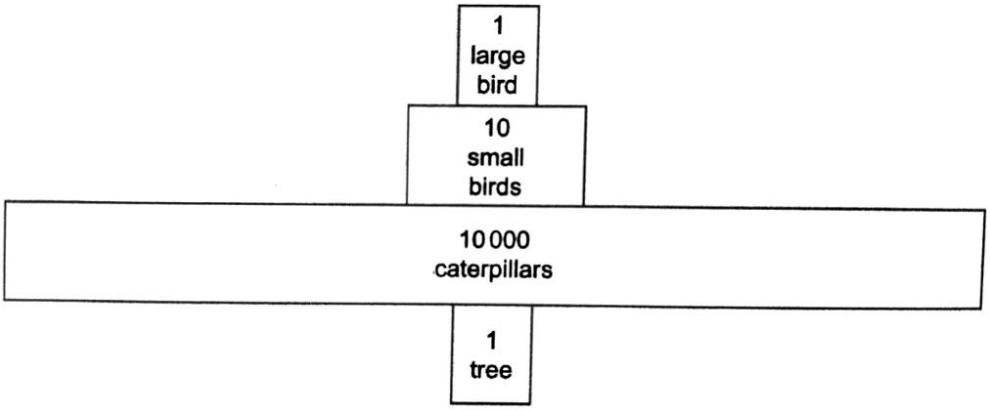
5 Insect larvae feed on the leaves of trees.
A hawk feeds on small birds that feed on these larvae.
The diagram shows the pyramid of numbers and the pyramid of biomass for this food chain.
Four levels are labelled A, B, C and D.



Which level is described correctly? (2014 P1 Q40)

A biomass of primary consumers
B biomass of secondary consumers
C number of producers
D number of herbivores

6 The diagram shows a pyramid of numbers for a food chain.

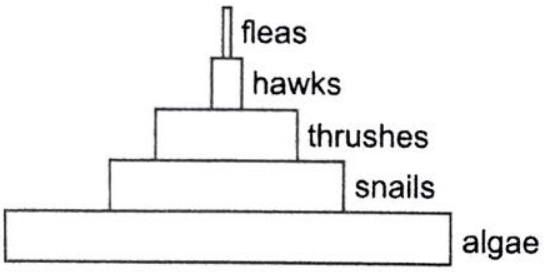


Which statement is correct? (2018 P1 Q40)

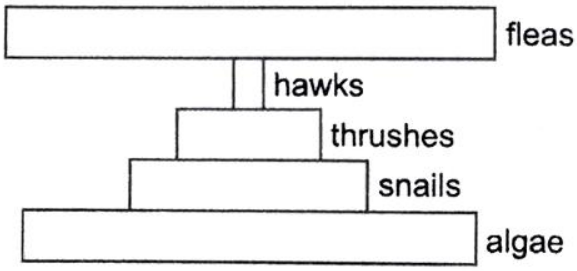
A The caterpillars have the greatest total biomass.
B The large bird has more total biomass than the small birds.
C The small birds have more total biomass than the caterpillars.
D The tree has the greatest biomass.

7 Algae are organisms found on the surface of stones. Snails feed on algae and are a food source for thrushes. Hawks are predators that feed on thrushes. Thrushes are a type of small bird. Fleas live between the feathers of hawks and feed on their blood.
Which diagram represents a pyramid of numbers for this food chain? (2019 P1 Q39)

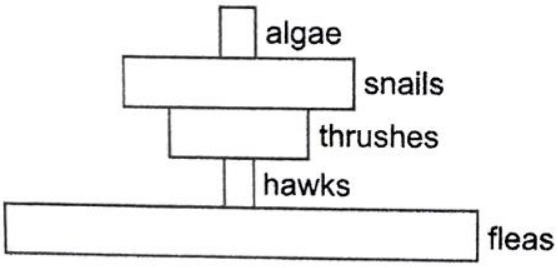
A



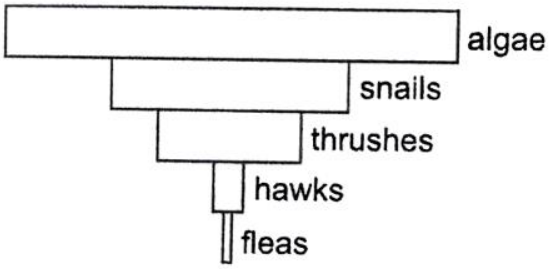
B



C



D



8 Which group(s) of organisms are not necessary for the carbon cycle to continue?
(2011 P1 Q40)

A bacteria and fungi
B green plants and fungi
C green plants only
D herbivores only

9 The statements below are about carbon sinks and carbon sources.

1. All oceans are carbon sinks.
2. Carbon sinks can become carbon sources.
3. Carbon sinks remove carbon dioxide permanently from the atmosphere.
4. Carbon sources absorb more carbon dioxide than they release.
5. Tropical rainforests are important carbon sinks.

Which statements are correct? (2015 P1 Q39)

A 1, 2 and 5
B 1, 3 and 4
C 2, 4 and 5
D 3, 4 and 5

10 Some processes are listed.

1. absorption of carbon dioxide by oceans
2. bioaccumulation
3. respiration by animals and plants
4. photosynthesis by land plants

Which processes act as carbon sinks? (2017 P1 Q40)

A 1 and 2
B 1 and 4
C 2 and 3
D 3 and 4

11 In sewage disposal, what are the results of processes that involve aerobic microorganisms and of processes that involve anaerobic microorganisms? (2014 P1 Q39)

	results of aerobic process	results of anaerobic process
A	carbon dioxide and water produced	methane is produced
B	fats and oils metabolised	urea is converted into nitrates
C	inorganic solids are removed	methane is produced
D	pesticides are deactivated	ammonia is removed

12 Bacteria are used in sewage treatment plants.
In which processes do bacteria play an active role? (2015 P1 Q40)

	breakdown of organic molecules	production of methane	reduction of phosphate levels in effluent	reduction of water content in primary sludge
A	✓	✓	✓	✓
B	✓	✓	✓	✗
C	✗	✓	✗	✗
D	✗	✗	✓	✓

13 The processes listed are some of those used in sewage treatment.

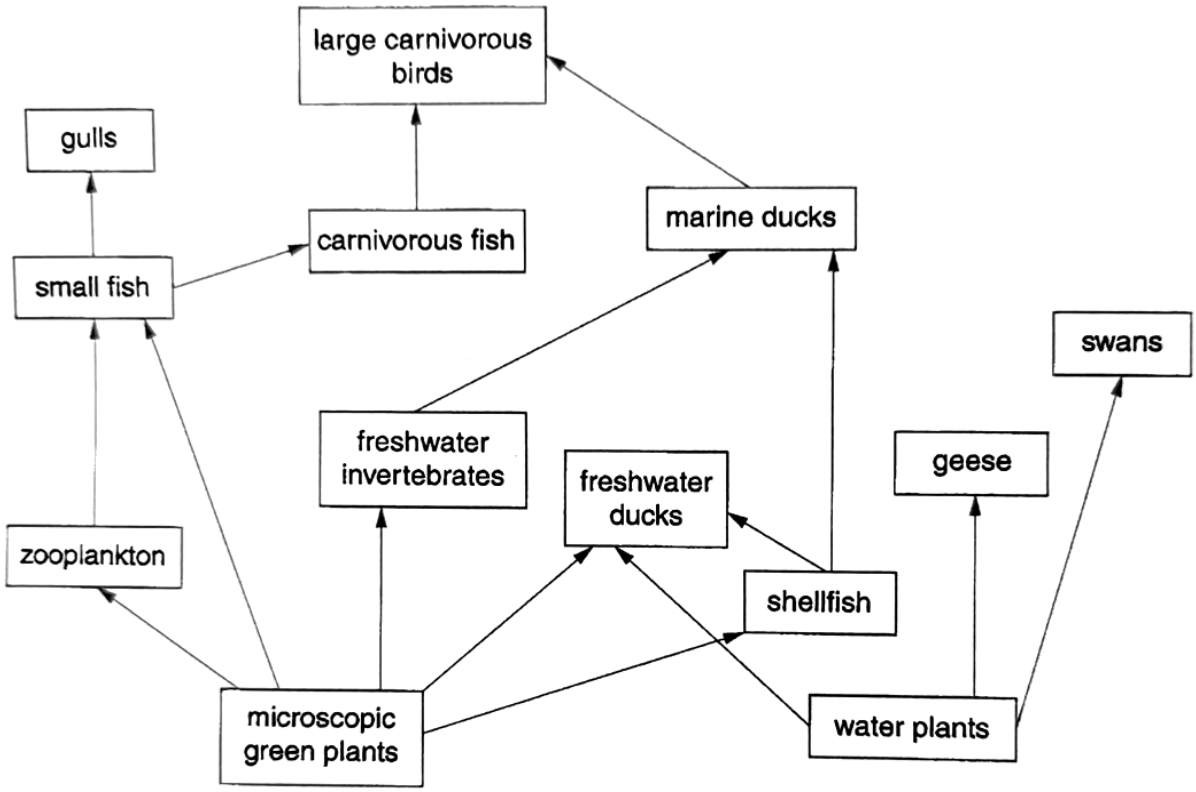
1. Separate solid and liquid parts into separate tanks
2. Remove urea from liquid sewage
3. Convert solid waste to soluble waste and methane

Which of the listed processes involve microorganisms? (2019 P1 Q40)

A 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 3 only

Structured questions

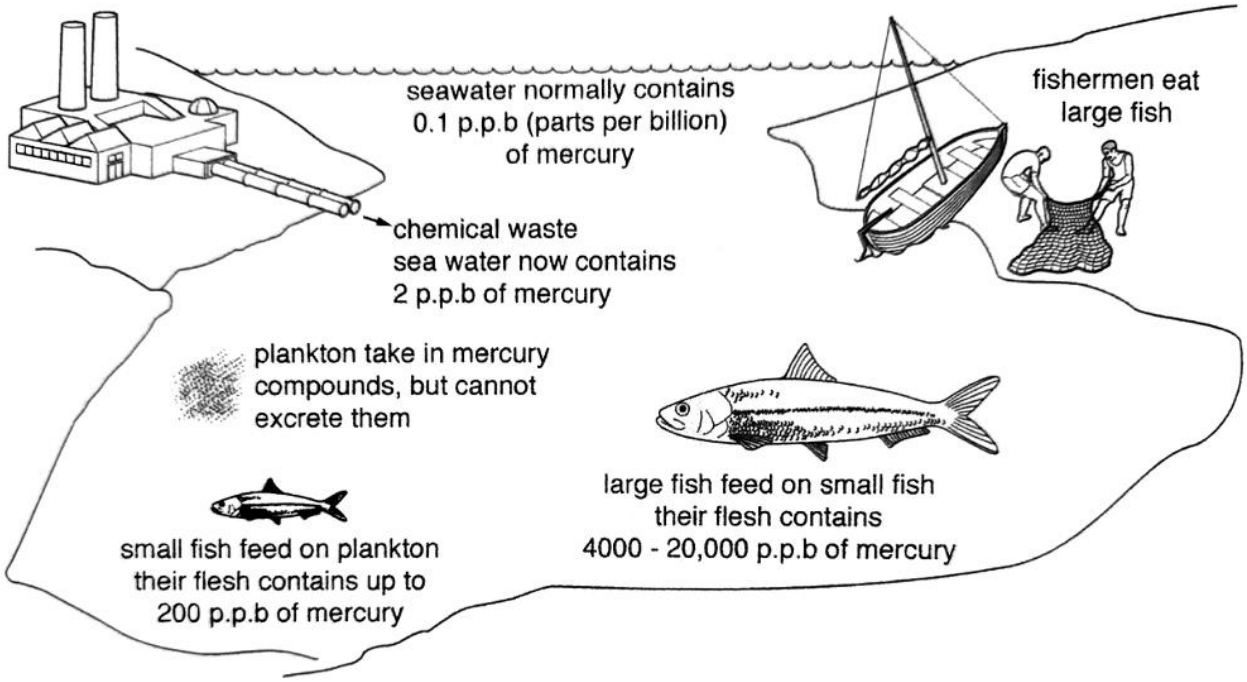
1 The figure below shows a food web in a river. (2013 P2 A5)



With reference to the figure, explain the term producer. [3]

- A producer is an organism that can photosynthesise and make its own organic food from inorganic materials.
- The chlorophyll in these plants traps and converts light energy from the Sun into chemical energy stored in food during photosynthesis. The chemical energy is passed down the food chain when other organisms such as zooplankton and freshwater ducks feed on the plants.
- A food chain starts with a producer such as microscopic green plants or water plants.

2 A food chain in the ocean may be affected by pollutants such as mercury, as shown in the figure below. (2015 P2 A7)



(a) Draw the food chain shown above. [2]

plankton → small fish → large fish → fishermen

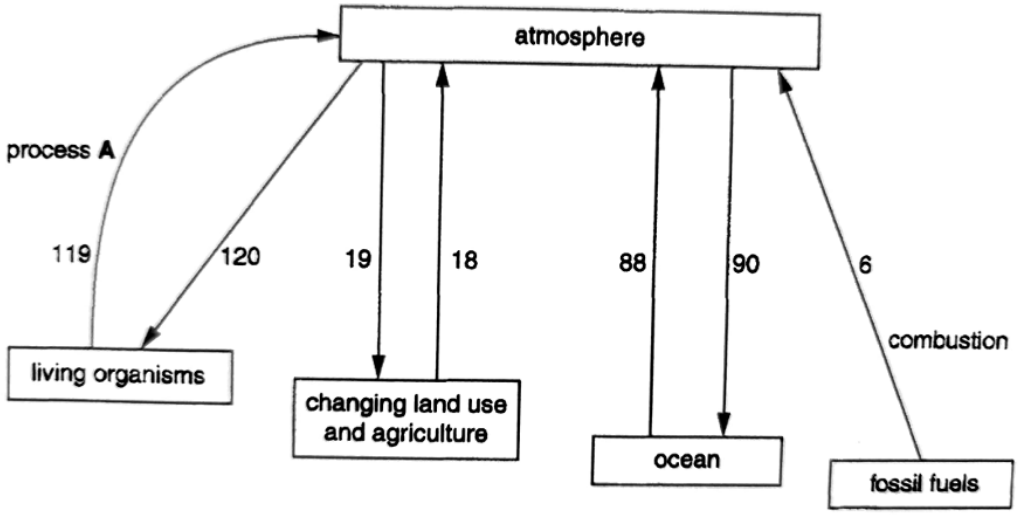
(b) The food chain above illustrates the process of bioaccumulation.
With reference to the plankton and the small fish, suggest how this process occurs. [3]

- Chemical waste discharged into the seawater raises the mercury level from 0.1 p.p.b to 2 p.p.b.
- The plankton take in mercury compounds from the seawater but are unable to excrete them.
- The mercury is then passed along the food chain from the plankton to the small fish when the small fish feed on the plankton. As the small fish feed on a large amount of plankton in order to obtain enough energy, bioaccumulation occurs and the mercury accumulates and becomes concentrated in the flesh of the small fish at 200 p.p.b.

3 Explain why there are usually very few predators of tertiary consumers. [2]
(2019 P2 A6c)

- A large amount (90%) of energy is lost at every trophic level in the food chain.
- There are very few predators of tertiary consumers as the energy transferred to them is a very small percentage of the energy available in the producers, which is unable to support a large number of predators of tertiary consumers.

4 The figure shows part of the carbon cycle.
The numbers represent the changes in the flow of carbon in gigatons of carbon per year between parts of the cycle. (2014 P2 A4)



(a) State what is meant by the term *carbon sink*. [2]

A reservoir that accumulates and stores carbon-containing compounds over a long period of time. It stores more carbon than it releases into the environment.

(b) Name process A. [1]

aerobic respiration

(c) State the effect that changing land use and agriculture has on the quantity of carbon dioxide in the atmosphere. [1]

Reduced quantity of carbon dioxide in atmosphere by 1 gigaton of carbon per year

(d) Calculate the total change in the amount of carbon in the atmosphere each year.
Show your working. [2]

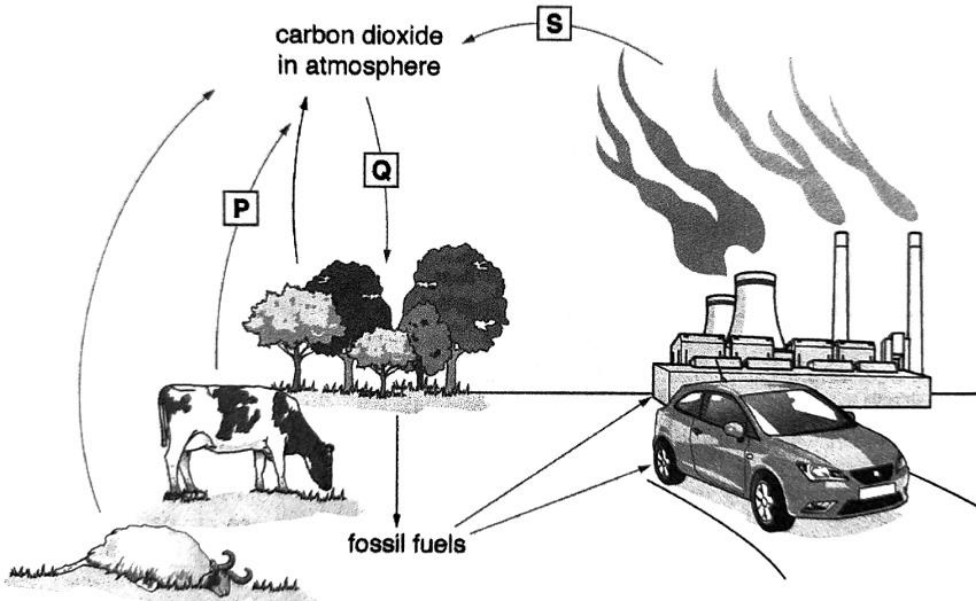
Amount of carbon absorbed from atmosphere = 120 + 19 + 90 = 229 gigatons
Amount of carbon released into atmosphere = 119 + 18 + 88 + 6 = 231 gigatons
Net amount of carbon released into atmosphere = 231 – 229 = 2 gigatons

(e) Suggest why the ocean gives out less carbon than it takes in. [5]

- Many organisms that carry out photosynthesis such as phytoplankton, algae and aquatic plants can be found in the ocean.
- These organisms absorb carbon dioxide dissolved in the water when they synthesise food during photosynthesis.
- The high rate of photosynthesis carried out by these organisms leads to a high rate of absorption of carbon dioxide in the ocean.

- When other marine organisms carry out respiration and produce carbon dioxide, the carbon dioxide is absorbed by these photosynthetic organisms.
- Thus, the ocean is a carbon sink as it gives out less carbon than it takes in.

5 The figure shows part of the carbon cycle. (2018 P2 A7)



(a) Explain the importance of the processes labelled P, Q and S in the figure above. [3]

- **P:** Living organisms such as animals and green plants oxidise glucose during respiration to release the energy stored in it for their life processes. They give out carbon dioxide into the atmosphere.
- **Q:** Green plants take in carbon dioxide from the atmosphere in the presence of sunlight to synthesise glucose via photosynthesis.
- **S:** Fossil fuels are combusted in vehicles and power staions to produce energy and release carbon dioxide into the atmosphere.
- Processes P and S give out carbon dioxide into the atmosphere, while process Q takes in carbon dioxide from the atmosphere. They maintain the correct concentration of carbon dioxide in the atmosphere.

(b) Describe the role of bacteria and fungi in the carbon cycle. [3]

Decomposers such as bacteria and fungi play a crucial role in the carbon cycle by recycling carbon back into the environment.

- Decomposers break down dead plant and animal matter and release the energy and nutrients stored in them.
- Decomposers only use a small amount of energy and nutrients for their own needs. Most of the nutrients locked up in the dead organisms can then be used again by green plants.
- When bacteria and fungi carry out decomposition, carbon dioxide is released into the atmosphere.

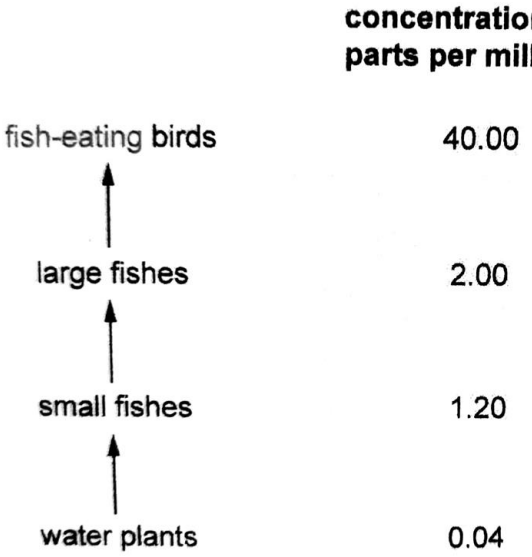
6 Describe how the carbon in a glucose molecule in the body of an animal is cycled in an ecosystem. [5]

(2009 P2 Q10 OR)

1) The carbon in a glucose molecule in the body of an animal can be passed from one organism to another through feeding in the food chain/food web.
2) Some of the glucose will be oxidised to release energy during respiration and carbon is released to atmosphere as carbon dioxide.
3) When organisms died, the decomposers break down dead organic matters and carbon is also released to the atmosphere as carbon dioxide.
4) Carbon dioxide in the atmosphere is taken in by producers which will used the carbon dioxide and water to synthesis glucose in the presence of light absorbed by chlorophyll and light.
5) The carbon in the glucose is cycled in the food chain again when the organisms is consumed by another organism.

7 Insecticide sprayed on crop plants washes into a lake. The figure below shows a food chain in the lake. The concentration of insecticide in the cells of organisms at each trophic level is shown.

(2020 P2 A5)



(a) Calculate how many times greater the concentration of insecticide is in the fish-eating birds compared to the water plants. [1]

40.00 / 0.04 = x 1000

(b) Explain why a higher proportion of fish-eating birds died compared to other organisms in the food chain. [3]

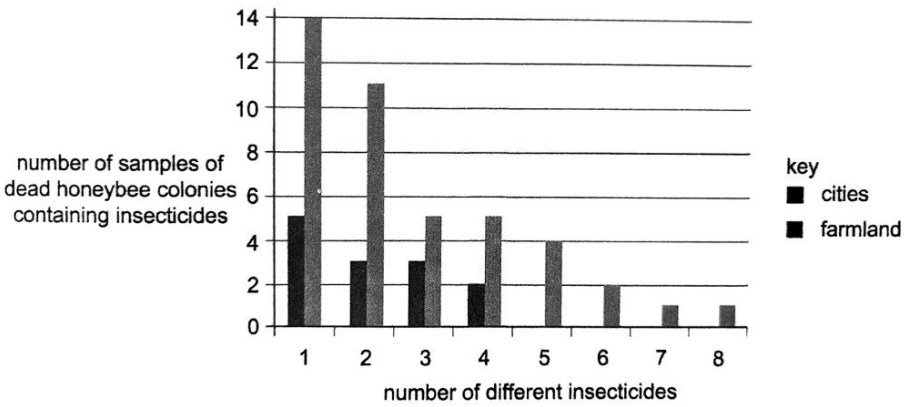
This is due to the effect of bioaccumulation.

- The insecticide is likely to be non-biodegradable and accumulates in the water plants. As the small fishes feed on the water plants, the insecticide in the water plants enters the small fishes and accumulates in their bodies.
- As the trophic level increases, higher concentrations of insecticide accumulate when it is consumed by other organisms and passed on along the food chain.
- The birds, being in the highest trophic level, have the highest concentration of insecticide accumulated which is dangerous enough to kill a large proportion of birds.

(c) Suggest and explain what might happen to the number of small fishes in the lake if all the fish-eating birds die. [3]

- When all the fish-eating birds die, the large fish population will increase due to a lack of predators.
- This leads to a sharp decrease in the population of small fishes
- as the larger population of large fishes will prey on them.

8 Scientists studied the suspected poisoning of honeybees by insecticides in a country. They counted the number of insecticides present in equal samples of dead honeybee colonies in cities and farmland areas.
The bar chart in the figure below shows the results. (2020 P2 B9 OR)



(a) Compare the data in the bar chart for cities and farmland areas. [3]

- Higher number of samples of dead honeybee colonies containing insecticides in farmland than in cities
- 14 dead honeybee colonies in farmland had 1 insecticide found in them as compared to 5 dead honeybee colonies in cities
- 9 dead honeybee colonies more in farmlands than cities

(b) Suggest reasons for the different results in cities and farmland areas. [3]

- Regulations of the use of insecticides in cities are tighter than in farmlands + lesser usage of insecticides in cities than farmlands
- more agricultural activity in farmlands than in cities + greater usage of different insecticides by farmers in farmlands that make a living through the sales of produce from plants + lesser usage of insecticides for plants in cities
- Suitable environmental conditions (temperature of environment / availability of food source) for growth of honeybees farmlands than in cities

(c) Explain why scientists are concerned about the suspected poisoning of honeybee colonies by insecticides. [4]

- Honeybees are important pollinators (transfer of pollen grains from anthers to stigma) + number of plant pollinated decrease
- Lesser plant growth and reproduction
- Since plants are producers + lesser light energy absorbed by plants and converted to chemical energy
- Lesser chemical energy available for living things + for cellular activities

9 Fig 1 shows the level of mercury in certain types of fish in a food chain and the recommended frequency of consumption.

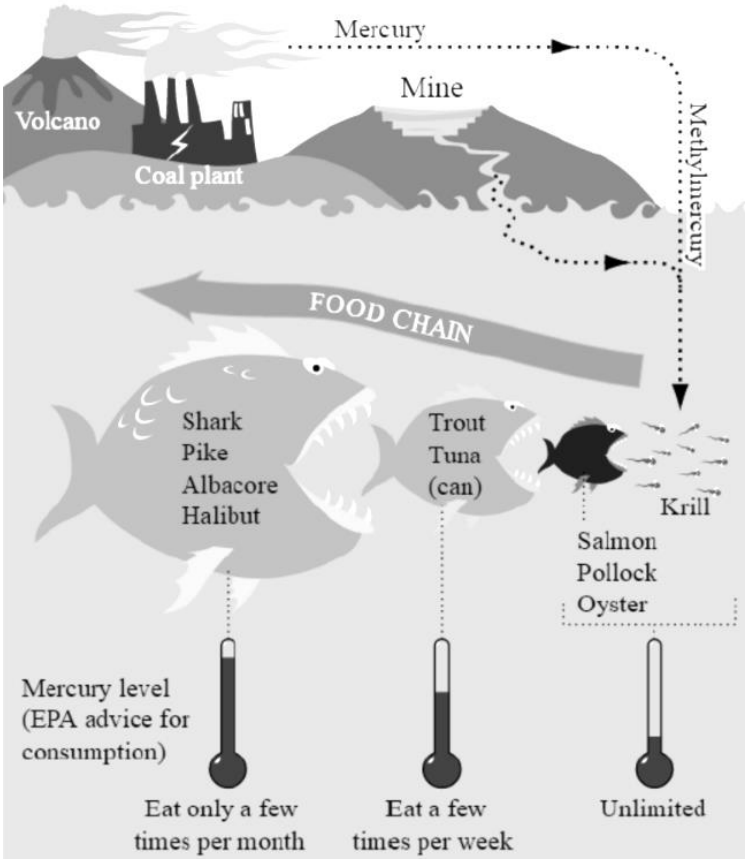


Fig 1

Mercury exposure at high levels can harm the brain, heart, kidney, lungs and immune system. High levels of methyl mercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making them less able to think and learn.

Fig 2 shows the nutrient content in salmon and the recommended daily value (RDA) in 113 g of salmon fillet.

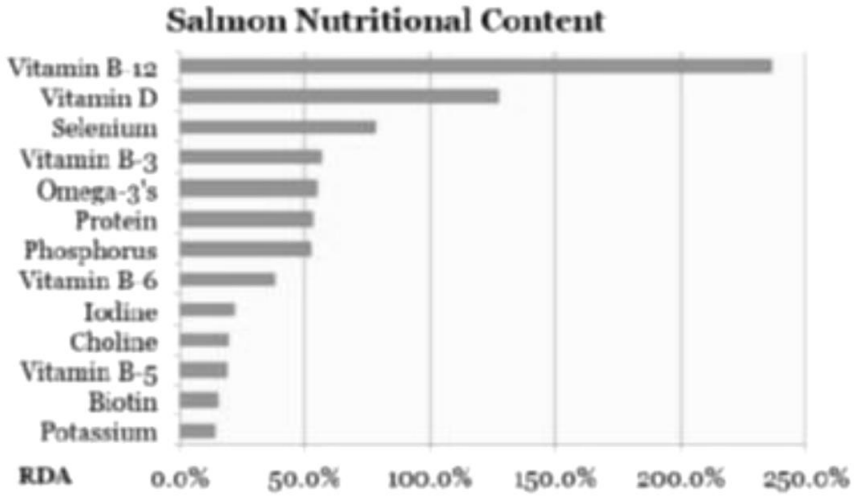


Fig 2

Selenium is a mineral that has high binding affinity to mercury, forming a new substance. This new compound makes it hard for the body to absorb mercury separately. Omega-3 is a type of good fatty acids that can promote development of the nervous system in the foetus.

(a) With reference with Fig 1, draw a food chain. [1]

phytoplankton → krill → salmon → trout → shark
(Note: must start a food chain with plant / producer)

(b) With reference to Fig 1, explain the increasing mercury along the food chain. [4]

- Mercury is non-biodegradable and insoluble in water + not excreted + stored in tissues of organisms that consume it
- When consumers keep on consuming food containing mercury, mercury concentration further increases in bodies, known as bioaccumulation
- As organisms are eaten, mercury is passed along food chain, increasing mercury concentration in bodies of organisms along trophic levels, known as bioamplification
- an example shown in figure

(c) Explain why it is advisable for humans to consume fishes like halibut only a few times per month. [1]

Frequent consumption may increase level of mercury to dangerous levels in human which may lead to toxic effects in humans.

(d) Fear of mercury poisoning causes consumers, especially pregnant mothers, to exclude fish in their diet.
Using information from Fig 2, suggest two reasons to encourage pregnant mothers to include salmon in their diet. [2]

- Salmon has high protein content. Any function of protein in humans e.g. synthesis of protoplasm for growth and development of fetus / enzymes and some hormones / formation of antibodies.
- Salmon has Omega-3 fatty acids (good fats). Synthesis of cell membrane for growth and development of fetus.
- Salmon has high levels of vitamins for overall development of fetus.

(contextualised for fetus)

(e) Discuss whether the fear of mercury poisoning from consuming fish is justified.
Support your answer with data provided. [2]

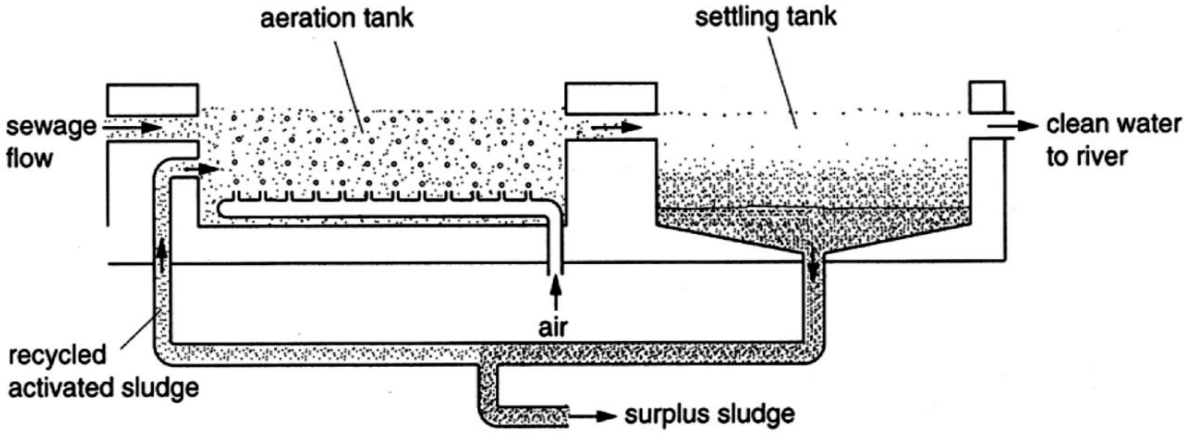
Partially justified / unjustified

- Depending on the trophic level of fish (e.g. salmon can be consumed unlimited number of times)
- And whether fish has high levels of selenium that can reduce mercury absorption

(f) Large volumes of carbon dioxide released may result in ocean acidification. Suggest one effect of ocean acidification on the organism in Fig 2. [1]

- Low pH levels denature enzymes in organism + slower rate of metabolic reactions
- Oysters are unable to form shells hence more susceptible to predators

10 The diagram below shows how the activated sludge process is used in the treatment of sewage.



(a) In the treatment, micro-organisms are present in activated sludge.

(i) Describe how the presence of micro-organisms helps purify sewage. [1]

Decomposition/breakdown of complex organic molecules to smaller molecules

(ii) Give an advantage of this method of sewage treatment. [1]

Activated sludge can be recycled

(b) A fault of this water treatment site results in the release of untreated sewage into the river. Explain the observations:

(i) The river's surface becomes covered in a 'green blanket'. [3]

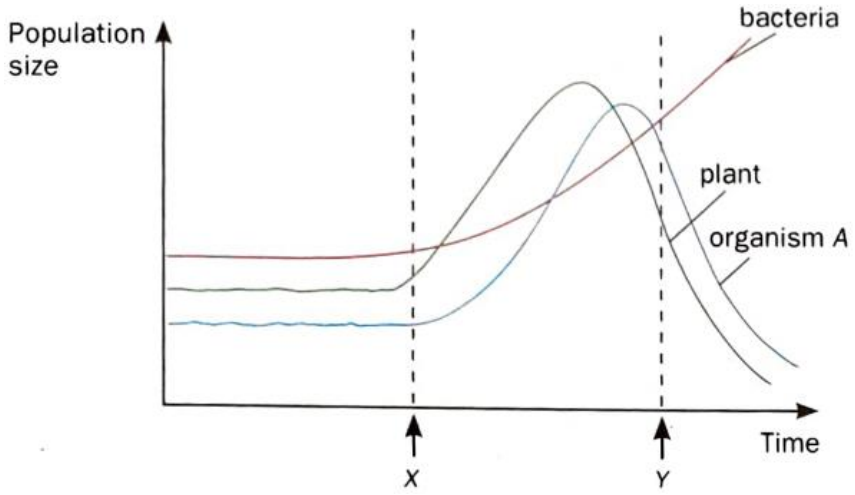
- Large release of nitrates and phosphates from decomposition of sewage
- which are absorbed by algae + used in synthesis of algal amino acids/proteins
- which promote growth / cell synthesis, thus causing rapid increase in population

(ii) Dead fish are seen floating on the river surface. [6]

- Algal cover reduces light penetration into pond water
- pond producers unable to photosynthesise efficiently + decrease in population

- causing interruption to energy flow in food chains / food webs + causing consumers such as fish to die
- Waste discharge causes explosion in bacteria/ decomposer population in pond
- which competes with fish for oxygen + causing fish to suffocate and die
- Waste discharge might contain toxins + kill fish

11 A food chain consisting of three different populations is found in a small lake. The graph below shows the changes in the sizes of these populations over a period of time.



(a) Which trophic level in the food chain does organism A belong to? Explain your answer.

Primary consumer.

The rise and fall of the population size of organism A follow that of the plant. This shows that organism A feeds on the plant.

As the plant population increases, more food is available for organism A. Hence, organism A reproduces more rapidly.

(b) What may have caused the rise in the population size of the plants and organism A at time X?

The addition of inorganic fertilisers into the lake.

The water becomes enriched with nutrients such as nitrates and phosphates.

These are used by plants for protein and nucleic acids synthesis, leading to increased growth and multiplication of the plants.

(c) Explain why

(i) the population sizes of the plants and organism A decrease after a time

Owercrowding occurs.

The plants near the water surface prevent sunlight from reaching the submerged plants. These submerged plants die. As the plant population decreases, less food is available for organism A. Competition for food results in the decrease in the size of population of organism A.

(ii) the population of bacteria continues to increase

The bacteria decompose dead bodies of plants and organism A. They feed on the decaying matter and reproduce rapidly, hence population increases.

(d) The graph below shows the amount of oxygen in the same lake before time X.
Complete the graph to show how the oxygen concentration will change over the same time period.