ECU
EDITH COWAN UNIVERSITY

2026 Biology ATAR Revision Session

Presented by Alison Siciliano

Creative thinkers made here.



Unit 4

Never measure the height of a mountain until you reach the top.

Then you will see how low it was.

Dag Hammerskjold

Unit 4: Surviving in a Changing Environment

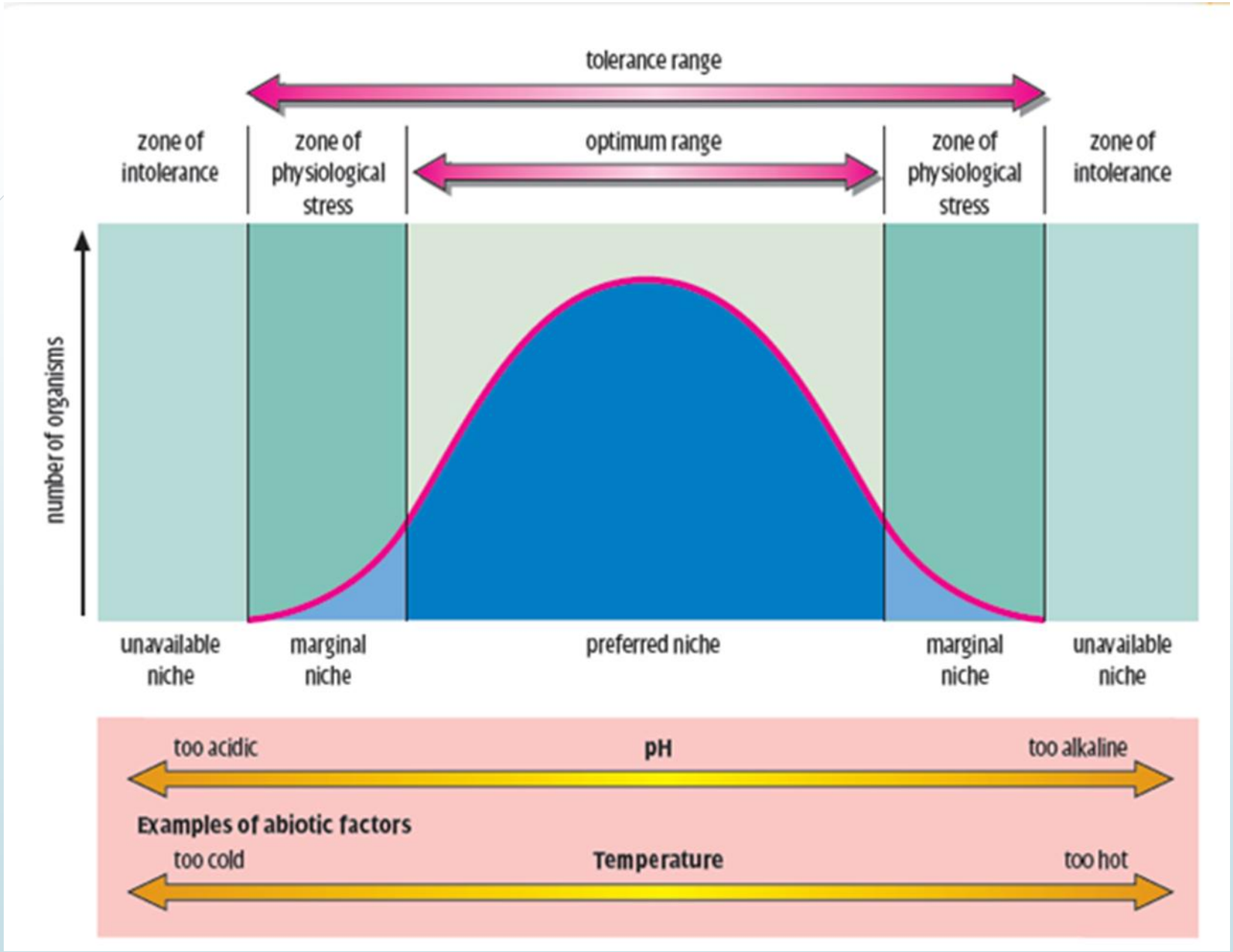
Understand the **mechanisms** by which plants and animals **use homeostasis to control their internal environment** in a **changing external environment.**

PART ONE:

- Homeostasis
  - stimulus-response model
  - negative feed-back loops
- Tolerance limits
- Thermoregulation: endothermic and ectothermic animals
- Water and Salt balance; land and aquatic animals
- Nitrogenous waste
- Xerophytes and halophytes

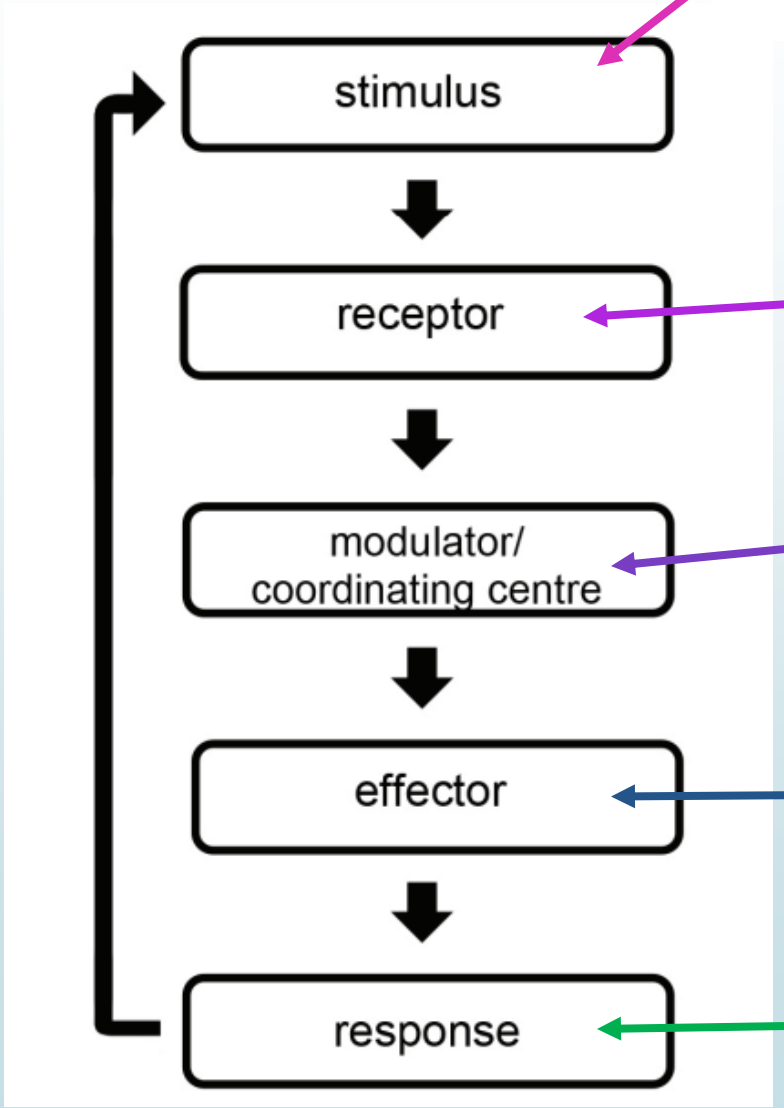
Homeostasis

The process by which the body (organism) maintains a *relatively* constant internal environment.


tolerance range
zone of intolerance
zone of physiological stress
optimum range
zone of physiological stress
zone of intolerance
number of organisms
unavailable niche
marginal niche
preferred niche
marginal niche
unavailable niche
too acidic
pH
too alkaline
Examples of abiotic factors
too cold
Temperature
too hot

Homeostasis

Evaporative cooling on skin surface: **body temperature decreases**.
Negative feedback



Blood temperature increases

Thermoreceptors detect change

Brain- hypothalamus

Sweat glands

Sweat production

Question 1: Many Australian mammals do not sweat. In order to cool themselves they will pant. Describe, in detail, the homeostatic mechanism of panting.

STIMULUS: increase in core body temperature.

RECEPTOR: thermoreceptors. [electrical/nerve message sent to modulator]

MODULATOR: hypothalamus [electrical/nerve messages sent].

EFFECTORS:

- **Respiratory muscles (diaphragm, intercostal muscles)- increase breathing rate.**
- **Blood vessels/arterioles in tongue & mouth- vasodilation.**
- **Salivary glands- increase saliva production.**

Question 1 continued…

RESPONSE:

- **Panting- short rapid breathing- heat loss through evaporation.**
- **Vasodilation (of arterioles NOT capillaries), heat loss through conduction/convection.**
- **Saliva production- heat loss through evaporation (uses energy).**

FEEDBACK: decrease in core body temperature. [negative feedback because it opposite of the stimulus.]

Most active at dawn and dusk when it is cooler

<u>Sweating</u>: during periods of activity

<u>Rests</u> in the shade during the heat of the day



<u>Panting</u>: reduces body temperature

<u>Crouch</u> with tail under body to reduce amount of surface exposed to sun

<u>Licks forearms</u>: evaporation of moisture reduces body temp.

<u>Shiver</u> during cold weather

Can redirect blood flow away from extremities to reduce heat loss

Michael Seebeck photography

Large ears to increase SA for heat loss



In heat individuals lay flat to increase SA:Vol ratio = ↑ heat loss

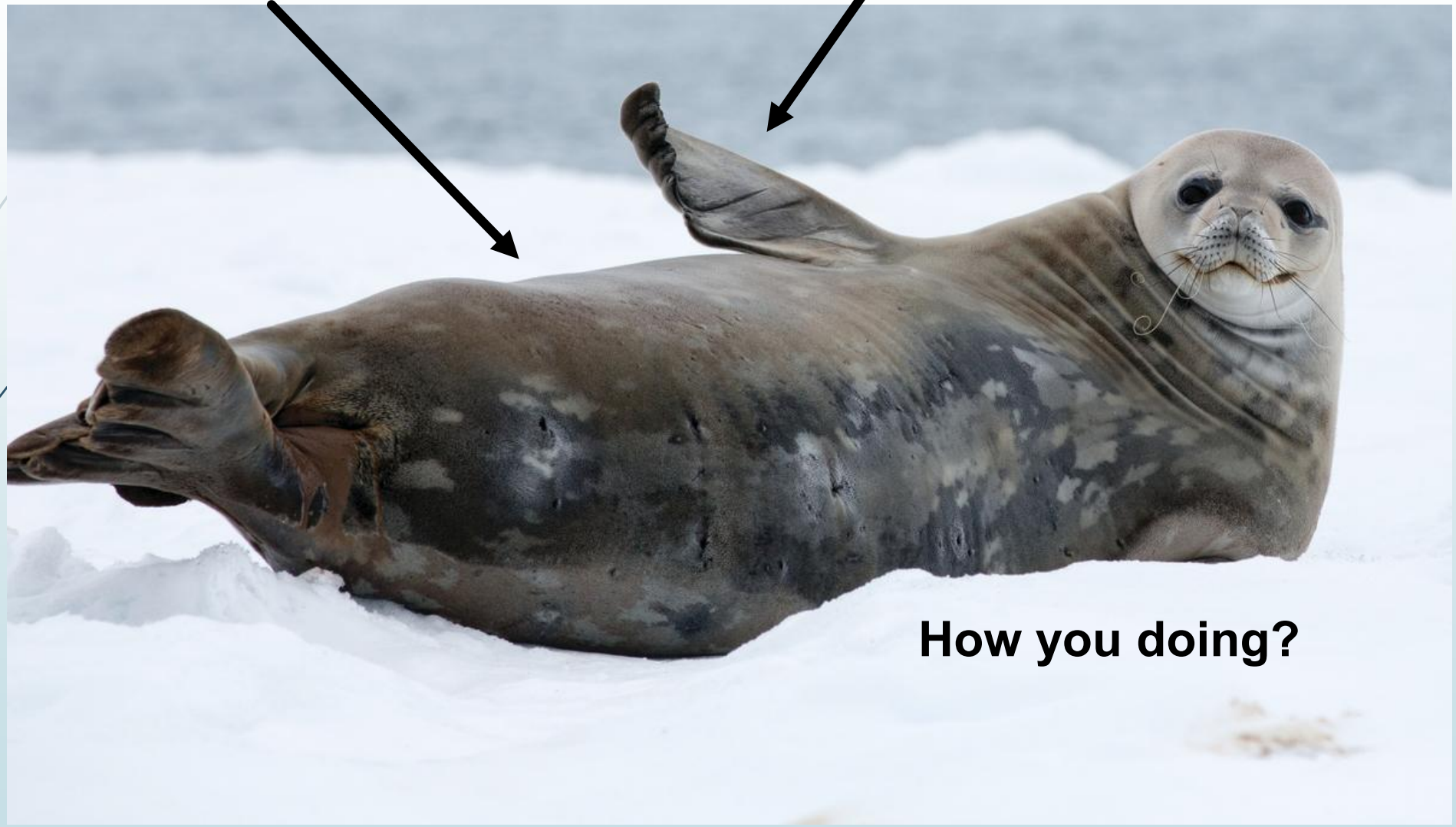
Nocturnal

Burrows: provides cool environment.

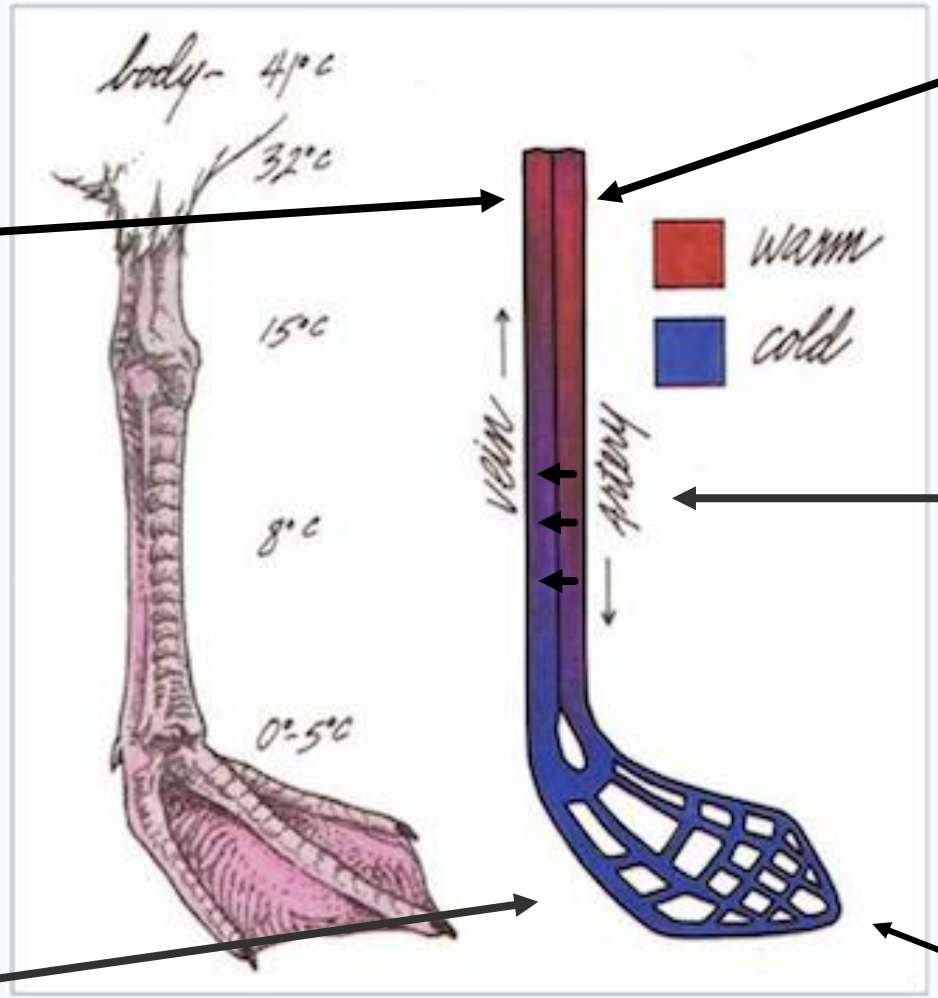
Huddling behaviour increases warmth- reduces SA:Vol ratio = ↓ heat loss

Blubber- insulation
-metabolise for energy

Counter-current blood flow



1. Warm arterial blood from the body moves towards extremities



FROM COLD TO WARM: Two views of a gull's leg show how heat is exchanged between blood vessels. Art by Michael McNelly (after Ricklefs. 1990. Ecology. W.H. Freeman, New York).

2. Heat passes from the arteries to the vein warming the cold blood returning from the foot. *Blood vessels in close proximity.*

The **temperature gradient** between the foot & the environment is **much less**, therefore **less heat is lost**.

3. The arterial blood is cooler so it loses less heat at the extremities.

4. Venous blood has been warmed by the time it returns to the body.

Q2: The thorny lizard (*moloch horridus*) lives in desert areas in Australia. Scientists measured the rate of oxygen consumption in thorny lizards at rest at four different environmental; temperatures in the laboratory. The results are shown in the table below.

Environmental temperature (oC)	Mean rate of oxygen consumption at rest (cm3g-1hr-1)
15	0.3
20	0.6
25	1.1
35	1.5

a. (i) **State the relationship** between environmental temperature and mean rate of oxygen consumption in thorny lizards at rest. (1 mark)

(ii) **Explain the reason** for the relationship described in part a.i (3 marks)

WACE 2020

Question 2a answers

(i) As environmental temperature increases so does oxygen consumption **OR** vice versa.

(ii) Oxygen consumption is a measure of the metabolic rate

metabolic rate of the lizard *depends upon* the body temperature

(higher body temperature = higher metabolic rate)

lizard is ectothermic (body temperature of the lizard varies with the environment)



Q2 continued

b. The *colour of the scales* on a thorny lizard *changes* from pale during warmer months to darker during cooler months.

Explain how this helps the lizard to thermoregulate. (4 marks)

- In cooler months external temperature is cooler/lower
- Pale scales reflect radiant heat
- Dark scales absorb radiant heat
- Therefore, dark scales increase heating of body during cooler months



Osmoregulation

The terrestrial environment is very dry (in comparison to an aquatic one). Terrestrial animals are under continual water stress, therefore they are always regulating water losses and gains.

Maintaining water balance is called OSMOREGULATION.



Question 3

The Spinifex hopping mouse is a small Australian mammal. It can survive long periods in a hot desert without drinking water. These animals have a number of adaptations which enable them to avoid dehydration.

a. List FOUR ways in which a desert mammal such as the spinifex hopping mouse, would lose water.

Answer:

- Evaporation from respiratory surfaces
- Sweating and panting
- Faeces
- Urine

Question 3 continued

b. To reduce water loss, many desert mammals are nocturnal. Give ONE other behavioural adaptation that would help a mammal such as this reduce water loss and explain how it would help.

Answer:

✓ Living in burrows with other mammals- increases humidity, reducing water loss.



Question 3 continued

c. When comparing the kidney of a spinifex hopping mouse with that of a similar sized mammal which is not adapted to an arid environment, state **ONE** difference you would expect to find.

Answer: long Loop of Henle

d. Explain how the difference in kidney structure you have given above would help the spinifex hopping mouse survive in a dry environment.

Answer: increases salt gradient, allows for greater water absorption

Osmoregulation in aquatic animals

Q4 Some species of fish inhabit bodies of water in arid regions in Australia. The salinity (salt content) of these bodies of water is usually higher than that of seawater but can fall below that of seawater after large amounts of rainfall.

Explain the challenges that fish face in maintaining salt-water balance in these bodies of water.

(4 marks) [WACE 2021 shorth answer Q32 e]

Answer in 2 parts: *high salinity*, then *varying salt levels.*

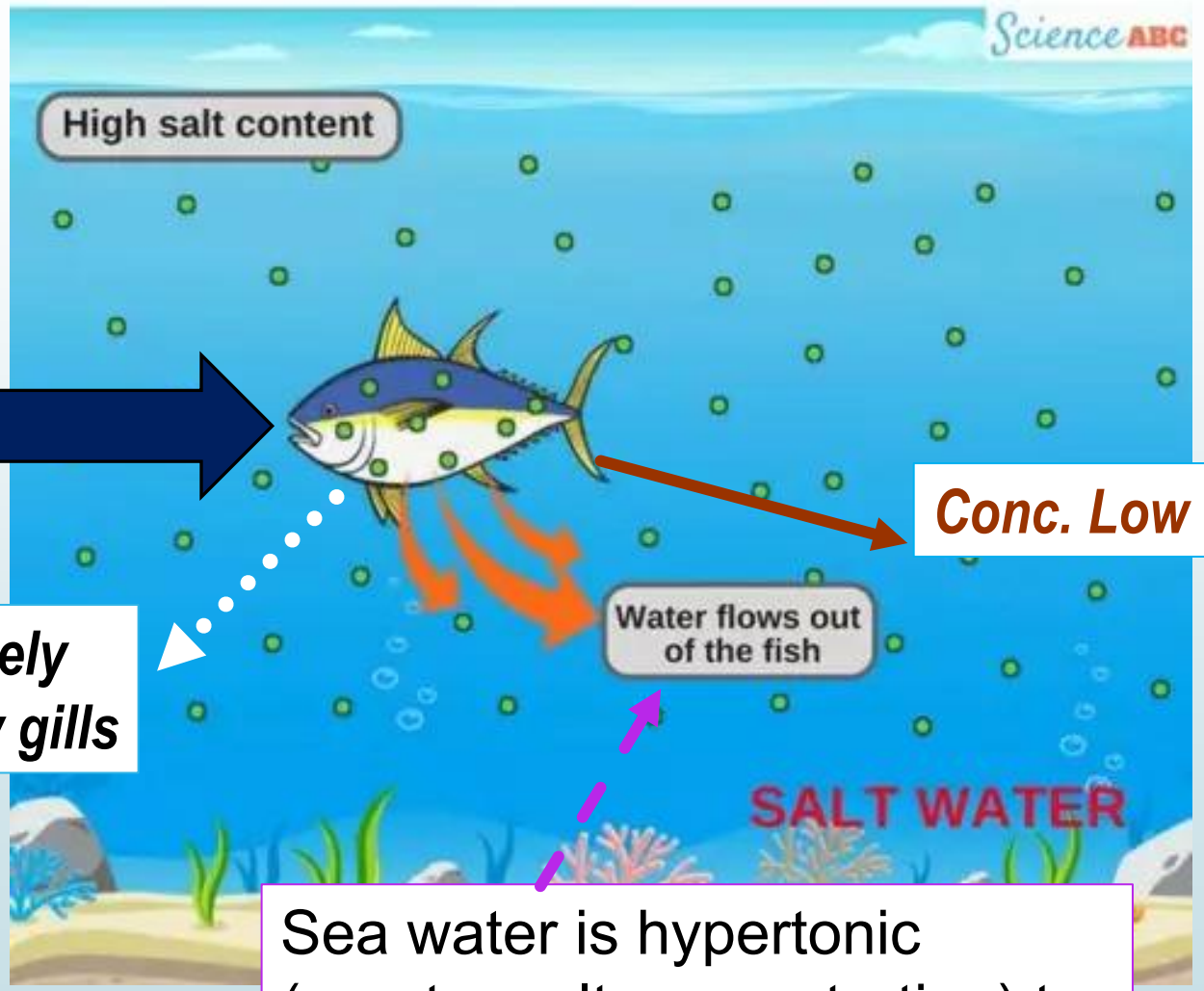
Salinity up to 3 marks

Fish perspective		Water perspective
salt content of fish is (usually) less/hypotonic to water	**OR**	salt content of water is (usually) higher/hypertonic to fish
water will tend to flow from fish to water	**OR**	salt will tend to accumulate in fish of water is (usually) higher/hypertonic to fish
water loss/salt accumulation will occur at fast rate because the salt content of the water is much higher than that of fish	**OR**	because the salt content of fish is much lower than that of water

Varying salt content 1 mark, any of the following points:

- if/when salt content of water drops below that of fish (when there is a lot of rain), the fish will have the reverse problem **OR**
- will tend to accumulate water and lose salts **OR**
- will have to change the direction of osmoregulation





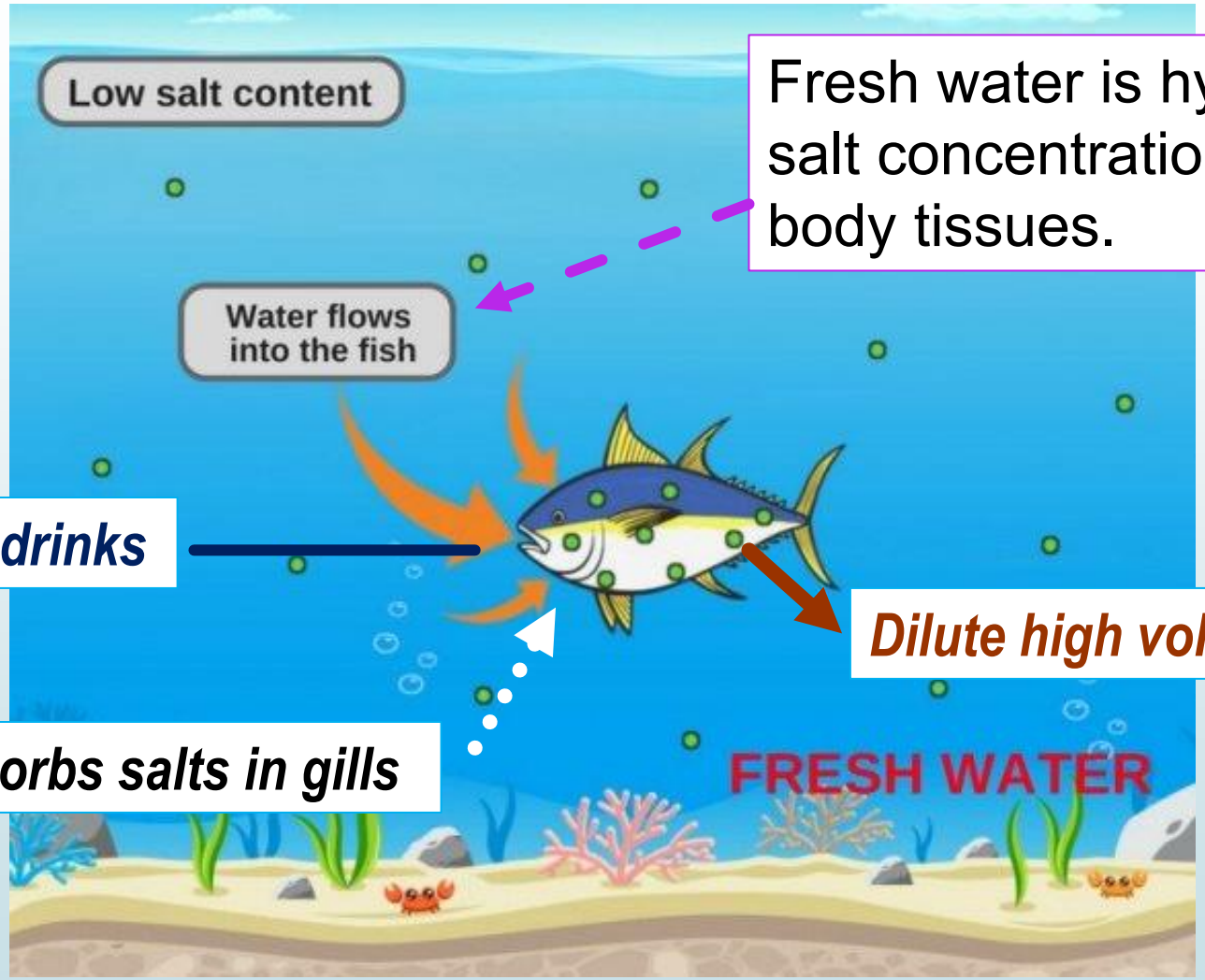
Drinks water

Conc. Low volume urine [urea]

Salt actively secreted by gills

Sea water is hypertonic (greater salt concentration) to the fishes body tissues.

Fresh water is hypotonic (lower salt concentrations) to the Fish body tissues.



Rarely drinks

Dilute high volume urine [ammonia]

Actively absorbs salts in gills

Nitrogenous waste- it’s all about water availability!

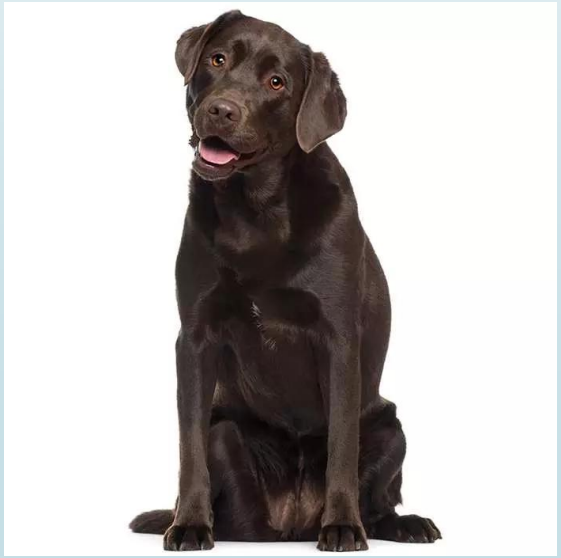


Nitrogenous Waste Question 5:

Q39 a 2016 WACE Extended Response

"**Name** the type of *nitrogenous waste* produced by *freshwater fish, a dog and a desert lizard*. **Explain** how these *relate to the availability of water* in each animal's environment and the *benefits & costs* of each type of waste to each animal."







Animal	N-waste	Availability of water	Benefits	Costs
Fresh-water fish	**AMMONIA**	**HIGH**	**LOW ENERGY REQUIREMENT**	**AMMONIA IS HIGHLY TOXIC**
Dog	**UREA**	**MODERATE**	**MODERATE TOXICITY SO CAN BE STORE FOR SHORT PERIODS OF TIME**	**MODERATE ENERGY COST TO PRODUCE, REQUIRES WATER**
Desert lizard	**URIC ACID**	**LOW**	**NON-TOXIC, CAN BE STORED FOR LONG PERIODS OF TIME. LOW WATER REQUIREMENT.**	**VERY HIGH ENERGY COST**



Homeostasis and Plants

Plant growth hormones regulate plant activities in response to environmental stimuli.

Temperature changes are also a major factor, for:

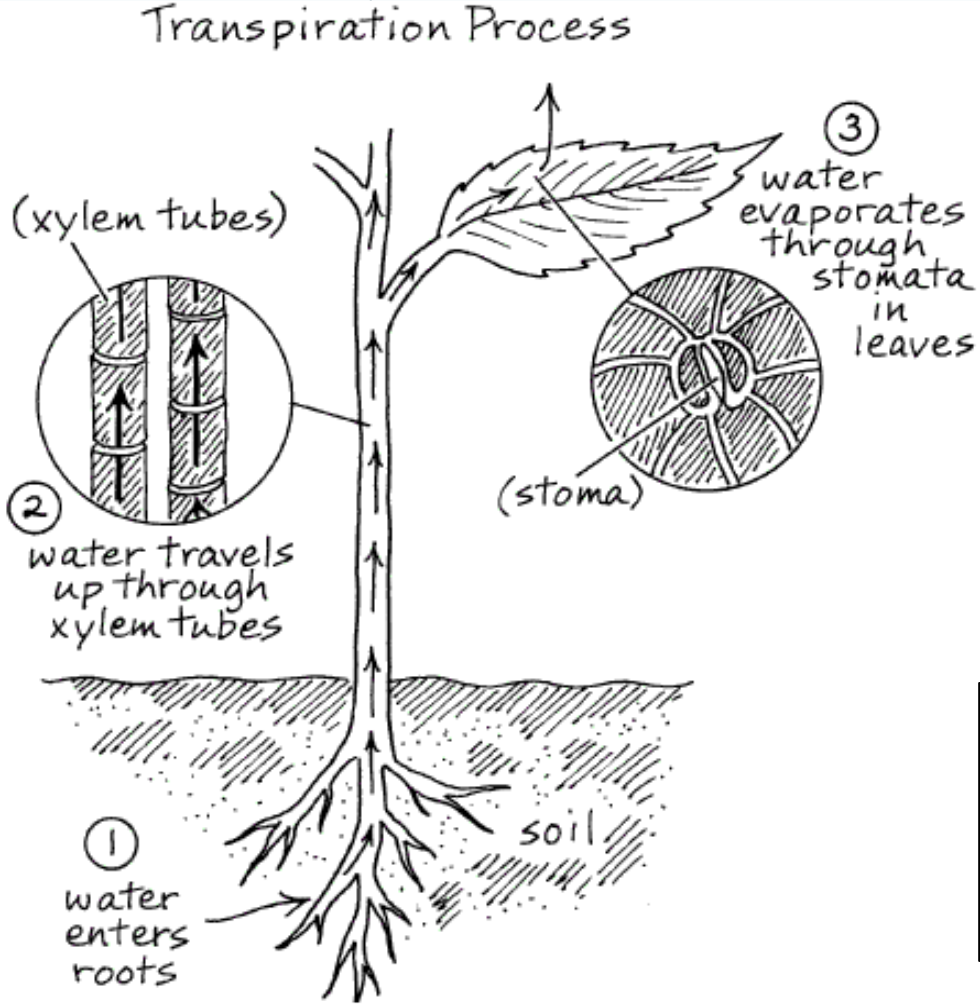
- Seed germination
- Growing seasons
- Flowering and seed dispersal

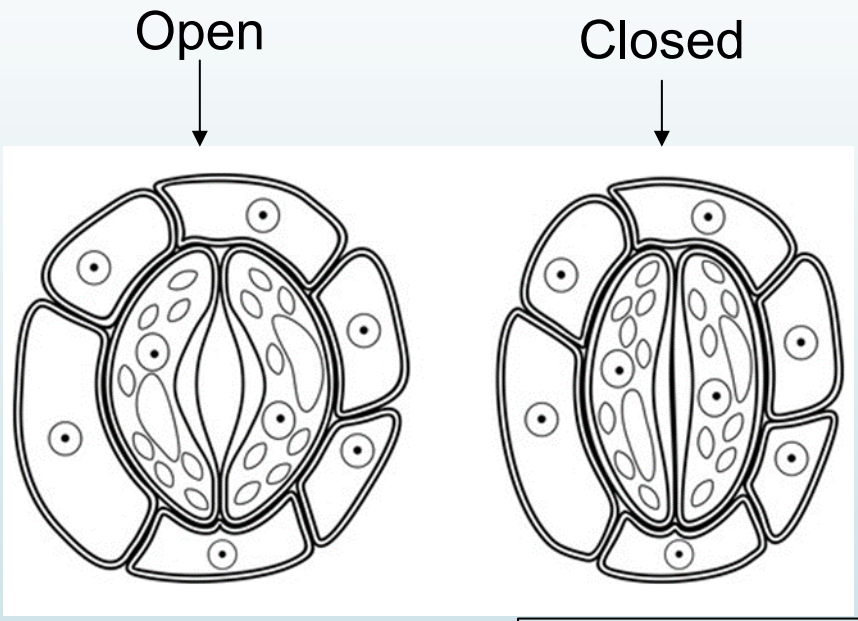
However, we are not concerned with this for Unit 4.

What you need to know are the adaptation of XEROPHYTES and HALOPHYTES.

Firstly- lets review stomatal function.

- Stomates allow gases to enter and leave the leaf.



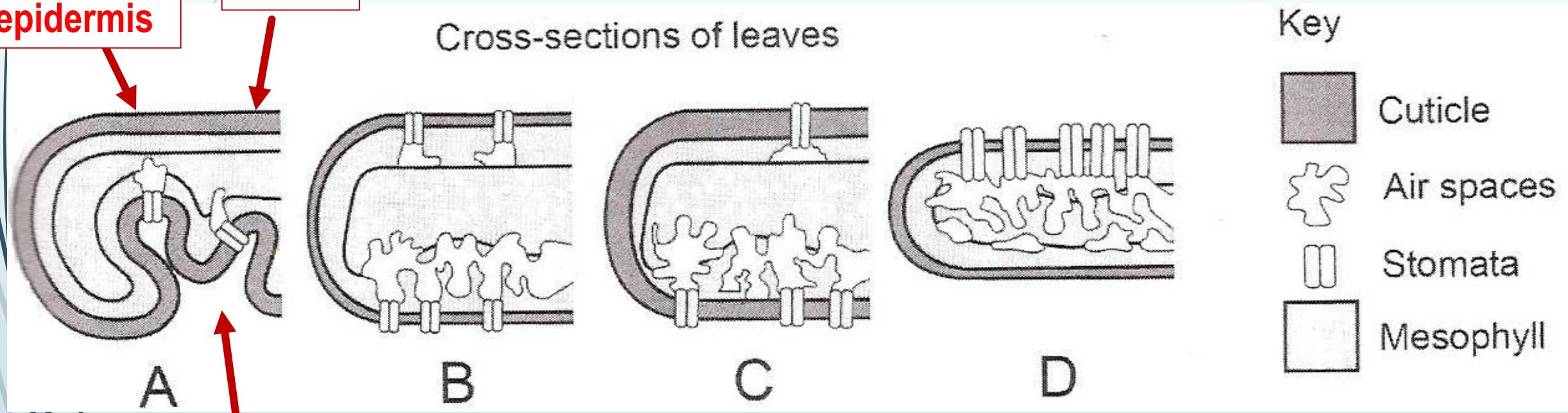


Guard cells are turgid: 'bean' shape.
Allows gases in and out of leaf

Guard cells are flaccid, inner membrane close against each other.
No gas exchange.

Arid Environments

Question 6. Which of these leaves represents a xerophyte? Give reasons for your answer.

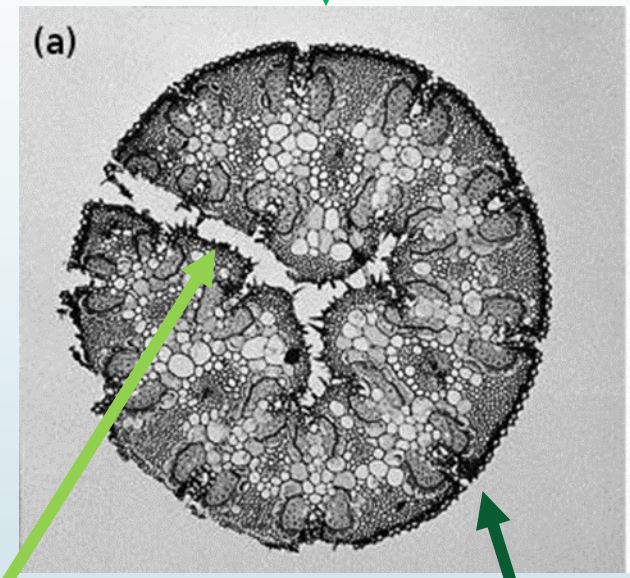


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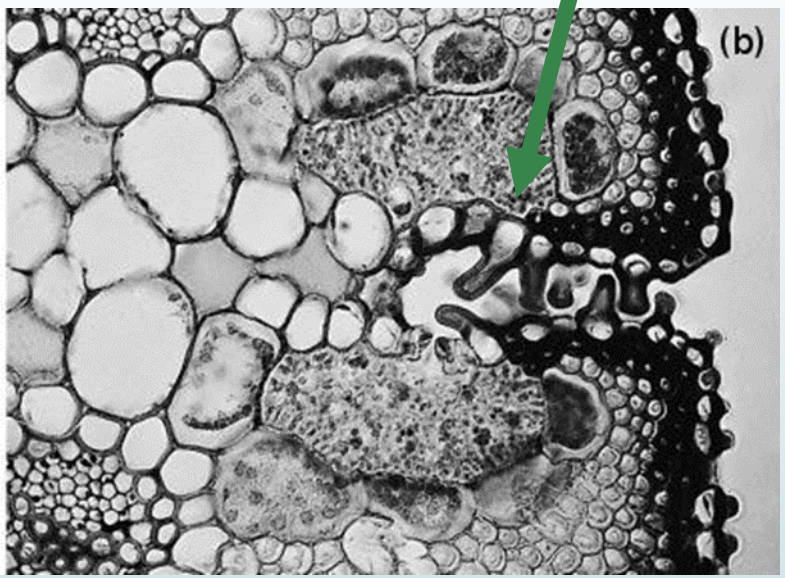
Q7: Spinifex Grass What adaptations can you see that help to prevent water loss?



Curled leaf



Hairs trap moisture increasing humidity around stomata



Air trapped inside the leaf is humid, reducing water loss

Stomata on upper epidermis are sunken

Question 8: WACE 2022 Extended Response

Explain how shallow branching roots with a high salt content and opening stomata only at night can help a plant to survive in an arid environment.

(10 marks)



First: Shallow branching roots [5 marks]

Second: Stomata opening at night [5 marks]

TIP: ***arid*** *environment; this means its all about gaining water and preventing water loss.*

Shallow branching roots [any 5 points for 5 marks]

- branching increases root surface area/surface area to volume ratio
- increases the chances of roots contacting water
- shallow means that roots are close to surface
- where the water is/to take advantage of surface water/rainfall before evaporation
- water uptake is via osmosis
- high salt means that there is (much) more salt in roots than in soil or a steep concentration
- this increases the rate of water uptake/osmosis

Stomata opening at night [any 5 points for 5 mark]

- stomata must be open sometimes (for gas exchange)
- water is lost through open stomata
- water is lost via evaporation/transpiration rate of evaporation is lower if environment is cooler/more humid or higher if environment is warmer/drier
- environment is likely to be cooler/more humid at night or warmer/drier during the day
- plants will lose less water if they open stomata at night or plants would lose more water if they opened stomata during the day

BRAIN BREAK



Infectious Disease

Understand the ways in which infection, transmission and spread of disease occur in vector-borne diseases

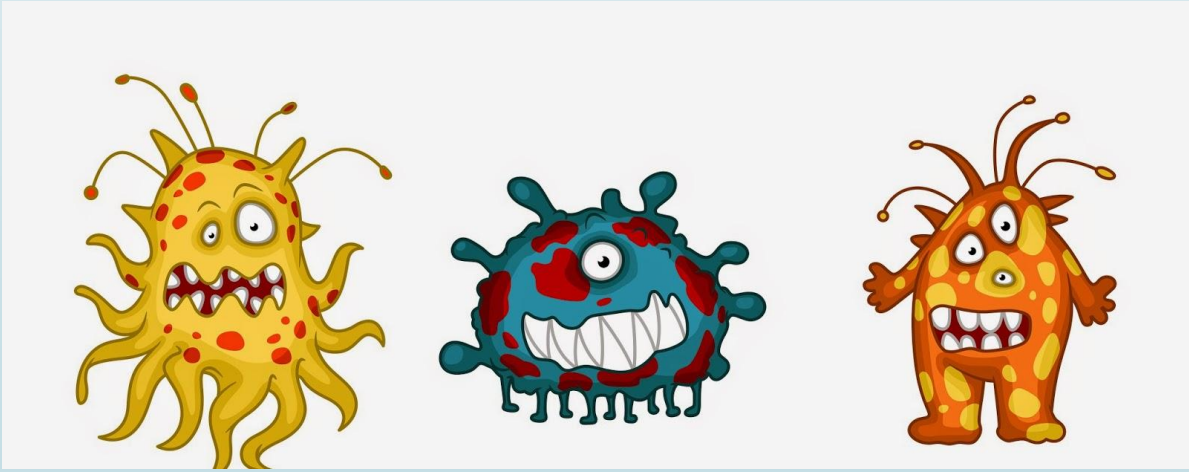
- Infectious Disease
- Zoonoses
- Bacteria
- Fungi
- Protists
- Viruses
- Spread of disease
- Management Strategies

Do you know your diseases?

The following diseases are prescribed in the syllabus.

- Tuberculosis
- Crown gall
- Chytridiomycosis [amphibian frog disease]
- Malaria
- Phytophthora [dieback]
- Influenza [flu]
- Ross River virus
- Viral diseases of honeybees

- Life cycle
- Method of invading host
- Impact on host
- Mode of transmission
- Survival success



Disease	Organism causing the disease	Organism affected by the disease
Tuberculosis	**BACTERIA**	**HUMAN**
Crown Gall	**BACTERIA**	**PLANTS**
Chytridiomycosis	**FUNGUS**	**FROG**
Phytophthora dieback	**PROTIST**	**PLANTS**
Influenza	**VIRUS**	**HUMAN**
Ross River	**VIRUS**	**HUMAN**
Malaria	**PROTIST**	**HUMAN**

Malaria: tips and tricks for answering questions

- Must know:
  - Life cycle- sexual (mosquito host) and asexual (human host)
  - Transmission: how, prevention
  - Management
- Links:
  - Global climate change and distribution





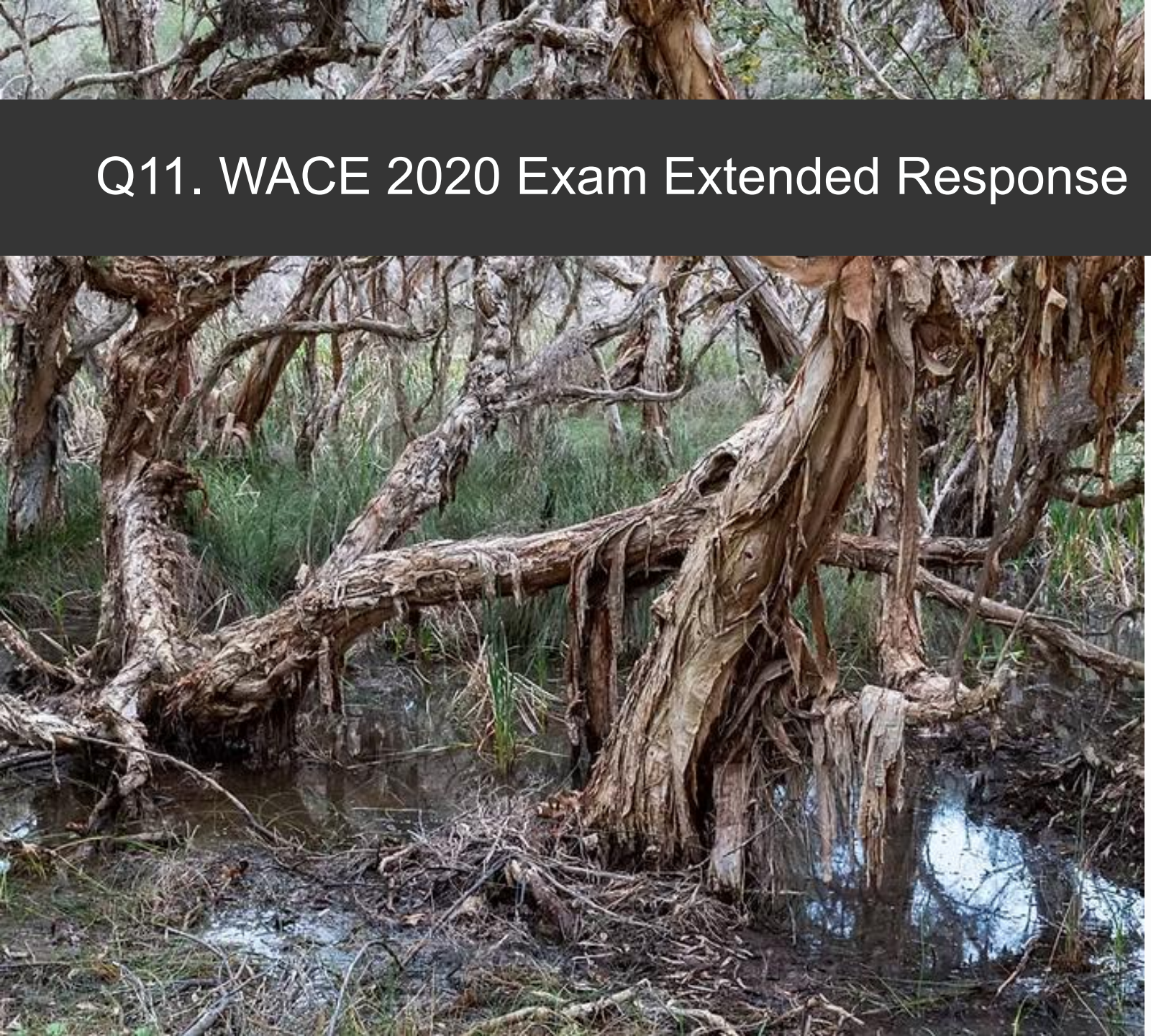
Q 10. **<u>Malaria</u>** is common among people living at *low altitudes in tropical regions* but is much *rarer at higher altitudes,* where the *temperature is cooler*. Global climate change is predicted to *increase the risk of malaria transmission at higher altitudes* in tropical regions.

<u>Explain why.</u>

(<u>4</u> marks)

- (Malaria is) Transferred by mosquito/Mosquito vector/Anopheles
- Mosquito thrives in a warm, moist environments OR is rare in cooler environments/at higher altitudes
- (Global climate change will) increase temperature and rainfall at higher altitudes
- Mosquito will spread to higher altitudes or will increase in abundance at higher altitudes OR will be more active at higher altitudes
- Mosquito will take the disease with it when it spreads OR people are more likely to be bitten if mosquitoes are more abundant/more active
- (Higher temperature) Will speed up the life-cycle of the pathogen/ Plasmodium/ protozoan
- This will increase the abundance of the pathogen
- Greater abundance of pathogen, means the risk of transmission is higher

Q11. WACE 2020 Exam Extended Response



Assess the **biological factors** that make malaria a difficult disease to **control**.

(10 marks)

Tips:

3 main factors to consider:

1. Vector- mosquito
2. Pathogen- plasmodium
3. Host- humans

Introduction:

- the lifecycle of the pathogen is complex, or the lifecycle of the pathogen involves a (mosquito) vector and a (human) host
- (therefore) difficult to disrupt life-cycle of pathogen

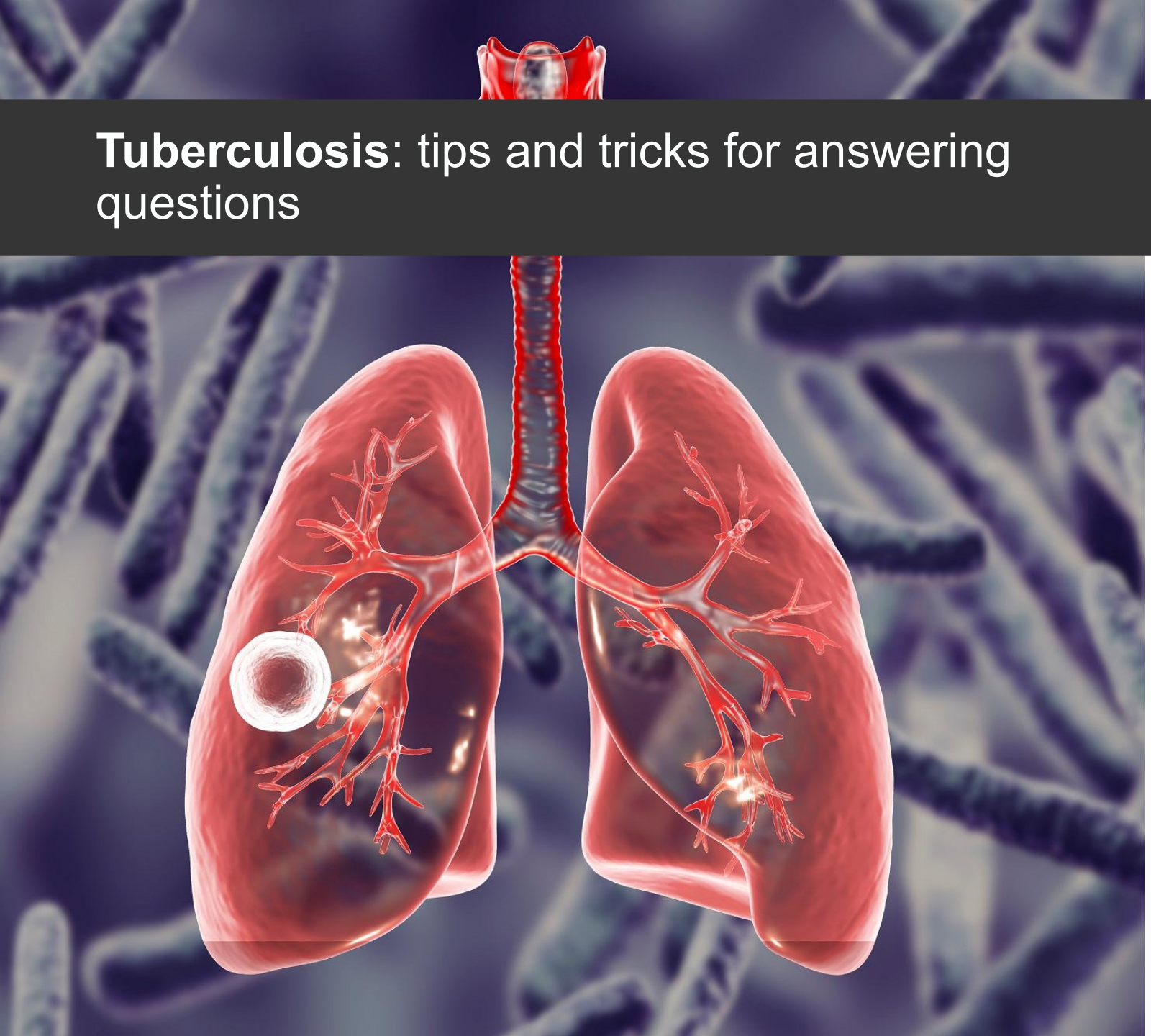
1. Vector: mosquito any 3 points for 3 marks

- mosquitoes evolve resistance to insecticides/pesticides/chemicals
- mosquitoes can breed quickly or build up population numbers quickly
- mosquitoes can breed in small/inaccessible places or often difficult to remove/treat mosquito breeding grounds
- mosquito has a wide range or range of mosquito is increasing with climate change
- Mosquitoes are asymptomatic therefore presence in new areas will not be obvious until host display symptoms

2. Pathogen- plasmodium any 3 points for 3 marks

- anti-malarial drugs are not always effective, or plasmodium/protist/pathogen evolve drug resistance
- difficulty developing a vaccine/vaccine has limited effects
- multiple strains of plasmodium/protist/pathogen make it harder to develop vaccine/effective drug
- long incubation/pathogen can be dormant/affected individuals can be symptomless
- multiple phases/stages that reproduce/increase the number of infectious particles
- 3. Host- Human any 2 points for 2 marks
- common in areas with limited healthcare/equipment/resources to buy medicine/supplies to reduce mosquito bites
- hard to prevent mosquito bites

Tuberculosis: tips and tricks for answering questions



Must know:

- Transmission
- Impacts
- Prevention and treatment

Links:

- Vaccination- herd immunity
- Antibiotic resistance

WACE 2023 Short answer question

12.a. Outline how tuberculosis is transmitted. (2 marks)

12.b. Explain why antibiotics are used to treat tuberculosis, but not influenza. (4 marks)

12.c. Explain how these resistant strains have arisen. (5 marks)



12a. Any 2 points for 2 marks

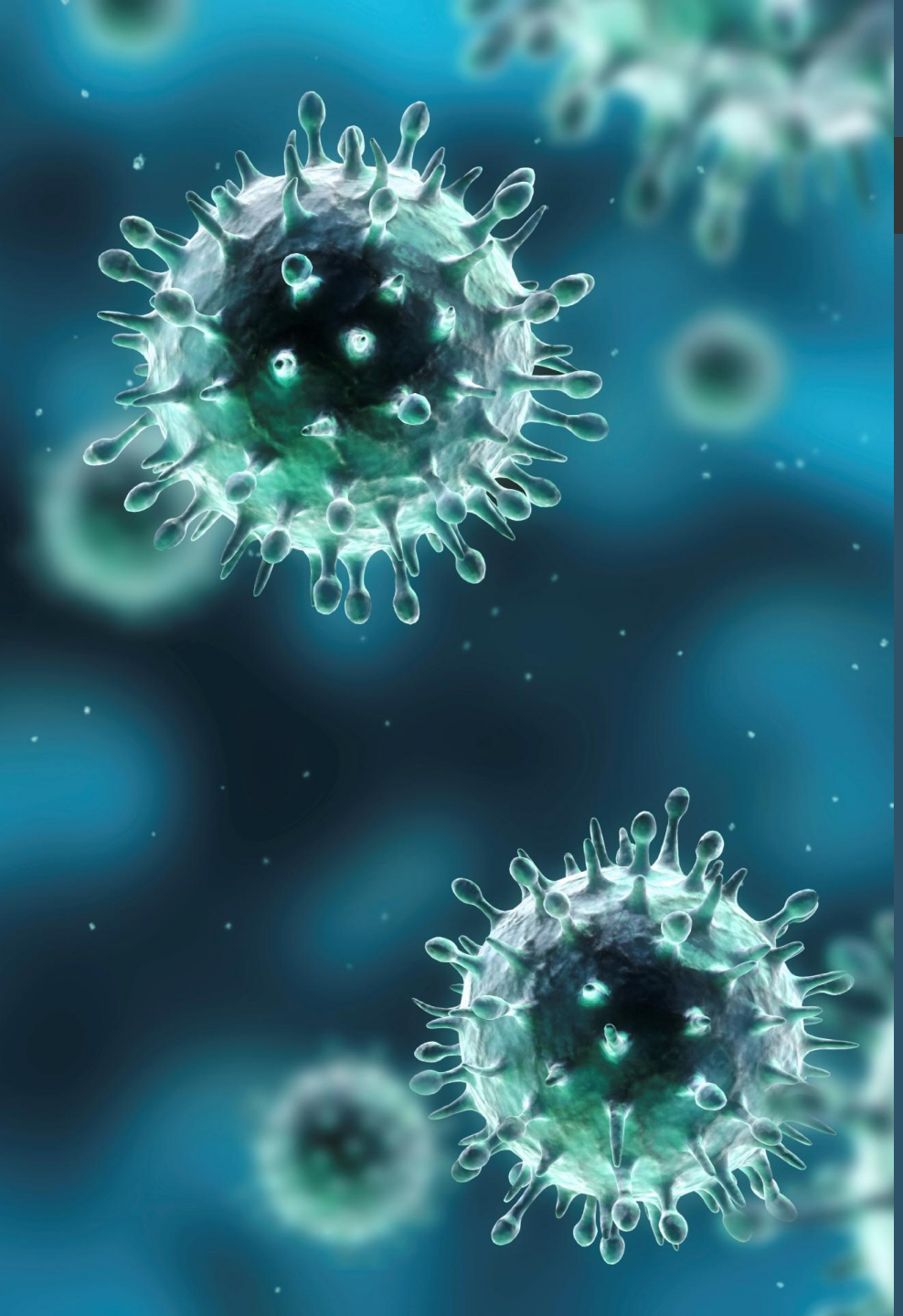
- airborne or spread through air
- pathogen is release into air when infected people breath/cough/speak
- (pathogen) is inhaled by new host

12b. Any 4 points for 4 marks

- tuberculosis is caused by a bacterium
- influenza is caused by a virus
- antibiotics affect bacteria but not viruses
- antibiotics affect cell structures/ribosomes/cell walls/DNA replication that occur in bacteria/that do not occur in viruses
- influenza is treated with antiviral medication rather than antibiotics

12c. Any 5 points for 5 marks

- natural selection/selection pressure/mutation generates resistance
- some bacteria are resistant to antibiotics
- these bacteria survive/reproduce, or susceptible bacteria do not survive reproduce
- number of resistant bacteria increases, or frequency of resistant allele increases through time
- bacteria have a short generation time, so resistance will evolve over a short period of time
- long treatment increases chances people will not complete treatment or fail to complete antibiotic course, increases chances some resistant bacterial cells will survive



Influenza: tips and tricks for answering questions

- **Must know!**
  - Life cycle
  - Transmission
  - Management
- **Links to:**
  - Vaccination- herd immunity
  - Public Health



Q13. Influenza

WACE 2024 Extended Response

Using influenza as an example, **explain why** urban areas are susceptible to epidemics and **how** vaccination and **three other** healthcare provisions can *reduce disease transmission*.
10 marks

Tip: answer in 3 parts:

1. Urban areas- what factors affect transmission?
2. Vaccinations- how they prevent disease transmission?
3. Other healthcare provisions

Previous slide continued

1. Urban areas any 4 points for 4 marks

- influenza is easily spread or transmitted via direct contact or airborne particles
- urban areas have high population density
- increases disease/influenza transmission
- uninfected people are more likely to come into contact with an infected person
- increased travel/migration to urban areas increases the chance of introducing a new strain (little resistance in population)



2. Vaccination any 3 points for 3 marks

- vaccines give people immunity (without catching the disease)
- reduces the chances of an individual catching the disease (even if they are in contact with an infected individual)
- spread of disease will slow/transmission will be reduced if a large proportion of the population are vaccinated/immune/with herd immunity

3. Other healthcare provisions any points for 3 marks

- education/advice about good hygiene/mask wearing/hand washing
- can implement isolation/quarantine of infected people
- antiviral medication to reduce severity/duration of symptoms
- monitoring/reporting can result in early detection/early implementation of control measures

Q14. Viral Reproduction: LYTIC Phase

1. **Virus particle binds to the wall of the host**

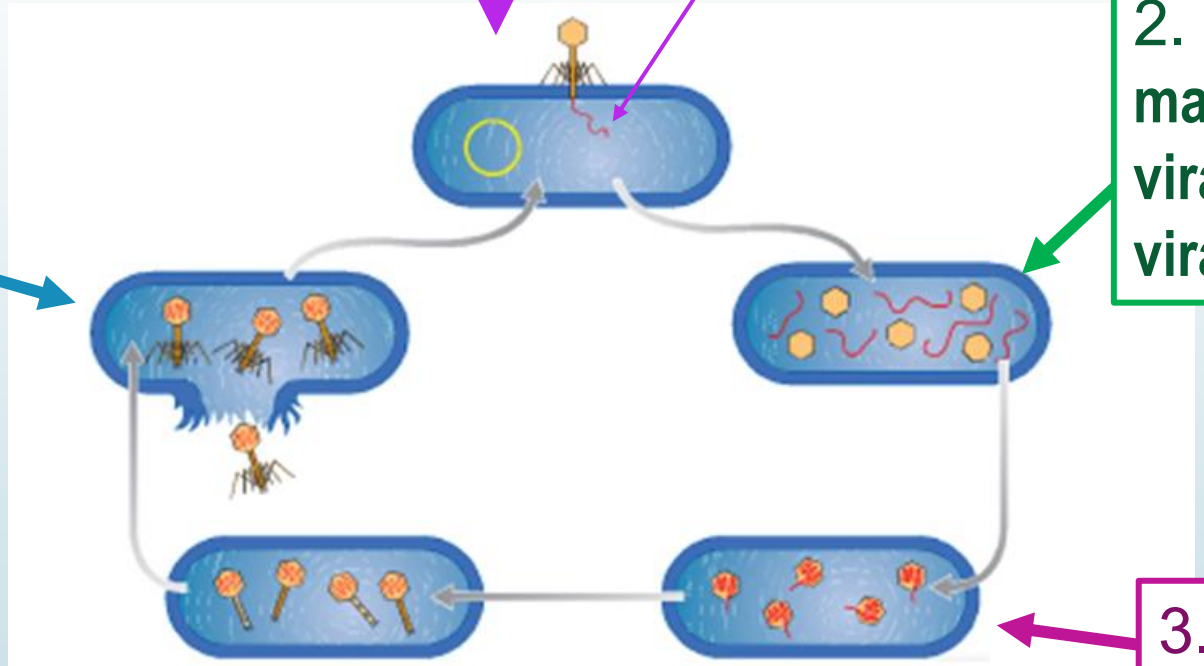
Viral DNA enters cell's cytoplasm

2. **Viral DNA directs cell machinery to produce viral proteins & copies of viral DNA**

3. **Viral proteins are assembled into 'coats' → DNA packaged inside**

4. **Tail fibres & other components are added to coats**

5. **Host cell undergoes LYSIS & dies. Infectious viral particles are released.**



Viruses can remain dormant, this is called the LYSOGENIC Phase.

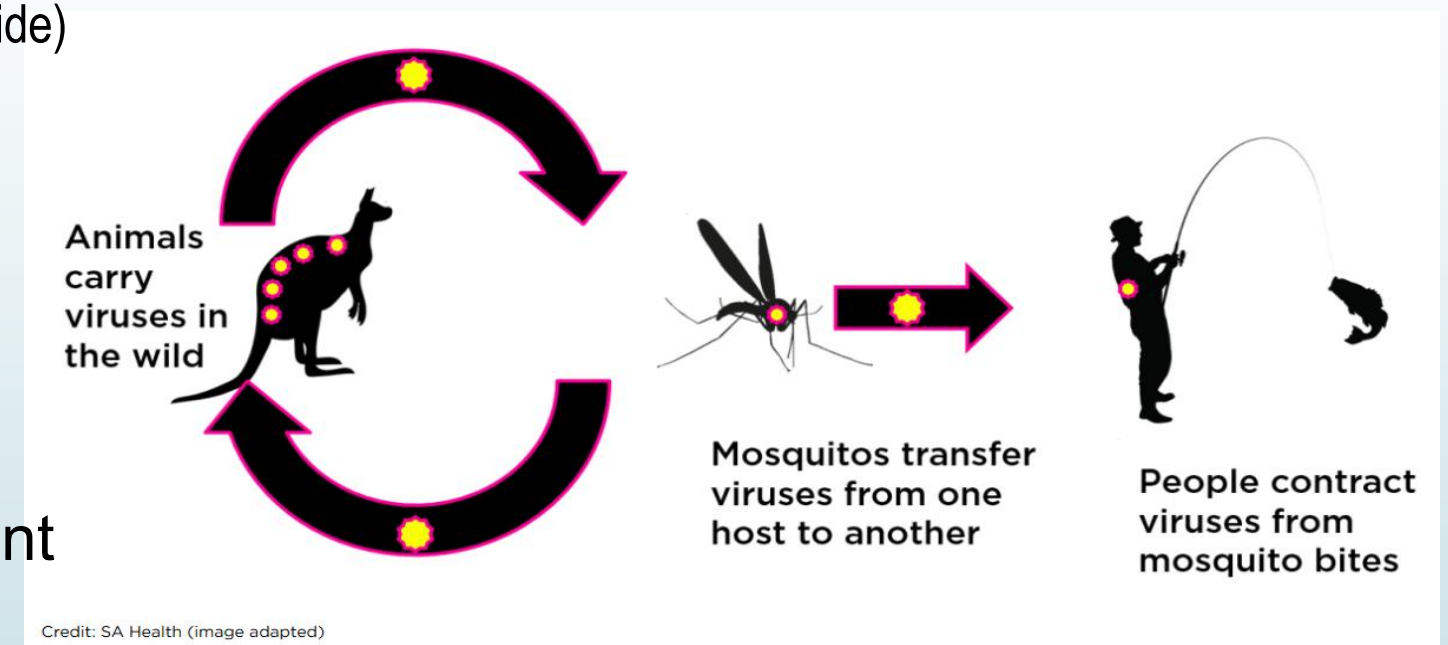
Ross river virus: tips and tricks for answering questions

Must know!

- Life cycle (see previous slide)
- Transmission
- Symptoms
- Prevention

Linked to:

- Mosquito management
- Zoonoses/animal vectors



Management Strategies- Ross River virus
and other mosquito-borne diseases

Preventing bites	Disrupt lifecycle of pathogen (mosquito control)
• alter behaviour to avoid mosquitoes: do not go outside at dawn/dusk/peak mosquito activity • wear protective clothing: long sleeved loose clothing. • use personal insect repellent when outdoors • use screens on windows/doors or use mosquito nets	• remove breeding sites or reduce amount of standing water • use insecticide/fogging on wetland areas • biological control agent ie microbats, mosquito fish

Chytridiomycosis: tips and tricks for answering questions

Must know!

- Life cycle
- How it affects frogs
- Symptoms

Links to

- metabolism



WACE 2017 Extended Response Question

3 parts to this question!

Q 16. Describe the life cycle of ***the pathogen that causes chytridiomycosis*** (amphibian chytrid fungus disease) and **discuss** the ***impact that the pathogen has on the host*** and the ***mode of transmission*** of the pathogen.

(10 marks)



Describe the life cycle of ***the pathogen that causes chytridiomycosis*** (amphibian chytrid fungus disease) up to 5 marks

- **Fungus/Thallus produces (zoo)spores**
- **Spores are produced by asexual reproduction**
- **(Zoo)spores are released into water (or reinfect host)**
- **(Zoo)spores swim**
- **Encounter/invade host Invade skin cell/surface layer of skin**
- **Zoospores develop into a thallus**
- **Thallus matures (into sporangium)**

Discuss the ***impact that the pathogen has on the host.*** *Any three for* 3 marks

Nervous system:

- **affects frog's behaviour/sit out in sun**
- **sluggish, no appetite**
- **has its legs spread slightly away from itself**

Part of frog's skin that has keratin:

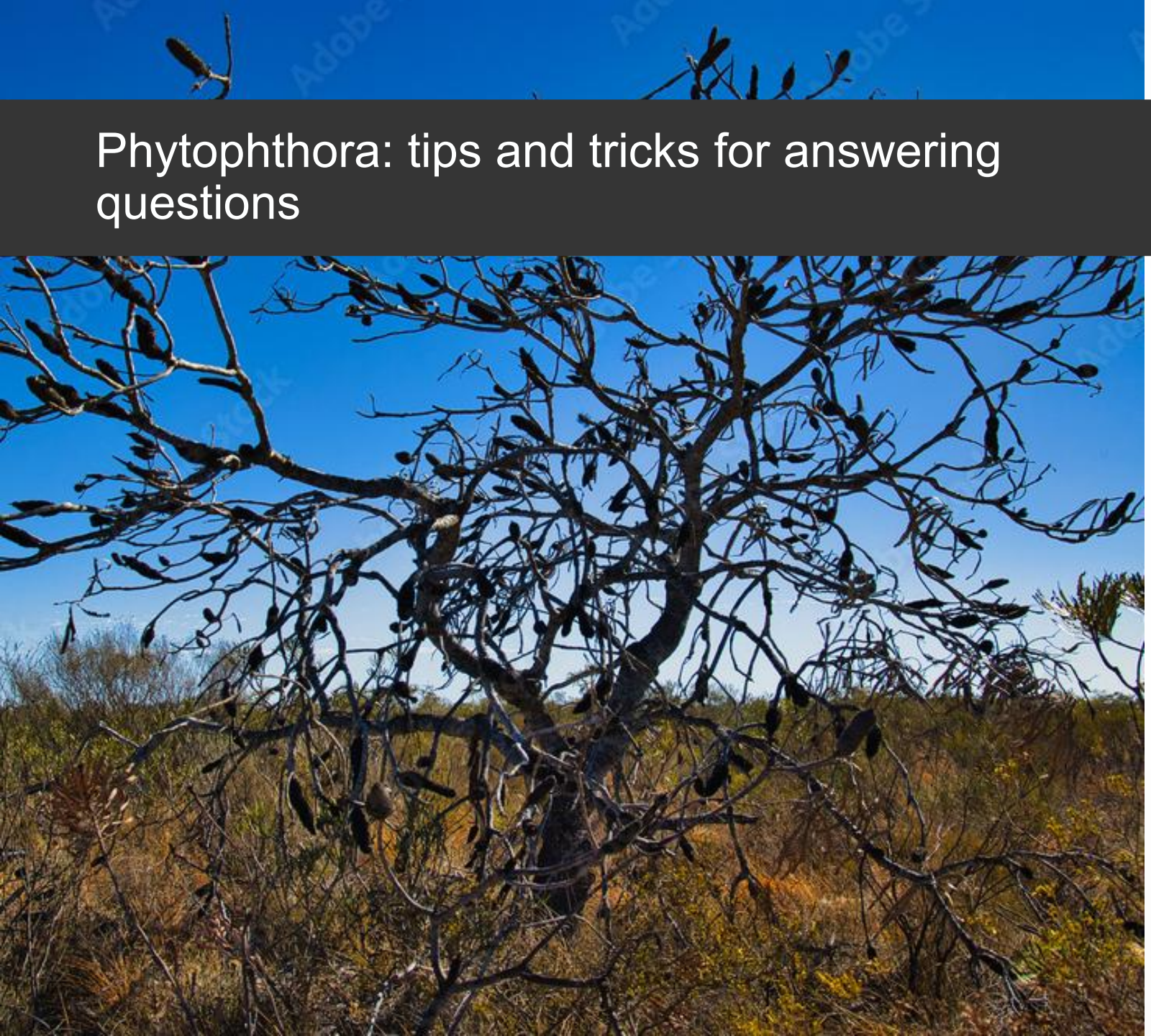
- **Causes skin cells to shed/thicken/harden**
- **Disrupts function of skin cells (disrupting homeostasis)**
- **Frogs use skin to exchange gases and water and salts**
- **Leads to osmotic problems**

- **Frogs die (cardiac arrest)**

discuss …the ***mode of transmission*** of the pathogen. Any two for 2 marks

- **Contact with contaminated water/water containing zoospores**
- **Direct contact between frogs**
- **Humans or other animals (e.g. ducks) (may spread over land)**
- **Transmission outside of water is not well known**

Phytophthora: tips and tricks for answering questions



Must know

- Lifecycle
- Transmission
- Management

Links

- Survival adaptations

2020 WACE short answer question 31

Q17. The pathogen that causes jarrah dieback is a type of protist.

(a) (i) **List** two structural features of protists that are not found in bacteria. (2 marks)

- protists are eukaryotes/have a nucleus
- protists have membrane-bound organelles/mitochondria
- cell walls of protists are made of cellulose (not peptidoglycan)

(ii) **List** two structural features of protists that are not found in fungi. (2 marks)

- protists are (usually) unicellular
- protists (often) have flagella (except in Chytrid zoospores)/cilia
- cell walls of protists (when present) are made of cellulose (not chitin)

2020 WACE short answer question 31 continued

In order to prevent the spread of jarrah dieback, vehicles are banned from driving on some tracks when the soil is wet.

(b) Explain how this can prevent the spread of jarrah dieback. (4 marks)

- disease is spread (from plant to plant) by spores/zoospores
- spores/zoospores are more active when it is wet
- vehicles pick up more (contaminated) soil when it is wet; (therefore) risk of transmission/spread is greater when the soil is wet
- vehicles can spread disease/spores/zoospores over a large area



Crown gall *(agrobacterium)*: tips and tricks for answering questions

Must know!

- Life cycle
- Mode of infection

Links to:

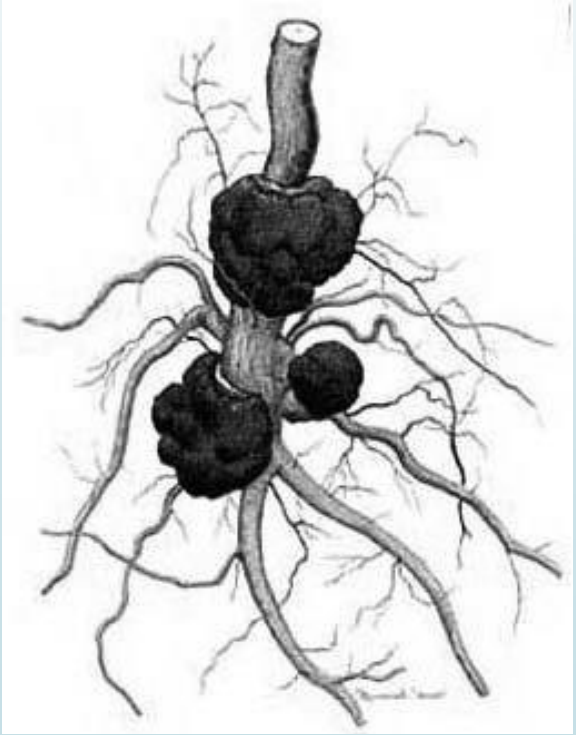
- Biotechnology

Q18: For crown gall disease, **explain how** the pathogen invades the host and causes disease, and **two** distinctly different *management strategies* to prevent the spread of the disease. (10 marks) WACE 2024

NB this is almost exactly same as a question on Crown Gall in the 2020 WACE exam!

Tips! Answer in 3 parts:

- Invasion
- How It causes disease
- Management strategies



Q18 answers

Invasion:

- Enters through a wound on the plant
- Inserts plasmid into the host genome

How it causes disease:

- Causes rapid division of host (plant) cells
- Develop into ‘galls’ (balls/tumours) on roots, where roots join to trunk and main stem & branches.
- Reduces ability of plants to resist stressful conditions ie drought.

Q18 answers

Management Strategies (any 2 explained – 2 marks each strategy)

- Prevent damage to plants **OR** keep tools clean
  - Stops the transfer of bacteria/pathogen from plant to plant.
- Destroy infected plants **OR** apply chemical control
  - Kill/reduce number of bacteria in soil/environment.
- Apply biosecurity measures at borders **OR** inspect imported plants/soils/ quarantine infected plants/soils
  - To contain disease to a certain area **OR** stop introduction of disease to an area
- Education/public awareness
  - So, people can recognise disease and act quickly **OR** know about control measures

Viral diseases of Honeybees



Must know!

- Virus: structure, life cycle
- Management strategies

Links to:

- Disease vector: *Varrora* mite

Q19 Honeybees suffer from a range of viral diseases.

a. (i) List two main structural features of a virus.

- Protein coat/protein layer/capsid
- Any one of: nucleic acid/ RNA/ DNA

Many biologists do not regard a virus as a living organisms.

(ii) List two characteristics of a virus that suggest that it is not a living organism.

- Cannot reproduce without a host
- Does not have cellular structure/cell organelles
- Does not produce own energy/does not respire
- Does not grow

(WACE 2021)

Q19 continued…

One of these viruses, the deformed wing virus, causes shrunken and abnormal wings in honey bees, as shown in the honey bee in the photograph below. The *varrora* mite (a type of arthropod) invades honey bee colonies, and attacks and feeds on the bees. It is a vector for this virus.



b. (i) Is deformed wing in honey bees an infectious
Give reasons for your answer.

Yes (must be stated)

because caused by a pathogen (must say pathogen)

Can be transmitted

Q19 continued…

b. (ii) State what is a disease vector.

- An organism/agent that transmit a pathogen
- Into another species/type of organism eg mite to bee

c. The *varrora* mite is common in many countries but there is no established infestation in Australia. However, the mite has been detected in a bee colony in Queensland. Outline two measures that could be used to reduce the chances of this mite becoming established in Australia. (4 marks)



Q19 continued…

Any two – 2 marks each

- Biosecurity measure: prohibit/stop import of bees/bee products (contaminated with mite)
  - Stop mite entering Australia
- Monitoring: bee colonies in Australia for mite infestation.
  - Destroy/treat infested bee colonies (before mite can spread)
- Limit movement of bees/bee products within Australia
  - Infestations remain localised
- Education: beekeepers/ general public about varrora mite
  - Increase chances of detecting mite early OR people following biosecurity measures.


and they lived happily ever after.
hashtag the end.
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