# Respiratory Systems Revision

A Level

## Part A Fish gills

Which of the following statements describe how fish gills take in oxygen? Select all that apply.

- [ ] water moves in through the mouth and **out** across the gills
- [ ] water moves **in** across the gills and out through the mouth
- [ ] blood is pumped through the gills in the **same** direction to the flow of water across the gills
- [ ] blood is pumped through the gills in the **opposite** direction to the flow of water across the gills
- [ ] because blood and water flow in the **same** direction, a steep diffusion gradient is maintained across the gill capillaries, thus increasing gas exchange efficiency
- [ ] because blood and water flow in **opposite** directions, a steep diffusion gradient is maintained across the gill capillaries, thus increasing gas exchange efficiency

## Part B Mammalian lungs adaptations

Fill in the table below by matching the feature of the mammalian lungs to the description of how this feature improves efficiency of gas exchange between the air and the bloodstream.

| Feature | How this feature improves efficiency of gas exchange |
|---|---|
| | ensures a very small distance for gases to diffuse across |
| | increases the surface area for diffusion of gases to occur |
| | increases the concentration gradient of oxygen by ensuring that the lungs are continuously supplied with oxygen-poor blood |
| | increases concentration gradient of oxygen by ensuring that the lungs are continuously filled with oxygen-rich air |

Items:

**lungs are composed of a large number of alveoli**

**alveoli are surrounded by blood capillaries**

**alveoli are lined with a thin layer of cells (squamous epithelium)**

**lungs are actively ventilated**

## Part C Mammalian ventilation

Which of the following statements describe how mammalian lungs take in air? Select all that apply.

- [ ] The diaphragm **contracts**, changing from a more domed shape to a flatter shape, causing the lungs to expand downwards.
- [ ] The diaphragm **relaxes**, changing from a flatter shape to a more domed shape, causing the lungs to expand downwards.
- [ ] The external intercostal muscles **contract**, causing the lungs to expand outwards and upwards.
- [ ] The external intercostal muscles **relax**, causing the lungs to expand outwards and upwards.
- [ ] The expansion of the lungs **increases** thoracic pressure, which causes air to move into the lungs from outside the body.
- [ ] The expansion of the lungs **decreases** thoracic pressure, which causes air to move into the lungs from outside the body.

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## Part D Pulmonary ventilation

A group of students were investigating the effect of exercise on pulmonary ventilation.

The table below shows some of the results recorded for one of the students in the group.

| | |
|---|---|
| Tidal volume | $0.45\ \mathrm{dm^3}$ |
| Vital capacity | $3.45\ \mathrm{dm^3}$ |
| Mean breathing rate at rest | $14\ \mathrm{min^{-1}}$ |
| Mean breathing rate during exercise | $18\ \mathrm{min^{-1}}$ |

Calculate the total volume of air that moved in and out of this student's lungs in a five minute period **before** the start of exercise.

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# Circulatory Systems Revision

A Level

## Part A Double circulation

Which of the following statements about double circulation are correct? Select all that apply.

- [ ] double circulation refers to the fact that the heart has two types of chambers: atria and ventricles
- [ ] double circulation refers to the fact that blood passes through the heart twice for each complete circuit of the circulatory system
- [ ] all vertebrates have a double circulatory system
- [ ] mammals and birds have a double circulatory system, whereas fish have a single circulatory system
- [ ] double circulation ensures that blood travels through the body at a higher pressure and faster speed than in a single circulatory system
- [ ] double circulation ensures that blood travels through the body at a lower pressure and slower speed than in a single circulatory system

## Part B Systole vs diastole

In the table below, show which process each statement refers to: systole or diastole.

| Statement | Systole or Diastole |
|---|---|
| blood moves from the vena cava and pulmonary veins into the atria | |
| blood moves from the ventricles out into the aorta and pulmonary artery | |
| the semi-lunar valves open | |
| the atrioventricular valves open | |
| caused by electrical excitation (i.e. depolarisation) | |

Items:

**systole** **diastole**

## Part C Oxygen saturation

In mammalian blood, oxygen is mainly transported combined with haemoglobin. The presence of haemoglobin greatly increases the oxygen carrying capacity of blood.

- $100\,\mathrm{cm}^3$ of plasma contains $0.3\,\mathrm{cm}^3$ of oxygen when fully saturated.
- $100\,\mathrm{cm}^3$ of blood contains $20.1\,\mathrm{cm}^3$ of oxygen when fully saturated.

Calculate the percentage increase in oxygen carried in fully saturated blood compared with oxygen carried in fully saturated plasma. Give your answer to the nearest percent.

## Part D Cardiac output

The average stroke volume of a particular person is $60\,\mathrm{ml}$, and their average heart rate is $82\,\mathrm{bpm}$.

Calculate this person's cardiac output.

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**STEM SMART Biology Week 22**

# Capillary Pressures and Interstitial Fluid

A Level

**Figure 1** below shows a capillary (**c**) surrounded by interstitial fluid (**i**). Hydrostatic pressures (**P**) and oncotic pressures ($\pi$) are shown. All values are given in $\mathrm{mmHg}$.

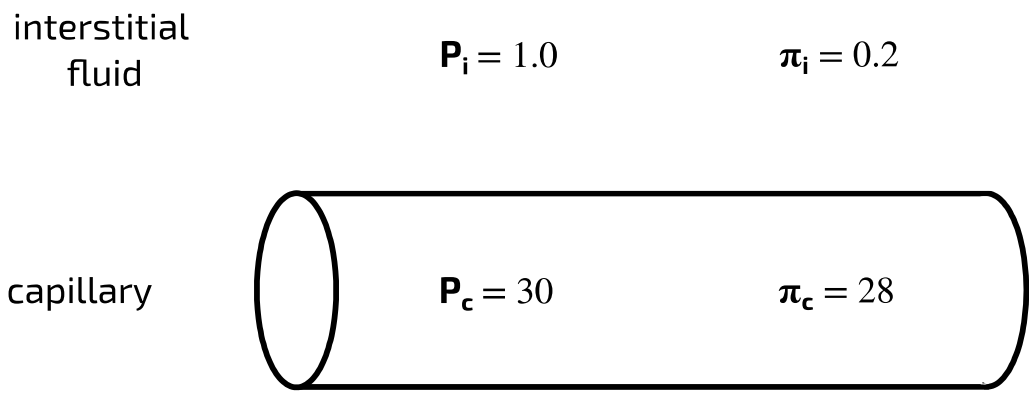


**Figure 1:** Hydrostatic and oncotic pressures in a blood capillary and in the surrounding interstitial fluid.

The net movement of fluid between the capillary and interstitial tissue is determined by the net driving force (NDF):

$$\mathrm{NDF} = (\mathbf{P_c} - \mathbf{P_i}) - (\boldsymbol{\pi}_\mathbf{c} - \boldsymbol{\pi}_\mathbf{i})$$

When NDF $> 0$, fluid leaves the capillary.

When NDF $< 0$, fluid enters the capillary.

## Part A Calculate the NDF

Calculate the net driving force (NDF) for the capillary shown in **Figure 1**.

Which of the following processes will occur? Select all that apply.

- [ ] fluid will enter the capillary
- [ ] fluid will leave the capillary
- [ ] interstitial fluid will be produced
- [ ] interstitial fluid will be lost

## Part B Pressure equilibrium

Assuming the other values remain the same (as in **Figure 1**), what value for the capillary hydrostatic pressure would result in no net fluid movement between the capillary and the interstitial fluid?

Adapted with permission from OCR A Level Biology B, June 2017, Fundamentals of Biology, Question 18

Gameboard:
**STEM SMART Biology Week 22**

# Plant Physiology Revision

A Level

## Part A Xylem vs phloem

Fill in the table below to compare xylem and phloem.

| Xylem | Phloem |
| --- | --- |
| xylem transports water and [ ] | phloem transports [ ] |
| xylem vessel walls are reinforced with [ ] | sieve tube walls have no additional support |
| xylem vessel walls contain [ ] that allow water to pass into adjacent vessels | there are many gaps in the cell walls between companion cells and sieve tube elements called [ ] |

Items:

lignin | chitin | plasmodesmata | mineral ions e.g. nitrates and phosphates | assimilates e.g. sucrose and amino acids | pits

## Part B Phloem loading

A scientist isolated companion cells and conducted some experiments to investigate the mechanism involved in loading sucrose into the sieve tubes. The scientist recorded the following observations:

- Observation 1: isolated companion cells became slightly negatively charged compared with their surroundings.
- Observation 2: companion cells could decrease the pH of the surrounding solution from $7.0$ to $5.6$.
- Observation 3: the pH inside the companion cells rose from $7.0$ to $8.2$.
- Observation 4: treatment with cyanide (which stops aerobic respiration) prevents the change in pH occurring.

Which of the following conclusions can be drawn from the observations above? Select all that apply.

- [ ] hydrogen ions are moving from the companion cells to the surrounding solution
- [ ] hydrogen ions are moving from the surrounding solution into the companion cells
- [ ] hydrogen ions are moving by passive transport
- [ ] hydrogen ions are moving by active transport

## Part C Xerophytes

Xerophytes are plants that are adapted to living in dry conditions.

The table below describes four general features of leaves. In each section, one leaf belongs to a xerophyte.

| | |
|---|---|
| **Presence of hairs on leaves** | |
| Leaf **A** | no |
| Leaf **B** | yes |
| Leaf **C** | no |
| **Mean number of stomata** $(\mathrm{cm}^{-2})$ | |
| Leaf **D** | 30 000 |
| Leaf **E** | 23 000 |
| Leaf **F** | 13 000 |
| **Mean surface area of one leaf** $(\mathrm{cm}^{2})$ | |
| Leaf **G** | 0.2 |
| Leaf **H** | 10.0 |
| Leaf **I** | 23.0 |
| **Thickness of cuticle** $(\mu\mathrm{m})$ | |
| Leaf **J** | 4.25 |
| Leaf **K** | 8.50 |
| Leaf **L** | 2.00 |

Which four leaves belong to xerophytes? Choose one from each section.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F

- [ ] G
- [ ] H
- [ ] I
- [ ] J
- [ ] K
- [ ] L

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Adapted with permission from OCR AS Level Biology A, June 2013, Cells, Exchange and Transport, Question 6 and OCR AS Level Biology A, June 2014, Cells, Exchange and Transport, Question 4

Gameboard:
**STEM SMART Biology Week 22**

# Xylem Calculations

A Level

A $0.2\,\mathrm{cm}$ long section of xylem, with internal diameter $60\,\mu\mathrm{m}$, was studied.

The velocity at which water was transported through the xylem in a plant was found to be $3.6$ metres per hour in the morning.

## Part A Velocity

Calculate the velocity of water transport in the xylem of this plant in the morning.

## Part B Internal volume

Calculate the internal volume of this section of xylem.

Give your answer to 2 significant figures.

## Part C How much water?

How much water would move through this section of xylem, per hour, in the morning?

Give your answer to 2 significant figures.

## Part D An increase in velocity

Later in the day, the velocity of water transport was measured and was found to be greater than in the morning.

Which of the following environmental factors could have resulted in this change in velocity? Select all that apply.

- [ ] increased sunlight
- [ ] decreased sunlight
- [ ] increased wind speed
- [ ] decreased wind speed
- [ ] increased humidity
- [ ] decreased humidity

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Adapted with permission from NSAA 2022 Section 2 Q53

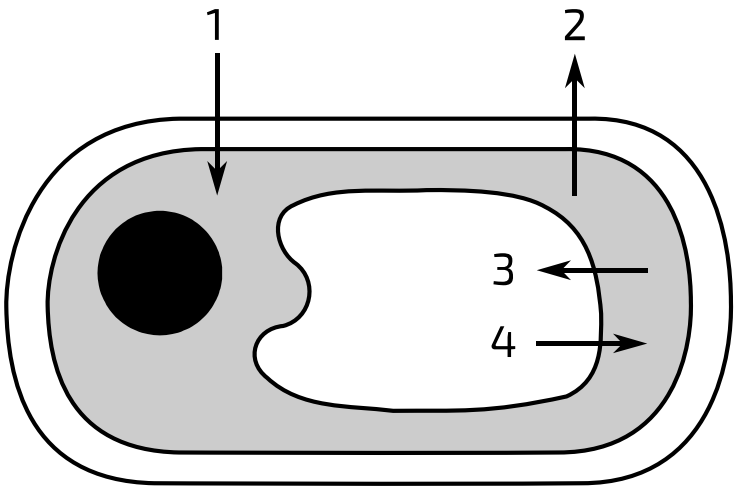
Gameboard:
**STEM SMART Biology Week 22**

# Plant Processes

A Level

## Part A Osmosis

The diagram below shows a plant cell.

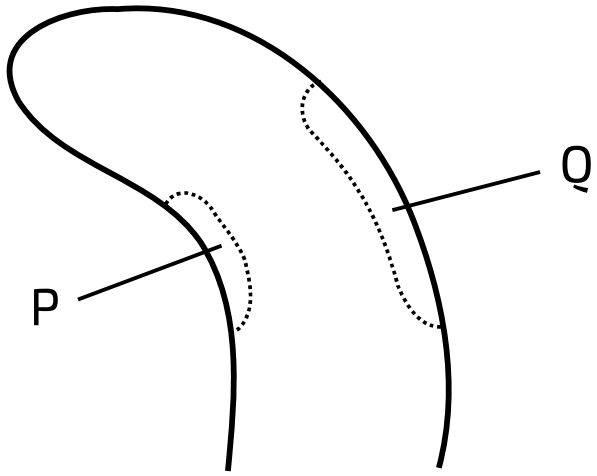



Which of the arrows on the diagram show the net movement of water molecules, by osmosis, when the cell is surrounded by a solution that is more concentrated than the solution in the cytoplasm? Select all that apply.

- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] none of the above

## Part B Growth

The diagram below shows the tip of a plant shoot, with two areas labelled P and Q.




Which of the following statements could explain the growth of this shoot? Select all that apply.

- [ ] Concentration of plant hormone is higher at Q than P.
- [ ] Unidirectional light has caused a change in the concentration of plant hormone at P.
- [ ] Cells at P are smaller than the cells at Q.

Question elements adapted with permission from NSAA 2016 Section 1 Q56 and Q63