UACE Biology 2023 paper 2

1. Figure 1 shows the effect of temperature variation on the rate of photosynthesis and respiration in leaves of the same plant. The plant was given adequate amount of light with other factors kept.
   Figure 2 shows the effect of temperature variation on the amount of carbon dioxide absorbed by two plants species; A and B. Plant A and B each uses different carbon dioxide fixation pathway.
   Study the two figures and answer the questions that follow

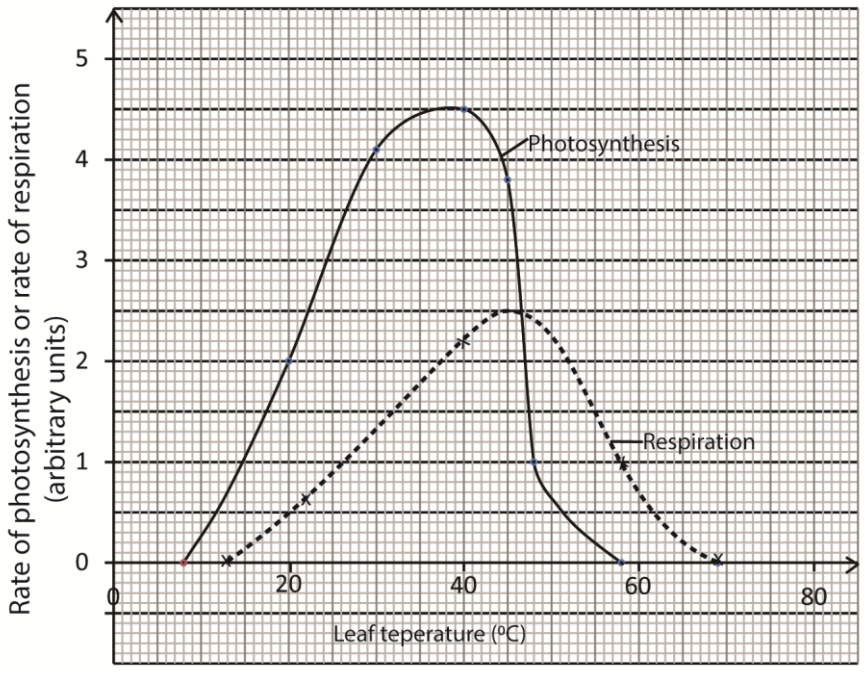


Fig. 1

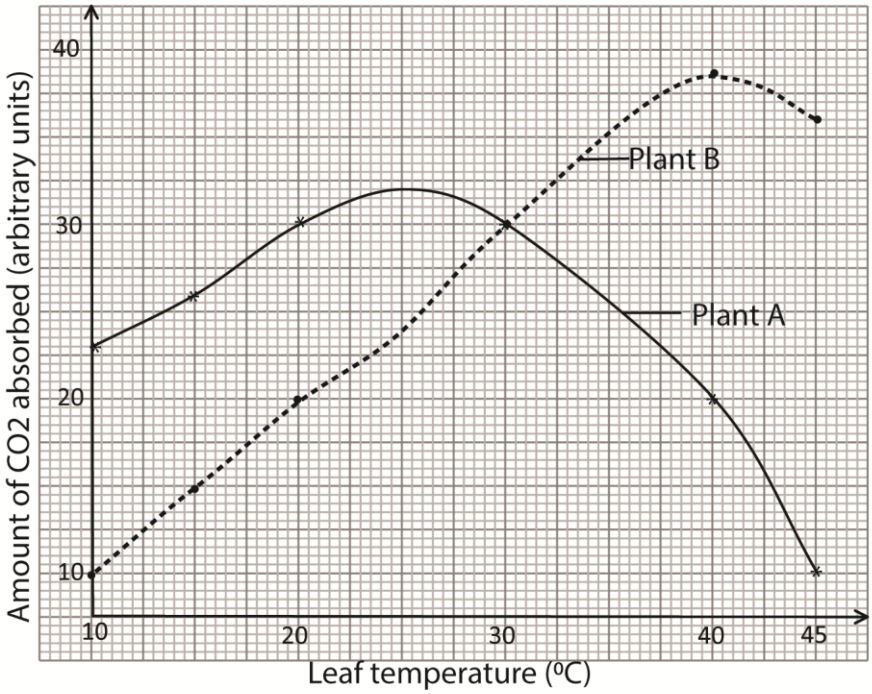


Fig. 2

(a) From figure 1
  (i) Describe the rate of photosynthesis varies with temperature of the leaf. (04 marks)
  (ii) Explain how the rate of respiration varies with temperature of the leaf. (05 marks)
  (iii) Explain how difference in the rates of photosynthesis and respiration between leaf temperatures of 40^0C and 70^0C. (08marks)
  (iv) Explain the relationship between respiration and photosynthesis. (04marks)

(b) Compare the amounts of carbon dioxide absorbed by each of the two plant species A and B in figure 2.

(c) From figure 1 and 2, suggest the plant species whose rate of photosynthesis was studied in figure 1. Give reason(s) for your answer. (04 marks)

(d) Explain any two other factors that affect the rate of photosynthesis. (04marks)

(e) Describe how carbon dioxide from the atmosphere is fixed in the bundle sheath cells.

SECTION B (60 MARKS)

Answer any three questions from this section

Any additional question(s) answered will not be marked

2. (a) Describe the ecological significance of each of the following forms of behaviour:
  (i) Territorial behaviour (06marks)
  (ii) Courtship behaviour (07marks)

  (b) Giving an example in each case, suggest ways by which animals avoid predation. (07 marks)

3. (a) Describe the structure of mature vascular tissue in flowering plants.
  (b) Explain how the movement of water from the soil provides support in a herbaceous plant? (05marks)
4. (a) How is human placenta adapted for exchange of materials between the mother and foetus? (05marks)

(b) The mammalian embryo develops inside mother's womb before being born. Explain the importance of this embryo development. (06marks)

(c) Describe the difference exchange mechanisms by which materials move between the foetus and the mother. (09 marks)

5. (a) Giving examples, describe the different functions performed by proteins in mammals. (14marks)

   (b) Explain the factors that can cause protein denaturation. (06marks)

6. (a) State three major distinguishing features of gaseous exchange in fish and terrestrial insects. (03marks)

   (b) How is gaseous exchange in a bony fish different from that of a cartilaginous fish?

   (c) How is ventilation in man controlled?

Suggested answers

1. Figure 1 shows the effect of temperature variation on the rate of photosynthesis and respiration in leaves of the same plant. The plant was given adequate amount of light with other factors kept.

   Figure 2 shows the effect of temperature variation on the amount of carbon dioxide absorbed by two plants species; A and B. Plant A and B each uses different carbon dioxide fixation pathway. Study the two figures and answer the questions that follow

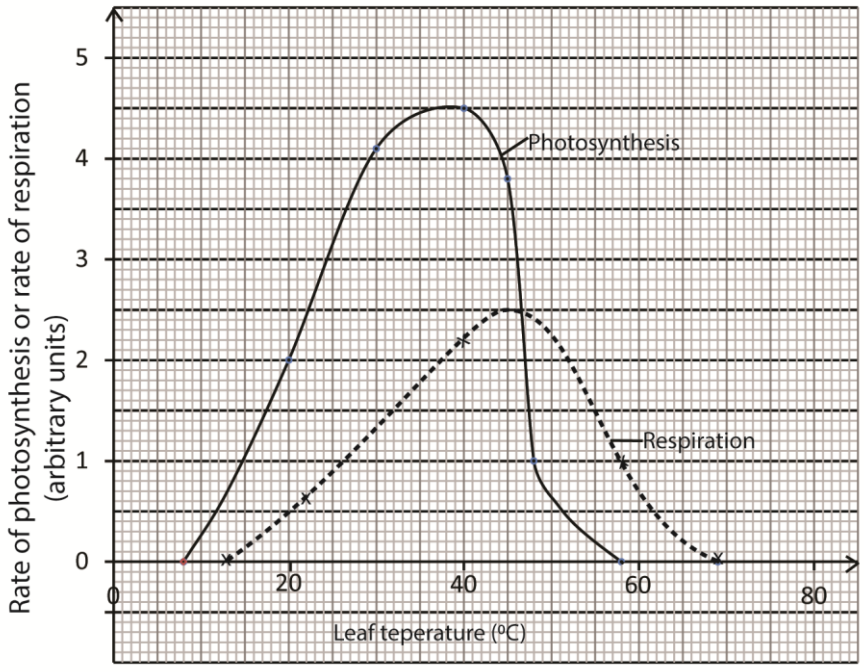


Fig. 1

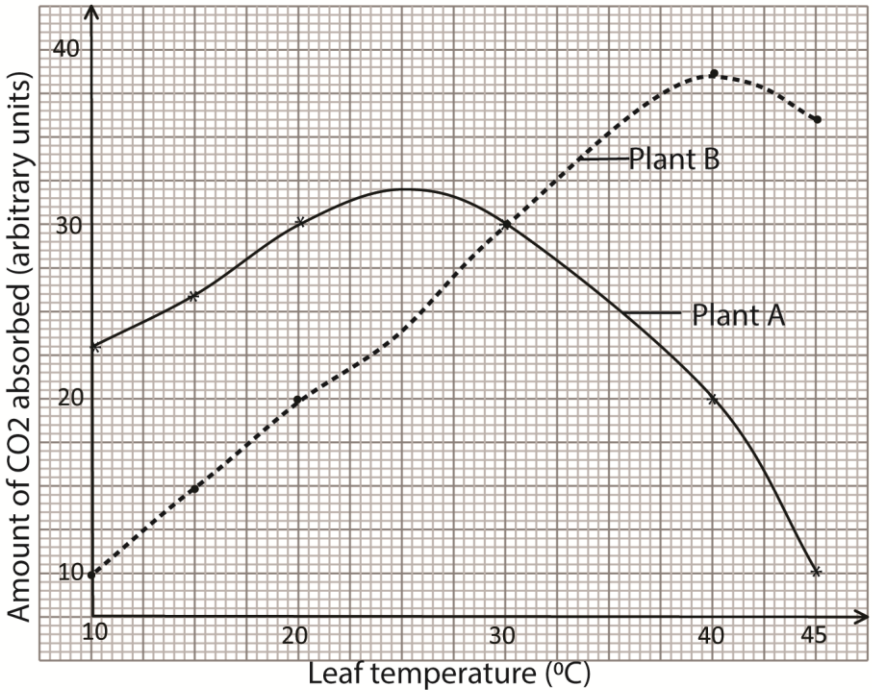


Fig. 2

(a) From figure 1

(i) Describe the rate of photosynthesis varies with temperature of the leaf. (04 marks)
The rate of photosynthesis is zero below 80C; it then increase steeply from zero between 8^0C and 30^0C; then increases slowly between 30^0C and 40^0C; then rapidly falls to zero between 40^0C and 60^0C.

(ii) Explain how the rate of respiration varies with temperature of the leaf. (05 marks)

- Below 13^0C the rate of respiration is zero because the enzymes are inactive.
- Between 13^0C and 45^0C the rate of enzyme increases because the respiratory enzymes become more active.
- 45^0C is the optimum temperature for the enzyme
- Above 45^0C the rate of respiration decreases because enzymes are progressively denatured.

(iii) Explain how difference in the rates of photosynthesis and respiration between leaf temperatures of 40^0C and 70^0C. (08marks)

- The rate of photosynthesis reaches a maximum at a lower temperature (40^0C) than that of respiration (45^0C) because the enzymes for photosynthesis have lower optimum temperature and activation energy than those of respiration.
- The rate of photosynthesis fall rapidly to zero by 58^0C compared that of respiration 64^0C because the enzymes of photosynthesis are denatured at faster rate above the optimum temperature.
- The optimum rate of respiration is lower than that of photosynthesis because part of sugars are stored
- The optimum rate of respiration is lower than that of photosynthesis because photosynthesis produces some ATP
-

(iv) Explain the relationship between respiration and photosynthesis. (04marks)

- Respiration breaks down part of the carbohydrates produced by photosynthesis and excess carbohydrates are stored
- Respirations uses oxygen produced by photosynthesis while photosynthesis uses carbon dioxide produced by respiration
- Photosynthesis is the basic process underlying plant growth and food production while respiration is metabolic pathway that produces chemical energy to meet cell energy demands for growth and maintenance.
- Both maintain that balance between atmospheric oxygen and carbon dioxide concentration.
- Both processes use and produce ATP in reactions that are carried out on membranes and are controlled by enzymes.
- Respiration produces energy in the absence of photosynthesis in the dark

(b) Compare the amounts of carbon dioxide absorbed by each of the two plant species A and B in figure 2. (07 marks)

- Below 30^0C, plant A absorbs higher amount of carbon dioxide than plant B while above 30^0C, plant B absorbs higher amount of carbon dioxide than plant A.
- Plant A has maximum absorption of carbon dioxide at 25^0C while plant B has maximum carbon dioxide absorption at 40^0C.
- The maximum absorption of carbon dioxide of plant A is lower than that of plant B.
- The amount of carbon dioxide absorbed by plant A falls more rapidly between the maximum and 45^0C than in plant B

(c) From figure 1 and 2, suggest the plant species whose rate of photosynthesis was studied in figure 1. Give reason(s) for your answer. (04 marks)
Plant B was studied in figure 1 because its maximum optimum temperature of photosynthesis and carbon dioxide absorption is 40^0C since carbon dioxide absorbed is used for photosynthesis.

(d) Explain any two other factors that affect the rate of photosynthesis. (04marks)

- Light provides energy for photosynthesis
- Chlorophyll traps light energy for photosynthesis
- Water is a reagent in photosynthesis

(note that carbon dioxide and temperature have already been described on the graph)

(e) Describe how carbon dioxide from the atmosphere is fixed in the bundle sheath cells.

[In c4 plants] Atmospheric carbon dioxide is fixed in the mesophyll cells by phosphoenol pyruvic acid (PEP) carboxylase into a 4-carbon compound oxaloacetic acid.

Oxaloacetate is then converted to malate/malic acid and transported into the bundle-sheath cells. This allows carbon dioxide to concentrate in 'bundle of sheath' cells around Rubisco, effectively removing its contact with oxygen thus preventing photorespiration

Inside the bundle sheath, malate breaks down, releasing a molecule of carbon dioxide which is then fixed by Rubisco and made into sugars via the Calvin cycle.

SECTION B (60 MARKS)

Answer any three questions from this section

Any additional question(s) answered will not be marked

2. (a) Describe the ecological significance of each of the following forms of behaviour:
   (i) Territorial behaviour (06marks)
   - It limits mating to fit individuals produce vibrant off springs
   - Exclusive access to food; some animals hunt in groups
   - Allow one sex, usually the male to defend an area to which female are attracted for mating
   - Protection; organism defend themselves as a group from intruders or predators.
   - Provide breeding space.
   - Allow sharing of resources with those organs that cannot guard their family.
   - Promote inbreeding and unfit organisms
   - Promoted spreading of (venereal) diseases

   (ii) Courtship behaviour (07marks)
   - Allows the male mate with female when gonads are functional
   - It enables the mates to select opposite sex with the best quality enabling the community to evolve into the adapted individuals.
   - It tightens the bond between the mating pair.
   - Enable the male and female to look after the off spring together.
   - Synchronization of gonadal development so that the gametes mature at the same time.

   (b) Giving an example in each case, suggest ways by which animals avoid predation. (07 marks)

   - Confusing the predator. For example, a covey (small flock of bird) of bobwhite suddenly emerging out of a roost startles a fox and a hawk so much that it is unable to single out one of the birds to pursue.
   - Snakes, bees, spiders and other organisms bite and inject deadly poisons into the predators
   - Poison dart frog, rough-skinned salamander and millipedes produce poisonous substances on their skins that scare away predators
   - Porcupines use spines to pierce and scare predators
   - Fast and zigzag running/flying is used by flying insects and rabbits to escape predators.
   - Some animals such as chameleon camouflage with environment to hide from predators
   - Animals like tortoise and snail hide themselves in hard shells.
   - Some animals resemble dangerous animals (mimicry) to scare away predator e.g. Coral snakes mimic venomous king snakes.
   - Some animals like bull snakes, ravens produce startling sound.
   - Some are animals such opossums move at night to avoid predators.

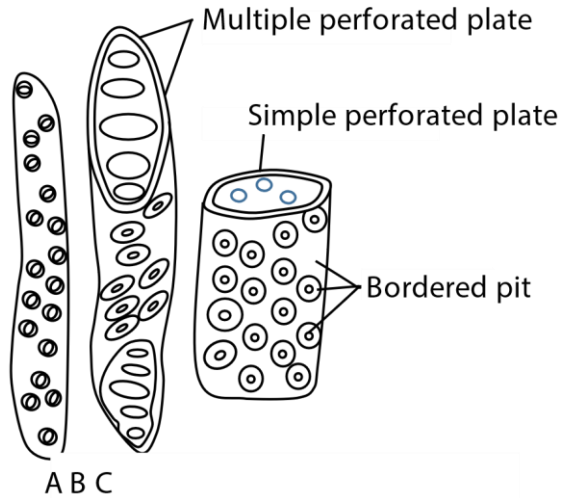
- Use specialized caste for defence against the colony e.g. soldier ants.

3. (a) Describe the structure of mature vascular tissue in flowering plants. (10 marks)

Water and mineral salts are transported xylem while the manufactured food is transported in the phloem

Xylem

Consist of parenchyma cells and fibers together with vessels and tracheid.

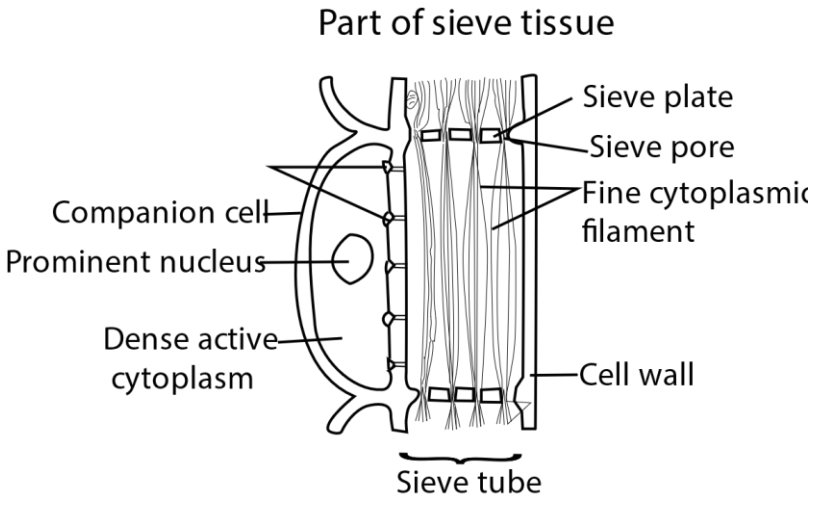


Xylem (A - tracheid, B and C vessels)

Vessels are made of cylindrical dead cells, one on top of another with the cross wall broken down to form a long continuous tube from the roots to the leaves.

The type of vessel found depends on the degree and nature of cell thickening. In the **protoxylem** the lignin is deposited in rings or spirals to the cells is still capable of expansion. In metaxylem there is more extensive lignification arranged in patterns known as reticulate, scalariform or pitted.

Phloem



The phloem consists of sieve tubes and companion cells.

Sieve tubes consist of columns of elongated, thin walled living cells called sieve tubes/elements. They have cross walls with many holes or pores called sieve plates. Each sieve tube has a companion cell.

(b) Explain how the movement of water from the soil provides support in herbaceous plant? (10 marks)

Herbaceous plants contain mainly parenchymal and collenchyma cells for support
These take up water by osmosis and become turgid; this causes them pack and press tightly against one another thereby providing support
Additionally, collenchymas cells have are strong cell walls made of cellulose and pectin that allow them, to sustain the plant.
Intercellular gaps are especially prevalent to keep the tissue flexible and prevent rupture.
Loss of water from these cells cause loss of turgidity and support

4. (a) How is human placenta adapted for exchange of materials between the mother and foetus? (05marks)

- Rich blood supply allow absorbs necessary nutrients and deliver waste products to mother's drug
- Has villi that that increases surface area for exchange of material
- Placental blood has high affinity for oxygen
- Thin membrane reduce diffusion distance
- Blood capillaries of the fetus and mother flow in opposite direction (counter current system) to maintain diffusion gradient.
- Contain numerous mitochondria to provide energy for active transport.

(b) The mammalian embryo develops inside mother's womb before being born. Explain the importance of this embryo development. (06marks)

- The mother protects the foetus from shock and damages
- The embryo is protected from dehydration
- The embryo is supplied with oxygen and nutrients
- Mothers blood is able remove waste products from foetal blood
- Mothers' antibodies protect the foetus from diseases and infection
- The foetus is protected from predators
- Creates a bond between the mother and new born to promote parental care
- Internal fertilization also enhances the fertilization of eggs by a specific male

(c) Describe the difference exchange mechanisms by which materials move between the foetus and the mother. (09 marks)

Mechanisms by which substances are transferred across the placenta

- Diffusion or the movement of particles (molecules or ions) from a region where they are comparatively concentrated to a region where they are at lower concentration for example oxygen from the mother's blood to the foetus and carbon dioxide from foetal blood the mother.

- **Facilitated diffusion:** this is a type of passive transport that allows substances such as glucose to cross membranes to the foetal blood with the assistance of special transport proteins.
- **Osmosis: t**his is the passage of water molecules from a region of their high concentration to a region of their low concentration through a partially permeable membrane/placental membrane.
- **Active transport:** It energy-consuming transport of molecules or ions across a membrane against a concentration gradient. Substances usually transported across cell membrane by active transport include Na^+, K+, ureate ion and amino acids
- **Exocytosis:** This is the process by which large particle are taken in through the placenta cell. It provided a means by which enzymes, hormones, antibodies and cell wall precursors are released from the cells. Here a vesicle containing the material moves towards the surface of the cell and fuse with the plasma membrane. The vesicle the opens to the exterior and its contents leave the cells
- **Endocytosis:** This provide a means by which big objects are taken by the cell. First the plasma membrane invaginates to form a flask-shaped depression which envelops the material. The neck of the flask then closes, and the invagination becomes sealed off to form a vesicle which moves into the cell. When a liquid like substance is taken in by the cell the process is referred to as **pinocytosis**. And solid particles are taken in by **phagocytosis**.

5. (a) Giving examples, describe the different functions performed by proteins in mammals. (14marks)

- Make up structures, e.g., collagen make up connective tissues which allows to build and repair body tissue
- Act as buffers in blood
- Soluble proteins maintain fluid balance in the body
- Play a role in transporting substances like drugs in blood
- Make up enzymes such as catalyse and amylase.
- Are constituent of hormone such as insulin
- They are constituents of antibodies that protect the body from foreign particles.
- Make up muscles such as myosin and actin
- They are storage food e.g. egg white
- Constitute toxins such as snake venom for protection.
- Provide energy when carbohydrate and fat intake is inadequate.
- Structural proteins on the skin prevents entry of infectious microbes
- Proteins help in contraction of muscle
- The protein found in the dermis, elastin, keeps skin flexible.
- Tissue Regeneration

(b) Explain the factors that can cause protein denaturation. (06marks)

- Heat, which can disrupt hydrogen bonds and non-polar hydrophobic interactions.
- Freezing, which can cause ice crystals to form and damage the protein structure.
- pH change, which can alter the charge and polarity of amino acids and affect their interactions.

- Ionic strength change, which can affect the electrostatic forces between amino acids and their surroundings.
- Surface changes, which can expose the protein to different environments and solvents.
- exposure to UV light and radiation breaks bond in the proteins
- chemicals such as alcohol and heavy metals precipitate proteins from solution
- mechanical agitation can distort protein structures leading to denaturation

6. (a) State three major distinguishing features of gaseous exchange in fish and terrestrial insects. (03marks)

Differences between gaseous exchange in fish and terrestrial insects

Fish	Terrestrial insects
Gaseous exchange occurs across the gill	Gaseous exchange occurs across the tracheoles' membrane
Gaseous exchange occurs between water and blood	Gaseous exchange occurs between air and haemocoel
Water contains low oxygen content	Air contains high oxygen content
Ventilation of gills is by drawing water into open mouth and pumping it over the gills when the mouth is closed	Ventilation of tracheoles is done by contraction and relaxation abdominal muscle to force air out and into the tracheal system

(b) How is gaseous exchange in a bony fish different from that of a cartilaginous fish? (04 marks)

Differences between gaseous exchange in bony fish and cartilaginous fish

Bony fish	cartilaginous fish
Gill ventilation uses a muscular pump to force water over the gills and take oxygen	Gill ventilation rely on their constant swimming motion to force water over their gills and take oxygen
The blood and water flow in opposite direction over the gill	Water and blood flows in the same direction
Gills are covered by operculum	have gills that open to the ocean through slits

(c) How is ventilation in man controlled? (13 marks)

In human, the overall control of ventilation involves a group of nerve cells comprising a ventilation centre in the posterior part of the brain called medulla oblongata.

The 'ventilation centre' responds to the levels of carbon dioxide and lesser extent oxygen in the blood stream.

If the partial pressure of carbon dioxide increases, the centre responds by increasing the ventilation rate and vice versa.

The partial pressure is detected by chemoreceptors found between the internal and external carotid arteries on each side of the neck where they form the carotid bodies and aortic bodies in the walls of the aorta close to the heart.

Breathing rate is controlled by the autonomic nervous system; the parasympathetic system slows your breathing rate while sympathetic system increases the rate of breathing.

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