

Things to remember in the last hour before the exam: Life processes at the cellular level

(This is not a revision sheet – you've done that by now – it's a list of things you might want to remind yourself about ...)

1. Cell parts. Most structures/organelles common to animal and plant cells. [P] = plants only

- Cytoplasm – transparent jelly – cells activities occur here
- Cell/plasma membrane – regulates movement of materials in/out of cell. SELECTIVELY permeable. Phospholipid bilayer. Phosphate heads (hydrophilic) face inside cell/outside cell. Fatty acid tails of lipids (hydrophobic) to interior. Small molecules e.g. water diffuse through. Larger ones transported via protein channels.
- Nucleus – cell “control centre”, controls metabolism via enzymes. Contains genetic info – DNA. Chromosomes only visible when cell is dividing. Contains nucleolus – makes RNA and ribosomes.
- Cell wall [P] – protects cell – gives strength and support. Is permeable and made of cellulose. Controls turgidity (can resist high internal pressures without stretching).
- Chloroplasts [P] – site of photosynthesis. contain chlorophyll – green light-trapping pigment. Elongated shape maximises S.A. to volume ratio. increasing uptake of CO_2 and H_2O uptake and output of O_2 and glucose (photosynthetic capacity). Chlorophyll molecules embedded in grana (stacks of thylakoid membrane) – more S.A. = more chlorophyll = max. amount of light captured = more photosynthesis. Surrounded by stroma – enzymes and water.
- Large (central) vacuole [P] – large and permanent structure containing cell sap (salts, sugars, & amino acids). Salts in sap produce strong tendency for water to enter cell (by osmosis) keeping cell turgid. Vacuole displaces cytoplasm to edges of cell – meaning chloroplasts are close to CO_2 and light. Also short gas diffusion distances.
- Mitochondria – site of aerobic respiration. Enzymes attached to cristae (membranes folded to increase the S.A. = greater # of enzymes) produce ATP (adenosine triphosphate). Occur in high numbers in cells with large energy needs e.g. sperm & muscle cells.
- Golgi – flat disc shaped sacs – modify and package proteins
- ER: Rough – has bound ribosomes (site of protein synthesis) – makes proteins and transports proteins to Golgi. Smooth – has free ribosomes – makes steroids, lipids and hormones

2. Specialised cells – perform specialised functions in multicellular organisms. Examples include:

- Guard cells – form stoma (small opening in epidermis) when turgid. Turgid = crescent moon shaped. flaccid = oval shape. Thick inner walls help them open/close stoma. Allow CO_2 and O_2 in and out. Also main route of H_2O loss via transpiration. Swelling of vacuole controls opening/closing. Contain chloroplasts.
- Palisade cells – long, thin “column” shaped cells – many can fit close together. Contain MANY chloroplasts. Cells arranged vertically so light passes through less cell walls to cells beneath.
- Spongy mesophyll (beneath palisade layer) has more rounded & not so tightly packed cells. Large intercellular air spaces maximises diffusion rate of gases during photosynthesis. (CO_2 in & O_2 out).
- Root hair cells – Long and thin extension at one end with thin cell to vastly increase S.A. for absorbing water and minerals. No chloroplasts (as roots are underground!)

3. Movement. Three main mechanisms.

- **Diffusion:** Movement of substances from high concentration to low concentration – along a concentration gradient which exists until diffused substance is evenly distributed. Passive movement. E.g. CO₂ diffusing in / O₂ out of leaf (through stomata). Note: can occur just in solutions, as well as across membranes.
- **Osmosis:** Movement of H₂O from high concentration of H₂O to a low conc. of H₂O water through semi/selectively permeable membrane (from a more dil. Solution to a more conc. solution). Passive movement. E.g. absorbing water through plant roots. Kidney tubules reabsorbing water.
- **Active transport:** Movement from a low conc. to a high conc. Energy is required. E.g. absorption of Mg by roots, glucose uptake in intestines.

4. Enzymes. Protein molecules – acts as biological catalysts – increase rate of reactions. Substrate = molecule the enzyme acts. Increase in substrate concentration = increase in rate – up to a maximum. Enzymes are specific – have 3D shape with unique active site – only work on a particular substrate. Function best in particular conditions e.g. an optimum temperature and optimal pH. (function poorly outside these). At very low temperatures, enzyme action slow; as temp. increases reaction rate increases (more collisions/time) BUT at high temperatures enzyme is denatured (peptide chains unravel – active site is “lost” – enzyme is permanently inactive). Q₁₀ – every 10°C rise enzyme activity approx. doubles. Co-enzymes complete the active site – essential to enzyme action. Inhibitors (poisons) combine with active site to prevent enzyme function.

5. Photosynthesis. Needs CO₂ via stomata, H₂O via roots and xylem, sunlight and chlorophyll.

$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. Sunlight needed as source of (solar) energy. Rate affected by light: more light = more photosynthesis – up to point where plant is at max. photosynthesis level – any increase in light intensity won't affect the plant further. Rate at midday > early morning / evening. No photosynthesis at night. Rate in summer > winter. Temperature affects rate.

6. (Aerobic) Respiration. $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$. Breakdown of glucose occurs in 2 steps – glycolysis in cytoplasm, then Krebs/citric acid cycle in the matrix of the mitochondria and electron transport system on cristae of mitochondria. Energy from food (from breakdown of glucose and fatty acids) converts ADP + P → ATP. ATP = the energy carrier / energy in a usable form. ATP is broken down elsewhere to ADP + P releasing useful energy for cellular work.

7. Cell division.

- A cell cycles between periods of cell division, growth, normal activity (interphase) and back to division. DNA replication occurs – DNA makes exact copy of itself prior to cell division so there is a full set of genetic information available in each cell after division – then preparation for mitosis – then mitosis. The cycle repeats. DNA contains code for synthesis of proteins in its base sequences. All cells need the code to synthesise essential proteins for the cell to grow and carry out its role. DNA must replicate accurately so all new cells have a complete copy of the code.
- **Key steps.** DNA helix unwinds, two strands ‘unzip’ between bases, new nucleotides join to the exposed bases. DNA molecules winds up. Processes are controlled by different enzymes. Base pairing (A–T and C–G) essential – provides mechanism accurately making two identical DNA molecules. Replication is semi-conservative: each strand acts as a template for new strand – each DNA molecule produced has one original strand & one new strand.
- Mitosis occurs at a higher rate in areas where most growth / replacement of cells occurs, e.g. root / shoot tips, hair follicles, skin cells, areas of cellular repair and in cancer cells.