# AB2D Cells: Depth and Exam Drill

AQA 7402 · Calculator allowed · about 130 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** This question tests core vocabulary used to describe the cell-surface membrane and cell recognition.

**(a)** Define the term antigen. **(1)**

**(b)** State what is meant by the term antibody. **(1)**

**(c)** State the term used to describe a cell that has engulfed and digested a pathogen by phagocytosis. **(1)**

**(d)** State what is meant by clonal selection in the immune response. **(1)**

**(Total for Question 1 is 4 marks)**

**2** This question tests key facts about the phagocytic and specific immune responses. For each part, identify the correct option.

**(a)** Which type of lymphocyte matures in the thymus gland? **(1)**

- ☐ A) B lymphocyte
- ☐ B) T lymphocyte
- ☐ C) Phagocyte
- ☐ D) Erythrocyte

**(b)** Which cell type differentiates from an activated B lymphocyte and secretes large quantities of antibody? **(1)**

- ☐ A) T helper cell
- ☐ B) T killer cell
- ☐ C) Plasma cell
- ☐ D) Memory cell

**(c)** Which type of immunity is provided by injecting a person with ready-made antibodies? **(1)**

- ☐ A) Natural active immunity
- ☐ B) Artificial active immunity
- ☐ C) Natural passive immunity
- ☐ D) Artificial passive immunity

**(d)** Which statement correctly describes why monoclonal antibodies are described as 'monoclonal'? **(1)**

- ☐ A) They are produced by a single clone of genetically identical plasma cells, so all antibody molecules are identical
- ☐ B) They bind to many different antigens at once
- ☐ C) They are produced from a mixture of different B cell clones
- ☐ D) They are only found in monozygotic twins

**(Total for Question 2 is 4 marks)**

**3** A student investigated osmosis using cylinders of potato tissue. Cylinders of identical starting mass were placed into sucrose solutions of different concentration for 24 hours, then blotted dry and re-weighed. The percentage change in mass was calculated for each concentration.

| Sucrose concentration (mol/dm3) | Percentage change in mass (%) |
|---|---|
| 0.0 | +12.0 |
| 0.2 | +5.0 |
| 0.4 | -2.0 |
| 0.6 | -9.0 |
| 0.8 | -15.0 |
| 1.0 | -21.0 |

**(a)** State what is meant by water potential. **(1)**

**(b)** Using the data, estimate the sucrose concentration at which the potato tissue would show zero percentage change in mass, i.e. the concentration equal in water potential to the potato cells. Show your reasoning. **(3)**

**(c)** Explain, in terms of net water movement, why the potato cylinders gained mass in the 0.0 mol/dm3 solution. **(2)**

**(d)** Suggest why the potato cylinders were blotted dry before being re-weighed, and explain why using percentage change in mass, rather than absolute change in mass, improves the validity of comparisons between cylinders. **(3)**

**(Total for Question 3 is 9 marks)**

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**4** The fluid mosaic model describes the cell-surface membrane as a phospholipid bilayer with proteins embedded within it, and cholesterol molecules interspersed among the phospholipids.

**(a)** Explain why phospholipids naturally form a bilayer in a watery environment such as blood plasma. **(2)**

**(b)** Explain the role of cholesterol in maintaining the fluidity and stability of the membrane at both high and low temperatures. **(3)**

**(c)** Two membrane proteins are described as an intrinsic (integral) channel protein and an extrinsic (peripheral) glycoprotein. Distinguish between these two types of membrane protein in terms of their position in the membrane. **(2)**

**(d)** Explain the function of a glycoprotein on the outer surface of a cell-surface membrane in cell recognition. **(1)**

**(Total for Question 4 is 8 marks)**

**5** Human Immunodeficiency Virus (HIV) is a retrovirus that infects and eventually destroys T helper cells, progressively weakening the specific immune response.

**(a)** State the type of nucleic acid found inside an HIV particle, and name the enzyme HIV uses to convert this into DNA once inside a host cell. **(2)**

**(b)** Describe how HIV attaches to and enters a T helper cell. **(2)**

**(c)** Explain why a person infected with HIV becomes increasingly vulnerable to opportunistic infections as the number of T helper cells falls. **(3)**

**(d)** An HIV antibody test uses an ELISA (enzyme-linked immunosorbent assay) to detect HIV-specific antibodies in a patient's blood sample. A blue colour developing in the test well indicates a positive result. Explain how the enzyme included in this test produces a visible, measurable result. **(1)**

**(Total for Question 5 is 8 marks)**

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**6** Evaluate the effectiveness of a vaccination programme in achieving herd immunity within a population, including the biological basis of how vaccination protects both vaccinated and unvaccinated individuals.

**(Total for Question 6 is 6 marks)**

**7** A cell biologist used cell fractionation followed by density-gradient (differential) centrifugation to isolate organelles from a liver cell homogenate. The homogenate was kept ice-cold, isotonic and buffered throughout. Successive centrifugation stages were used, each at higher speed than the last, and the pellet was retained after each spin.

| Centrifugation speed | Organelle in pellet |
|---|---|
| Low speed (1000 x g) | Nuclei |
| Medium speed (10000 x g) | Mitochondria |
| High speed (100000 x g) | Ribosomes and small vesicles |

**(a)** Explain why the homogenate is kept ice-cold, isotonic and buffered during cell fractionation. **(3)**

**(b)** Explain why nuclei sediment out at the lowest centrifugation speed, while ribosomes only sediment out at the highest speed. **(2)**

**(c)** A student wants to check that the mitochondrial pellet is not significantly contaminated with nuclei. Suggest a suitable method to test the purity of the mitochondrial fraction, and explain what result would indicate contamination. **(2)**

**(d)** The original liver homogenate contained $2.4 \times 10^7$ mitochondria per cm3. After fractionation, the purified mitochondrial pellet was resuspended in 5.0 cm3 of buffer, and a sample was found to contain $3.6 \times 10^7$ mitochondria per cm3. Calculate the percentage of the total mitochondria that were successfully recovered in the pellet, if the original homogenate volume was 20 cm3. **(1)**

**(Total for Question 7 is 8 marks)**

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**8** A student examined a prepared root-tip squash of an onion (Allium cepa) under a light microscope to investigate the cell cycle. She counted 200 cells in the field of view and classified each by stage: 168 cells were in interphase, 14 were in prophase, 8 were in metaphase, 6 were in anaphase and 4 were in telophase.

**(a)** Calculate the mitotic index of this tissue sample, giving your answer to 3 significant figures. (Mitotic index = number of cells in mitosis / total number of cells observed.) **(3)**

**(b)** Explain why the number of cells observed in interphase is much greater than the number observed in any single stage of mitosis. **(2)**

**(c)** A tumour sample from the same tissue type shows a mitotic index of 0.420. Suggest an explanation for this higher value, and explain why an abnormally high mitotic index is of concern in a clinical context. **(3)**

**(Total for Question 8 is 8 marks)**

**9** Stem cells are undifferentiated cells that can divide to produce specialised cell types. Totipotent stem cells can differentiate into any cell type, including extra-embryonic tissue, whereas pluripotent stem cells can differentiate into almost any body cell type but not extra-embryonic tissue.

**(a)** Distinguish between totipotent and pluripotent stem cells, giving one named source of each in a mammal. **(3)**

**(b)** Induced pluripotent stem (iPS) cells are made in the laboratory by introducing specific transcription factor genes into an adult, fully differentiated body cell (e.g. a skin cell). Explain how this process can reprogramme a differentiated cell to become pluripotent. **(2)**

**(c)** Evaluate one advantage of using induced pluripotent stem cells, rather than embryonic stem cells, in medical research and therapy. **(2)**

**(Total for Question 9 is 7 marks)**

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**10** The rate of diffusion of a substance across a cell-surface membrane can be modelled using Fick's law: rate of diffusion is proportional to (surface area x concentration difference) / thickness of membrane.

**(a)** A cell has a surface area of 400 micrometres-squared and a membrane thickness of 8.0 nm. Under a fixed concentration difference, its rate of diffusion of a solute is measured as 24 arbitrary units. A second, larger cell of the same type has a surface area of 900 micrometres-squared and the same membrane thickness, under the same concentration difference. Calculate the expected rate of diffusion for the second cell, assuming Fick's law applies directly. **(3)**

**(b)** Explain why, despite having a larger surface area, a larger cell (or organism) generally has a lower surface area to volume ratio than a smaller one, and why this can limit the maximum size of a single cell relying on diffusion alone for exchange. **(3)**

**(c)** A pathological thickening of a membrane increases its thickness from 8.0 nm to 12.0 nm, with surface area and concentration difference unchanged. Calculate the percentage change in the rate of diffusion this would cause. **(2)**

**(Total for Question 10 is 8 marks)**

**11** A monoclonal antibody-based pregnancy test detects human chorionic gonadotrophin (hCG) in urine using antibodies bound to coloured latex beads.

**(a)** Explain how monoclonal antibodies are produced so that they are all identical and specific to a single antigen such as hCG. **(3)**

**(b)** Using your knowledge of antigen-antibody binding, explain why this test is highly specific to pregnancy (hCG) and would not give a positive result in the presence of a different hormone. **(2)**

**(c)** Evaluate the ethical and social benefits and drawbacks of using monoclonal antibodies in both diagnostic tests (such as pregnancy tests) and in targeted cancer therapies. **(2)**

**(Total for Question 11 is 7 marks)**

# Mark scheme · AB2D Cells: Depth and Exam Drill

## Question 1

- (a) **B1** a molecule (usually a protein) on the surface of a cell that can trigger an immune response/be recognised by the immune system as self or non-self oe
- **(a) Answer: A molecule, usually a protein, on a cell surface that the immune system can recognise as self or non-self.**
- (b) **B1** a protein produced by plasma cells (B cells) that binds specifically to a complementary antigen oe
- **(b) Answer: A protein made by plasma cells that binds specifically to a complementary antigen.**
- (c) **B1** phagocyte oe (accept named example, e.g. macrophage/neutrophil)
- **(c) Answer: Phagocyte (e.g. a macrophage or neutrophil).**
- (d) **B1** the process by which a lymphocyte with a receptor complementary to a specific antigen is selected and stimulated to divide (clone) oe
- **(d) Answer: The selection and activation of a lymphocyte whose receptor is complementary to a specific antigen, leading it to divide and form a clone.**

## Question 2

- (a) **B1** B
- **(a) Answer: B**
- (b) **B1** C
- **(b) Answer: C**
- (c) **B1** D
- **(c) Answer: D**
- (d) **B1** A
- **(d) Answer: A**

## Question 3

- (a) **B1** a measure of the tendency of water molecules to move (diffuse) out of a solution, relative to pure water, which has a water potential of zero oe
- **(a) Answer: A measure of the tendency of water to move out of a solution; pure water has a water potential of zero.**
- (b) **M1** identify the change in mass is zero between 0.2 (+5.0%) and 0.4 (-2.0%) mol/dm3, so linear interpolation is needed between these two points
- (b) **M1** correct interpolation, e.g. fraction = 5.0 / (5.0 + 2.0) = 0.714 of the way from 0.2 to 0.4
- (b) **A1** approximately 0.34-0.35 mol/dm3 (accept any value obtained by a valid graphical or numerical interpolation between 0.2 and 0.4), cao
- **(b) Answer: Approximately 0.34-0.35 mol/dm3.**
- (c) **B1** the water potential of distilled water (0.0 mol/dm3) is higher than the water potential inside the potato cells oe
- (c) **B1** so there is a net movement of water into the cells by osmosis, down the water potential gradient, causing the cells to gain mass/become turgid oe
- **(c) Answer: Distilled water has a higher water potential than the cell contents, so water moves into the cells by osmosis down the water potential gradient, increasing their mass.**
- (d) **B1** blotting removes surface water so that only the mass of water taken up/lost by the tissue itself is measured, not water clinging to the surface oe
- (d) **B1** using percentage change accounts for small differences in the starting mass of each cylinder oe
- (d) **B1** this allows a fairer comparison between cylinders of slightly different initial mass than comparing absolute mass changes oe
- **(d) Answer: Blotting removes surface water so only water taken up or lost by the tissue is measured. Using percentage change corrects for small differences in the cylinders' starting masses, making comparisons between cylinders fairer.**

## Question 4

- (a) **B1** phospholipids are amphipathic: the phosphate head is hydrophilic and the fatty acid tails are hydrophobic oe
- (a) **B1** in water, the hydrophilic heads orientate towards the water on both sides while the hydrophobic tails face inwards, away from water, forming a bilayer oe
- **(a) Answer: Because phospholipids have a hydrophilic head and hydrophobic tails, they arrange with heads facing the water on both sides and tails facing each other, forming a bilayer.**
- (b) **B1** cholesterol molecules fit between the phospholipids, binding to their fatty acid tails oe
- (b) **B1** at high temperatures cholesterol restricts the movement of phospholipids, reducing fluidity and preventing the membrane becoming too fluid/permeable oe
- (b) **B1** at low temperatures cholesterol prevents phospholipids from packing too closely together, maintaining fluidity and preventing the membrane becoming too rigid oe
- **(b) Answer: Cholesterol sits between phospholipid tails; at high temperatures it restricts movement to stop the membrane becoming too fluid, and at low temperatures it prevents tight packing, stopping the membrane becoming too rigid, so fluidity is maintained across a range of temperatures.**
- (c) **B1** intrinsic (integral) proteins span or are embedded within the phospholipid bilayer oe
- (c) **B1** extrinsic (peripheral) proteins are attached to the surface of the bilayer (do not span it) oe
- **(c) Answer: Intrinsic proteins are embedded within (or span) the bilayer; extrinsic proteins sit on its surface without spanning it.**
- (d) **B1** the carbohydrate (glycolipid/glycoprotein) chains act as antigens/cell-surface receptors that allow the immune system (or other cells) to recognise the cell as self or identify it as a specific cell type oe
- **(d) Answer: Glycoproteins act as antigens or recognition sites, allowing cells (including immune cells) to identify the cell as self or as a particular cell type.**

## Question 5

- (a) **B1** RNA
- (a) **B1** reverse transcriptase
- **(a) Answer: RNA; the enzyme reverse transcriptase converts it into DNA.**
- (b) **B1** a glycoprotein on the surface of HIV binds specifically (is complementary) to the CD4 receptor protein on the surface of the T helper cell oe
- (b) **B1** the viral envelope fuses with the cell-surface membrane, releasing the viral RNA/contents into the T helper cell oe
- **(b) Answer: A viral glycoprotein binds specifically to the CD4 receptor on the T helper cell; the viral envelope then fuses with the cell membrane, releasing its contents into the cell.**
- (c) **B1** T helper cells release cytokines/interleukins that stimulate B cells to divide and differentiate into plasma cells, and stimulate T killer cells to become active oe
- (c) **B1** with fewer T helper cells, this stimulation is reduced, so fewer plasma cells (and therefore less antibody) and fewer active T killer cells are produced oe
- (c) **B1** this weakens both the humoral and cell-mediated immune responses, so the body cannot mount an effective response to pathogens that it would normally destroy oe
- **(c) Answer: Because T helper cells stimulate both B cells (antibody production) and T killer cells, fewer T helper cells means a weaker humoral and cell-mediated response, leaving the body unable to fight off infections it would normally clear.**
- (d) **B1** the enzyme, linked to a secondary antibody that binds the patient's HIV antibody, catalyses a reaction with a colourless substrate to produce a coloured product; the intensity of colour is proportional to the amount of antibody present, and can be measured with a colorimeter oe
- **(d) Answer: The linked enzyme converts a colourless substrate into a coloured product; the depth of colour, measurable with a colorimeter, is proportional to the amount of HIV antibody present in the sample.**

## Question 6

- **Level 3** (5-6): A detailed, well-structured evaluation explaining how vaccination stimulates active immunity and immunological memory, how a sufficiently high proportion of vaccinated individuals reduces transmission and protects unvaccinated people (herd immunity), and discusses at least two factors that limit the effectiveness of a vaccination programme (e.g. antigenic variability, uptake rate, individual variation in response), with a supported overall judgement.
- **Level 2** (3-4): A reasonably clear account of how vaccination produces immunity and contributes to herd immunity, with at least one relevant limiting factor discussed, but the evaluation is not fully balanced or a key idea (e.g. memory cells, threshold proportion) is only partially explained.
- **Level 1** (1-2): Basic description of vaccination producing immunity, with little or no explanation of herd immunity or limiting factors; limited use of biological terminology.
- **Indicative content:**
  - Vaccination introduces antigenic material (attenuated pathogen, dead pathogen, or isolated antigen) which triggers a primary immune response, producing antibodies and, crucially, memory B and T cells.
  - If the vaccinated individual later meets the live pathogen, memory cells allow a rapid secondary immune response, destroying the pathogen before symptoms/harm occur - this is active, artificial immunity.
  - If a sufficiently high proportion of the population is vaccinated, the pathogen cannot easily spread from person to person, breaking chains of transmission.
  - This protects individuals who cannot be vaccinated (e.g. immunocompromised people, newborns, allergy to a vaccine component) because they are unlikely to come into contact with an infected person - this is herd immunity.
  - Limiting factors: some pathogens (e.g. influenza) show antigenic variation, so vaccines must be updated regularly and past immunity may not protect against new strains.
  - Limiting factors: uptake below the threshold needed for herd immunity leaves gaps allowing outbreaks; individual variation in immune response means some vaccinated people may not develop full immunity; cost, access and vaccine hesitancy affect uptake.
  - A balanced evaluation weighs strong reduction in disease incidence and protection of vulnerable groups against these practical and biological limitations, reaching a supported conclusion.

## Question 7

- (a) **B1** ice-cold: reduces the rate of enzyme activity (including hydrolytic/lysosomal enzymes), reducing the breakdown/damage of organelles oe
- (a) **B1** isotonic: prevents osmotic movement of water into or out of the organelles, which would otherwise cause them to burst or shrink and distort oe
- (a) **B1** buffered: keeps the pH constant/prevents enzymes and proteins denaturing/being damaged by pH changes oe
- **(a) Answer: Ice-cold conditions slow enzyme-catalysed breakdown of organelles; isotonic solution prevents osmotic damage (bursting or shrinking); buffering maintains a constant pH, preventing denaturation.**
- (b) **B1** denser/larger organelles (such as nuclei) require less centrifugal force to sediment, so they pellet first at low speed oe
- (b) **B1** smaller/less dense structures (such as ribosomes) require much greater centrifugal force to overcome their slower sedimentation, so they only pellet at the highest speed oe
- **(b) Answer: Larger, denser structures like nuclei sediment at low speed, while small structures like ribosomes need much greater centrifugal force and so only pellet at the highest speed.**
- (c) **B1** a valid method, e.g. examine a sample of the mitochondrial fraction under a light or electron microscope, or test for a marker/enzyme specific to nuclei oe
- (c) **B1** seeing nuclei present in the sample (or a positive result for a nucleus-specific marker) would indicate contamination oe
- **(c) Answer: Examine the mitochondrial fraction under a microscope (or test for a nucleus-specific marker); seeing nuclei present, or a positive marker result, would indicate contamination.**
- (d) **B1** 37.5% (working: original total = 2.4e7 x 20 = 4.8e8; recovered total = 3.6e7 x 5.0 = 1.8e8; percentage = 1.8e8/4.8e8 x 100 = 37.5%), cao
- **(d) Answer: 37.5%**

## Question 8

- (a) **M1** cells in mitosis = 14 + 8 + 6 + 4 = 32
- (a) **M1** mitotic index = 32 / 200
- (a) **A1** 0.160, cao
- **(a) Answer: 0.160**
- (b) **B1** interphase is the longest part of the cell cycle, during which the cell grows and replicates its DNA, so at any moment most cells are in interphase oe
- (b) **B1** each stage of mitosis is comparatively brief, so fewer cells are 'caught' in that stage at any one time oe
- **(b) Answer: Interphase takes up most of the cell cycle (growth and DNA replication occur here), while each mitotic stage is brief, so far fewer cells are seen in mitosis at any snapshot in time.**
- (c) **B1** a higher mitotic index suggests a much greater proportion of cells are undergoing mitosis at any time, i.e. the cells are dividing more frequently/rapidly oe
- (c) **B1** this suggests loss of normal control over the cell cycle (e.g. checkpoint failure, uncontrolled proliferation), characteristic of cancerous/tumour cells oe
- (c) **B1** uncontrolled cell division can lead to tumour growth, so a high mitotic index is used clinically as an indicator of tumour grade/how aggressively it may grow oe
- **(c) Answer: A mitotic index of 0.420 suggests cells are dividing much more frequently, indicating a loss of normal cell cycle control typical of tumour cells; clinically this is used as a marker of how aggressively a tumour may grow.**

## Question 9

- (a) **B1** totipotent cells can differentiate into any cell type, including extra-embryonic tissue (e.g. placenta); found in the very early embryo (e.g. the zygote/cells up to the 8-cell stage) oe
- (a) **B1** pluripotent cells can differentiate into almost any body cell type but not extra-embryonic tissue; found in the embryonic inner cell mass (blastocyst) oe
- (a) **B1** correct named source given for each (e.g. zygote/early embryo for totipotent; inner cell mass of the blastocyst for pluripotent)
- **(a) Answer: Totipotent cells (e.g. the zygote) can form any cell type including extra-embryonic tissue; pluripotent cells (e.g. the inner cell mass of the blastocyst) can form almost any body cell type but not extra-embryonic tissue.**
- (b) **B1** the introduced transcription factors switch on (or switch off) specific genes that were previously inactive (or active) in the differentiated cell oe
- (b) **B1** this alters the pattern of gene expression back to that of an undifferentiated/embryonic-like cell, restoring the potential to differentiate into a wide range of cell types oe
- **(b) Answer: The transcription factors alter which genes are expressed, resetting the cell's pattern of gene expression to an embryonic-like state, restoring its potential to differentiate into many cell types.**
- (c) **B1** a valid advantage, e.g. avoids the ethical concerns of destroying embryos to obtain stem cells oe
- (c) **B1** a valid supporting point, e.g. iPS cells can be made from the patient's own cells, reducing the risk of immune rejection if used therapeutically oe
- **(c) Answer: iPS cells avoid the ethical issues of destroying embryos, and can be derived from a patient's own cells, reducing the risk of immune rejection if used in therapy.**

## Question 10

- (a) **M1** recognise that rate is directly proportional to surface area when concentration difference and thickness are unchanged
- (a) **M1** scale factor = 900 / 400 = 2.25, so new rate = 24 x 2.25
- (a) **A1** 54 arbitrary units, cao
- **(a) Answer: 54 arbitrary units**
- (b) **B1** as an object increases in size, volume increases faster than surface area (volume increases with the cube of linear dimension, surface area with the square), so the surface area to volume ratio falls oe
- (b) **B1** diffusion rate depends on surface area available for exchange, while metabolic demand depends on volume oe
- (b) **B1** in a large cell, the smaller surface area to volume ratio means diffusion alone cannot supply substances (e.g. oxygen, nutrients) or remove wastes fast enough to meet the demands of the whole volume, limiting maximum cell size oe
- **(b) Answer: Volume increases faster than surface area as size increases, so larger cells have a lower surface area to volume ratio; because diffusion depends on surface area but demand depends on volume, this limits how large a cell can be while still being adequately supplied by diffusion alone.**
- (c) **M1** rate is inversely proportional to thickness, so new rate / old rate = 8.0 / 12.0 = 0.667
- (c) **A1** a decrease of 33.3% (cao); accept new rate is 66.7% of the original
- **(c) Answer: The rate decreases by approximately 33.3%.**

## Question 11

- (a) **B1** a mouse (or other animal) is exposed to the target antigen (hCG), stimulating specific B lymphocytes to produce the complementary antibody oe
- (a) **B1** these B lymphocytes are fused with a tumour cell (myeloma) to form a hybridoma, which can divide indefinitely (immortal) while still producing the specific antibody oe
- (a) **B1** hybridoma cells are cloned, and the clone producing the antibody with the highest specificity to hCG is selected and cultured to produce large quantities of identical (monoclonal) antibody oe
- **(a) Answer: B lymphocytes producing anti-hCG antibody are fused with myeloma cells to form immortal hybridomas, which are cloned and screened to select a clone producing the required antibody in bulk.**
- (b) **B1** the antibody's variable region/binding site has a shape (tertiary structure) complementary only to hCG oe
- (b) **B1** a different hormone would have a different molecular shape and so would not bind (or bind poorly) to the antibody, giving no colour change/no positive result oe
- **(b) Answer: The antibody's binding site is complementary in shape only to hCG; a different hormone would not fit and so would not trigger a positive (colour) result.**
- (c) **B1** a valid benefit, e.g. rapid, specific, low-cost diagnosis; targeted cancer therapy reduces damage to healthy cells compared with non-specific chemotherapy oe
- (c) **B1** a valid drawback, e.g. animal use in production raises ethical concerns; production and therapy can be expensive/limit access; possible immune reactions to the antibody oe
- **(c) Answer: Benefits include rapid, specific and relatively cheap diagnosis, and more targeted, less damaging cancer treatment; drawbacks include the ethical concerns of using animals in production, high cost limiting access, and possible immune reactions to the antibody.**