Model Answers: Medium

1

The correct answer is **C.**

The following molecules can **form hydrogen bonds with water** because they are **hydrophilic**:

- Phosphate heads of phospholipids
- The hydrophilic head of a cholesterol molecule
- Carbohydrate chains and some amino acids of glycoproteins
- Carbohydrate chains and phosphate head of glycolipids

The **carbohydrate chains** of glycolipids and glycoproteins recognise and **bind** to ligands, such as **hormones** and **antibodies**.

- **Hormones** are molecules that elicit a **response** from a cell and are a **communication** method within the body.
- **Antibodies** are proteins of the **immune system** produced by B-lymphocytes that detect self and non-self cells in the body.
- If an antibody binds to a glycolipid or glycoprotein of a pathogen they target it for death, in order to keep the body from being invaded and to prevent diseases.

A, B & **D** are incorrect as phospholipids and cholesterol have a structural function in the cell membrane and do not bind hormones or antibodies.

2

The correct answer is **B** as

- **Chloride ions** are **charged** and therefore **cannot** pass through the **hydrophobic** middle section of the phospholipid bilayer
- Chloride ions require a **hydrophilic pore** created by protein to be able to cross the membrane
- Proteins are able to create pores because they can be folded so they have **hydrophobic amino acids** in contact with the phospholipid bilayer and **hydrophilic amino acids** in contact with the solution and ion within the pore
- If a chloride ion is moving **down** its concentration gradient (from high to low concentration) it will travel through a **channel protein**
- If a chloride ion is moving **against** its concentration gradient (from low to high concentration) it will travel through a **carrier protein**

A is incorrect as the role of **cholesterol** is to maintain the correct **fluidity** of the membrane and it does **not** transport ions.

C & **D** are incorrect as **glycolipids** and **glycoproteins** are used in cell recognition, signalling and adhesion but do **not** transport ions.

3

The correct answer is **A** as

1 is cholesterol

- The role of cholesterol is to regulate **membrane fluidity** and stabilise the membrane
- Cholesterol has a **hydrophilic head** section that can form **hydrogen bonds** with water which stabilise the membrane by enabling it to sit within the hydrogen bonding network of water

- Cholesterol has a **hydrophobic tail** region that forms **intermolecular forces** with the **fatty acid tails** of phospholipids:
    - At **high temperatures** molecules have more energy and so the phospholipids **move more freely** and are less close to each other. Cholesterol forms intermolecular attractions with the fatty acid chains, bringing them closer together and creating a more stable structure.
    - Therefore, cholesterol **decreases** membrane fluidity at **high** temperatures.
    - At **low temperatures** the phospholipids **move less** and form more intermolecular forces between separate phospholipids. Cholesterol is smaller than phospholipids and therefore reduces the amount of intermolecular forces.
    - Therefore, cholesterol **increases** the fluidity of the membrane at **low** temperatures.

2 is a protein channel

- Ions and polar molecules **cannot** pass directly through the phospholipid bilayer and therefore rely on proteins to form **hydrophilic pores** across the membrane

3 is a glycoprotein

- A glycoprotein is a membrane **protein** with a **carbohydrate chain** added to its extracellular side
- The function of a glycoprotein is to **recognise** and **bind** to molecules involved in cell signalling, recognition and adhesion

4

The correct answer is **D** as:

- The **fluidity** of the membrane is **increased** by an increased proportion of **unsaturated** fatty acid tails
- Unsaturated fatty acids contain carbon **carbon double bonds** (C=C) which create a bend in the fatty acid chain
- Fatty acids are packed together in the middle of the bilayer **and intermolecular forces** form between separate molecules
- If the fatty acid tails are less tightly packed due to a **bend** in a chain there are **less intermolecular forces** and therefore the membrane is **more fluid** (there is more movement)

5

The correct answer is **B** as:

- B labels the carbohydrate chain of a glycolipid
- The **carbohydrate chain** of glycolipids are **variable** depending on the individual as they lead to cell recognition
- Blood groups describe different types of **antibodies** (proteins of the immune system) and **antigens** (glycoproteins and glycolipids) found on the surface of **red blood cells**
- Antibodies bind to certain carbohydrate chain structures on glycoproteins and glycolipids to determine whether a cell is **self or non-self**
- Blood groups are important because during **blood transfusions**, if the wrong blood is given the red blood cells may have glycoproteins and glycolipids that are not

recognised by the body, which will elicit an **immune response** and rejection of the blood

A is incorrect as this is a channel protein, the structure of which is specific to the molecule that they transport but do **not** vary within species.

C is incorrect as this is the protein section of a glycoprotein and is **not** responsible for the specificity of the glycoprotein.

D is incorrect a is a phospholipid, the structure of which is universal.

6

The correct answer is **C**.

W is an **intrinsic protein**

- Intrinsic proteins are embedded into the membrane and span the **whole width** of the bilayer
- Intrinsic proteins can be used as channels to **transport ions**

X is an **extrinsic protein**

- Extrinsic proteins are attached to the membrane, sometimes transiently, and only span half the membrane or sit on the membrane surface
- Extrinsic proteins are usually associated with intrinsic proteins to perform a role in cell signalling
- For example: **G proteins** in the cell signalling pathway that produce GTP when the cell surface receptor binds its ligand and goes through a conformational change

Y is a **glycoprotein**

- Made of an intrinsic protein embedded into the cell membrane and a carbohydrate branched chain on the extracellular side of the membrane
- The carbohydrate chain acts as a label for the cell so that the cell can be recognised by hormones, antibodies and other cells

Z is a **phospholipid**

- Phospholipids consist of a hydrophilic phosphate head and hydrophobic fatty acid tails
- Phospholipids cause the formation of the bilayer and are the more abundant molecule in the membrane
- fat-soluble molecules such as respiratory gases (O2 and CO2) and steroid hormones can pass through the phospholipid bilayer unaided

Cell shape is determined by the cytoskeleton acting like a scaffold, holding the cell membrane and cell organelles in place. The cytoskeleton is made from fibrous proteins.

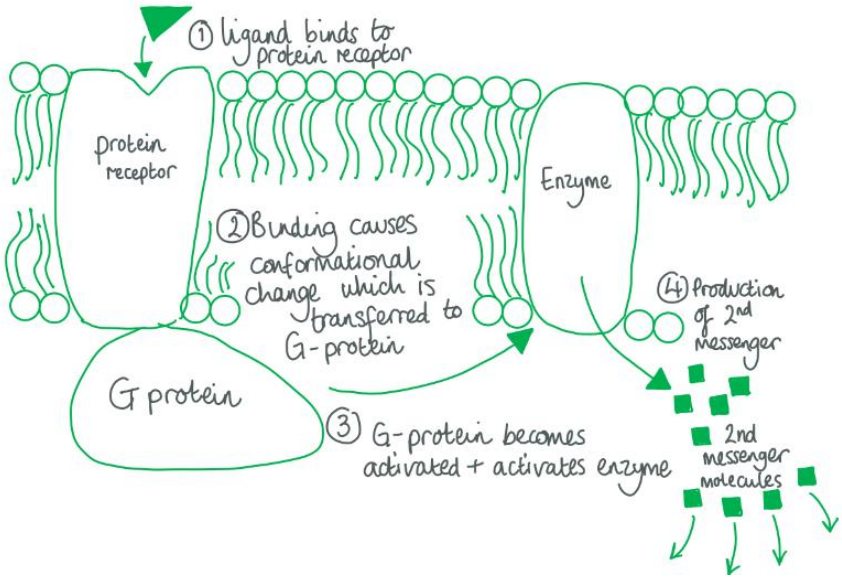
7

The correct answer is **B** as:

- A water-soluble signalling molecule, such as a **hormone** or **neurotransmitter**, binds to a **transmembrane protein receptor** (a protein that spans the length of the membrane and binds to a specific molecule)
- Binding of the signalling molecule causes a **conformational change** (change of shape) in the protein receptor which is **transferred** to a G protein
- The **G protein** is associated with the intracellular side of the transmembrane protein and when **activated** by the conformational change **produces GTP**
- GTP production releases the activated G protein and allows it to move to and

activate an **enzymatic membrane protein**

- The enzymatic membrane protein produces a '**2nd messenger**' which works to cause a **response** within the cell by activating cellular enzymes
- For one molecule binding to the transmembrane protein, multiple 2nd messengers can be made – this **amplifies** the signal



8

The correct answer is **D** as:

- The fluidity of the membrane is **increased** by an increased proportion of **unsaturated fatty acid tails**
- Unsaturated fatty acids contain **carbon carbon double bonds** (C=C) which create a **bend** in the fatty acid chain
- Fatty acids are packed together in the middle of the bilayer and **intermolecular forces** form between separate molecules
- If the fatty acid tails are less tightly packed due to a bend in a chain there are **less intermolecular forces** and therefore the membrane is **more fluid** (there is more movement)

A is incorrect as the amount of intrinsic proteins does not affect the fluidity of the membrane. Intrinsic proteins span the width of the phospholipid bilayer and move with the surrounding phospholipids.

B is incorrect as bacteria do not have cholesterol in their cell surface membranes. Decreasing the amount of cholesterol in animals would cause the membrane to be less fluid in cold temperatures and the cholesterol wouldn't be there to decrease the number of intermolecular forces responsible for a stiff membrane.

C is incorrect as increasing the proportion of saturated phospholipids would increase the amount of intermolecular forces between fatty acid chains and decrease the fluidity.

9

The correct answer is **D** as:

- **Hydrophilic** means '**water-loving**' and means that a structure forms favourable interactions with water, such as **hydrogen bonds**

- **Hydrophobic** means '**water-hating**' and means that a structure is **not** able to form favourable interactions with water
- The **interior** of a **transport protein** is **hydrophilic** to enable **ions** and **polar** molecules to cross the membrane. They are not able to cross the phospholipid bilayer without a transport protein because they are not hydrophobic.
- The **exterior** of an **intrinsic protein** is in contact with the middle of the **phospholipid bilayer** and therefore must be **hydrophobic**
- The **carbohydrate chain** on a glycolipid is on the outside of the cell membrane and is in contact with **extracellular solution** (tissue fluid or blood) and is therefore **hydrophilic**

10

The correct answer is **A** as:

- **A** labels an unsaturated fatty acid chain
- The fluidity of the membrane is **increased** by an increased proportion of **unsaturated fatty acid tails**
- Unsaturated fatty acids contain **carbon carbon double bonds** (C=C) which create a **bend** in the fatty acid chain
- Fatty acids are packed together in the middle of the bilayer and **intermolecular forces** form between separate molecules
- If the fatty acid tails are less tightly packed due to a bend in a chain there are **less intermolecular forces** and therefore the membrane is **more fluid** (there is more movement)

B is incorrect as B is the **protein** of a glycoprotein. Proteins do **not** affect the fluidity of a membrane.

C is incorrect as C is a **phosphate head**, these form the surface of the phospholipid bilayer but do **not** affect membrane fluidity.

D is incorrect as D is a **carbohydrate chain** of a glycolipid. Carbohydrate chains are found on the **extracellular surface** of the membrane and do **not** affect the fluidity of the membrane.