Model Answers: Easy

1

The correct answer is **C** as:

- **1** is **cholesterol**, which is a relatively small molecule with **both** hydrophilic and hydrophobic regions. It takes the place of a phospholipid and it is used to regulate the **fluidity** of the membrane.
- **2** is a **glycolipid**, which is a phospholipid that has been modified to have a **carbohydrate** (glyco) chain attached. Glycolipids are only found on the **exterior side** of the cell membrane and are used in cell recognition and adhesion.
- **3** is a protein, specifically an intrinsic **channel protein**. These proteins are embedded into the phospholipid bilayer and provide a **hydrophilic pore** for **charged** and **polar** molecules to cross the membrane. Each protein binds or transports a specific molecule or type of molecule. The section of the protein in contact with the middle of the bilayer is made from **hydrophobic** amino acids, and the part of the protein in contact with water and ions is **hydrophilic**.
- **4** is a **glycoprotein**, which is a protein that has been modified to have a **carbohydrate** (glyco) chain attached. Glycolipids are only found on the **exterior side** of the cell membrane and are used in cell recognition and adhesion.
- **5** is a **phospholipid**, which is a molecule made of a **hydrophilic phosphate head** (which forms the surface of a bilayer) and **hydrophobic fatty acid tail** (which forms the middle of the bilayer). Phospholipids form the **bilayer structure** of the cell membrane and make up the highest proportion of all molecules in cell membranes.

2

The correct answer is **A** as:

- Cell recognition is one of the ways cells **communicate** with one another
- Cells in a particular organ will have particular molecules in their **cell surface membrane** that help:
    - Signalling molecules in the blood illicit certain responses from specific organs e.g. there are glucagon **receptors** (**glycoproteins –** proteins with a **carbohydrate chain** on the extracellular side of the membrane) on liver cells (hepatocytes) so that the liver can produce glucose from glycogen stores, however other organs will not have glucagon receptors as they do not store glycogen
    - Adhesion of cells within organs in order for them to work together relies on **intrinsic proteins** (proteins that span the length of the cell membrane)

    - Recognition of self and non-self cells by the body's immune system depends on antigens. Antigens are **glycolipids** (phospholipids that have a **carbohydrate chain** on the extracellular side of the membrane).
- The carbohydrate chain on glycolipids and glycoproteins aids recognition by enabling certain ligands to bind.

Phospholipids form the bilayer, which is the basic structure of the membrane but do not contribute to cell recognition.

Cholesterol is a small molecule with a hydrophilic head and hydrophobic tail which alters the fluidity of the membrane but does not contribute to cell recognition.

3

The correct answer is **D** as

- The basic structure of a cell surface membrane is **two continuous rows**, or layers, of phospholipids on top of each other
- The phospholipid bilayer is formed to **isolate non-polar, hydrophobic fatty acid** (lipid) chains from water, this part of the phospholipids form the middle of the bilayer
- **Hydrophilic phosphate heads** are faced out towards the water and can make hydrogen bonds with the water molecules in the extracellular and intracellular space, this part of the phospholipids form the outer of the bilayer surface of the bilayer
- Fatty acid chains can be either **saturated** (has no C=C double bonds and a straight chain structure) or **unsaturated** (contains C=C double bonds and a bended chain structure)
- The higher proportion of **unsaturated** fatty acid chains results in a **more fluid** membrane
- The phosphate head and fatty acid tails are connected by a **glycerol molecule**

4

The correct answer is **C** as:

- Structure C is a **glycoprotein**. Glycoproteins are membrane proteins that have been modified and have a **carbohydrate chain** attached to their **extracellular** side. The carbohydrate chain enables **recognition of ligands** such as hormones and therefore glycoproteins function as **cell surface receptors**.
- Binding of a hormone to a glycoprotein causes a conformational change which is relayed through the membrane to the cytoplasm, where a **signalling cascade** (reactions that link the hormone binding to the overall resulting effect of the hormone).

- For example, insulin binds to its cell surface receptor in liver cells which activates a signalling pathway within the cell to increase the amount of glucose transporters on the cell membrane. The increase in glucose transporters allows the cell to take in more glucose from the blood, which lowers the blood glucose concentration.

A is incorrect as this is an **extrinsic protein** (a protein attached to the surface of the membrane instead of being submerged into the bilayer). This protein is also on the **intracellular side** of the membrane. Hormones must bind to the extracellular side of the cell surface membrane in contact with blood or tissue fluid to elicit a response.

B is incorrect as this is a **phospholipid** which, unless they are modified with a carbohydrate, do **not** bind molecules. Phospholipids have a **structural role** in the cell surface membrane and are responsible for the formation of the **bilayer**.

D is incorrect as this is a **channel protein** which provides a **hydrophilic pore** for small polar molecules and ions to diffuse through (into or out of the cell). Hormones **don't** usually enter the cell unless they act directly on the nucleus (steroid hormones). Steroid hormones are hydrophobic and pass straight through the phospholipid bilayer.

5

The correct answer is **B** as

- **Cholesterol** is a relatively small molecule with a **hydrophilic head** and **hydrophobic tail**
- At **low temperatures**, cholesterol **increases** the fluidity of the membrane, to stop it becoming too rigid, as it **prevents** close packing of the phospholipid tails
- The increased fluidity means cells can survive colder temperatures
- At **high temperatures**, cholesterol **decreases** the fluidity of the membrane by interacting with the phospholipid tails which stabilises the membrane
- Cholesterol also plays a role in maintaining the mechanical stability of membranes, as without it membranes quickly break and cells burst open

A is incorrect as **channel proteins** provide **hydrophilic channels** for the transport of glucose and ions in and out of cells

C is incorrect as **channel proteins** carry out **active transport** up a solutes concentration gradient

D is incorrect as **channel proteins** carry out **facilitated diffusion** down a solutes concentration gradient

6
The correct answer is **A** as

Membranes become **less fluid** when there is:

- An increased proportion of **saturated fatty acid chains** as the chains pack together tightly and therefore there is a high number of **intermolecular forces** between the chains
- A **lower temperature** as the molecules have **less energy** and therefore are not moving as freely which causes the structure to be more closely packed

Membranes become **more fluid** when there is:

- An increased proportion of **unsaturated fatty acid chains** as these chains are bended, which means the chains are less tightly packed together and there are **less intermolecular forces**
- A **higher temperatures** the molecules have more energy and therefore move more freely, which increasing membrane fluidity

7
The correct answer is **C** as

- **Hydrophilic** means '**water-loving**' and describes a structure that is able to form **hydrogen bonds** with water.
- **Phosphate heads** are made of a central phosphorus atom bonded to four oxygen molecules, at least one of which is **negatively charged**. Water stabilises the charge with hydrogen bonding.
- **Hydrophobic** means '**water-hating**' and describes a structure that is non-polar and is therefore **not** able to form hydrogen bonds with water. Water is made of a large network of water molecules hydrogen bonded to each other. Exposing a hydrophobic structure to water disrupts the **hydrogen bond network** and is therefore not favourable.
- Fatty acid tails are made from hydrocarbon chains and are therefore non-polar and hydrophobic.

8
The correct answer is **C** because:

- The cell surface membrane is made of a **phospholipid bilayer**

- The bilayer consists of **two rows of phospholipids** which are molecules with a **hydrophilic phosphate head** and a **hydrophobic fatty acid tail**
- If fatty acids have **longer chains** there are more **intermolecular forces** between them and therefore the membrane is more structured and **less fluid**
- Cholesterol can either decrease or increase membrane fluidity depending on temperature and is useful for a cells survival in multiple environments
- At high temperatures phospholipids move more freely
  - **cholesterol** decreases membrane fluidity in high temperatures because is forms **intermolecular forces** with fatty acid tails, holding them closer together and creating a more solid structure

A is incorrect as unsaturated fatty acids have **double bonds** between carbon atoms. These double bonds create a bend in the **hydrocarbon chain** and disrupts the tight packing of fatty acid tails and the intermolecular forces between tails. Less intermolecular forces results in a more fluid membrane.

B is incorrect as this option does not include fatty acids having longer chains, which also decreases fluidity

D is incorrect as this option does not include cholesterol, which also decreases fluidity at high temperatures

9

The correct answer is **C** as

- Molecule X is a **carbohydrate chain** on attached to a cell membrane protein
- Carbohydrates are polymers made from **monosaccharide** building blocks (monomers) such as mannose

A is incorrect as amino acids are the monomers that form polypeptides (proteins)

B is incorrect as nucleotides are the monomers of nucleic acids such as DNA and RNA

D is incorrect as fatty acids are monomers of lipids (fats)

10

The correct answer is **B** as:

- **Channel proteins** span the width of the bilayer as their function is to provide a hydrophilic pore **across** the membrane for small polar molecules (such as glucose) and ions
- Channel proteins are **permanently embedded** into the membrane, they can be added or taken away to regulate transport across the membrane but when they are in place they do **not** detach from the bilayer

A is incorrect as peripheral intrinsic membrane proteins do **not** exist because if a protein extends across the whole membrane (is intrinsic) it is folded directly **into** a membrane from the ribosome and therefore will not detach. Intrinsic proteins have a **hydrophobic surface** to enable their placement into the hydrophobic middle section of the bilayer and would become **denatured** in water-based solution.

C is incorrect as a **channel protein**'s function is to provide a **hydrophilic pore** through the membrane and it would be **unable** to do this if it is **extrinsic** (doesn't extend across the whole membrane) or **peripheral** (detaches from the membrane)

D is incorrect as a **channel protein**'s function is to provide a **hydrophilic pore** through the membrane and it would be **unable** to do this if it is **extrinsic** (doesn't extend across the whole membrane)