CHECKLIST OF KEY CONCEPTS

Types of lipids

1. All biological membranes are based on lipid bilayers, formed of lipids with polar head groups that face outwards and hydrophobic, inward facing tails.
2. Various categories of lipids are found: Neutral fats include triacylglycerols which commonly occur in food. Neutral fats do not occur in membranes.
3. The most common membrane lipids are glycerophospholipids, especially those based on phosphatidic acid.
4. A range of polar head groups can be attached to phosphatidic acid, including ethanolamine, choline, serine and inositol.
5. In sphingolipids the C-2 OH group of glycerol is changed to NH_2 and H on C-1 replaced by C_{15}. A range of derivatives of this basic structure exist.

Structure of membranes

6. The composition of membranes varies from cell to cell and from the outer layer of the membrane to the inner layer. Glycolipids are always pointing outwards.
7. In many membranes there is rapid lateral movement of constituents.
8. Membrane lipids are known to play an important role in signalling across membranes. In some cases this involves protein lipid interactions.
9. The fatty acids of membrane lipids are usually C_{14}-C_{18} although longer ones do occur. Double bonds are also commonly found in membrane fatty acids.
10. Unsaturated bonds increase membrane fluidity.

Membrane permeability

11. Cholesterol in membranes reduces the permeability of the lipid bilayers.
12. The effect of the lipid bilayers is to make the membrane relatively impermeable to polar molecules and ions. Water moves across quite freely but aquaporin can increase the rate of movement.
13. Cell membranes are a lipid fluid mosaic containing integral proteins and peripheral proteins.
14. Integral proteins have a hydrophobic region that is buried in the fatty acid layer and also regions that are polar and in contact with the region outside the lipid bilayers.
15. Many proteins cross the lipid bilayers more than once.
16. Material can cross a membrane via porin channels.
17. Peripheral proteins can interact with a membrane via hydrogen bonds and ionic interactions. Alternatively they may have a covalently bound fatty acid chain that is buried in the membrane.

Active transport

18. Active transport systems use energy to move solutes against a concentration gradient. Typically this energy is supplied by the hydrolysis of ATP.
19. The Na^+/K^+ pump exists in two forms. Form (a) is open to the inside and binds Na^+ but not K^+. Phosphorylation by ATP converts form (a) to form (b) that is open to the

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outside, does not bind Na^+ but does bind K^+. (b) can be reconverted to (a) by dephosphorylation.

20. Na^+ exit from the cell down a concentration gradient can be coupled to the inward transport of other compounds such as glucose. This is a symport system.
21. Antiport transport involves Na^+ and some other material, such as Ca^{2+} being transported outwards together.

Other transporters

22. Other materials are transported by ABC transporter proteins, which also use ATP as their source of energy. Diseases, including cystic fibrosis, are caused by a failure of ABC transporters.
23. Facilitated diffusion is where material moves down a concentration gradient in a carrier mediated process.
24. In some cases of facilitated diffusion the carrier only allows movement in response to a signal.
25. The structure of a bacterial K^+ channel shows how such channels function.

Signal transmission in nerves

26. Neurons transmit signals from one to another in response to acetylcholine release. This compound is rapidly hydrolysed by acetylcholinesterase and the action is thus terminated.
27. Acetylcholine gated cells respond to acetylcholine appearance by changing conformation so that a channel for Na^+ and K^+ opens transitorily.
28. In the resting state the leakage of K^+ across the membrane generates a potential of –60mV. When the channels open there is a greater influx of Na^+ than K^+ efflux (because of the negative membrane potential) and the potential becomes +65mV. This is called depolarization.
29. The membrane rapidly repolarizes and the resting potential is restored.
30. The depolarization spreads along the membrane until the end of the neuron is reached. It can only move in one direction because once depolarized there is a refractory period before the channels can respond again.

Control of nerve function at the molecular level

31. The Na^+ channel has four transmembrane domains, each with six α helices. One of the helices changes its position in response to membrane potential changes. This causes channel opening and closing.
32. It is known that in the case of the K^+ channel the refractory period arises because when the channel opens the N terminal peptide moves to block the channel.
33. Membrane depolarization causes Ca^{2+} inflow at the next synapse.
34. A key effect of the mechanism is that the signal is not attenuated during transmission.
35. Motor neurons are covered by a myelin sheath, with the Na^+ and K^+ channels spaced out at nodes of Ranvier. This results in faster transmission of signals.
36. The Na^+/K^+ pump acts much more slowly than nerve transmission.

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Maintenance of cell shape and adhesion

37. The shape of eukaryotic cells is maintained by the cytoskeleton. Red cell shape maintenance involves spectrin and ankyrin.
38. Epithelial cells transport molecules from one side to another by means of tight junctions.
39. Gap junctions allow the flow of small molecules from one cell to another.
40. Cadherins result in tissue specific adhesion of cells.

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