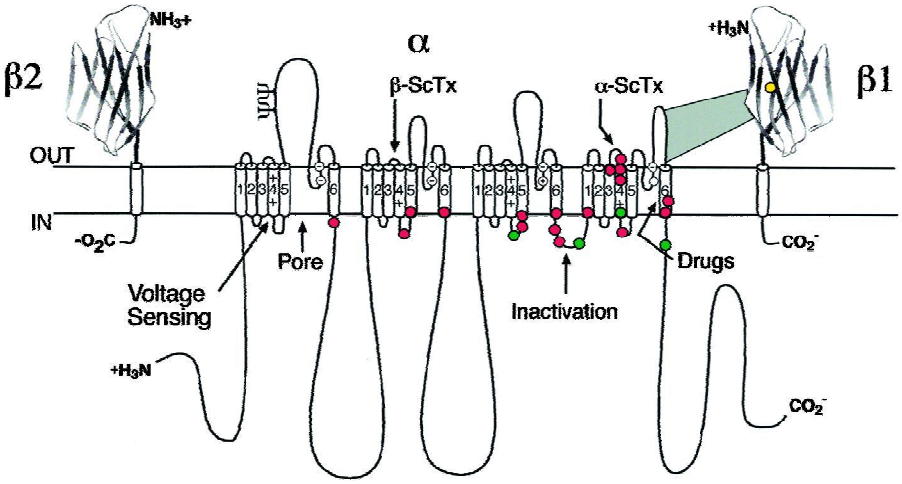
Module 0230725 Cellular and molecular neuroscience with specimen answers

Short answers:

1) Draw a diagram to illustrate the molecular structure of the mammalian sodium channel (8)



2. Briefly outline THREE functions of astrocytes in the CNS (9)

i, *Astrocytes help to create the blood-CNS barrier which prevents the access into the CNS of potentially dangerous molecules such as adrenaline, fatty acids, etc from the blood. Astrocytes do NOT form the barrier but stimulate capillary endothelial cells to form non-leaky tight junctions which can be damaged in inflammatory diseases of the CNS, tumours, etc., leading to a leaky barrier*

ii, *Astrocytes are located at synapses and function there to help in the removal of neurotransmitters such as glutamate and GABA. The astrocytes take up the neurotransmitters, metabolise them and release them for uptake by the neurone and conversion bback into the neurotransmitter. For example, glutamate is metabolised and released to neurones as glutamine. In this way astrocytes help to remove NTs at the synapse and so reduce the effect of the NT.*

iii, *Astrocytes are involved in sspatial buffering of ions in the CNS, especially K+ released at nodes as a result of impulse transmission. K+ is released at a node and is taken up into an astrocyte end foot at the node. The K ions are moved in the astrocyte to other end feet adjacent to blood vessels where the K ions are released. In this way the K+ concentration outside the axon is kept low.*

3a. Draw and label a diagram to show how oligodendrocytes ensheath axons in the CNS with a myelin sheath as observed in electron micrographs. On your diagram indicate the location of myelin basic protein and proteolipid protein and other relevant detail. (9)

See attached sheet

3b. Outline TWO characteristics that would allow you to distinguish between oligodendrocyte precursor cells and mature oligodendrocytes.

(i) OPCs are motile, proliferating cells with usually two or three processes. Mature OLs are multiproc essed, and are non-migratory.

(ii) OPCs carry several unique surface markers such as NG2, A2B5, GD3 and especially PDGRRα. Mature OLs lack all these markers but can be distionguished by the fact that they express MBP, PLP, MAG, MOG, GC markers.

3c. Explain what is meant by 'molecular mimicry' in relation to demyelination in Multiple sclerosis

This is one theory as to how demyelination may arise in Multiple Sclerosis. It is now known that proteins in some viruses/bacteria contain sequences of amino acids which are identical to those found in several myelin proteins-MBP, PLP. In Molecular mimicry it is proposed that an immune response generating antibodies or sensitised T-cells against a viral epitope could then bind to sequences on host proteins to trigger an inflammatory reaction or complement attack-resulting in damage to myelin, oligodendrocyte death, etc. and leading to demyelination and failure in impulse transmission.

4a. Give 3 behavioural symptoms of Alzheimer's disease (3 marks)

(i) Forgetfulness
(ii) Untidiness
(iii) Confusion

b. Give 3 neuroanatomical features of Alzheimer's disease (3 marks)

(i) Reduced cortex
(ii) plaques
(iii) tangles

c. Outline the function of the presenilin gene product (4 marks)

Extracellular enzymes called *secretases,* which cleave the *beta amyloid precursor protein* near terminus and in/near membrane

d. Name a cholinergic drug used in Alzheimer's disease (1)

Donepezil (for example)

e. Give three of the main reasions why cholinergic therapy is used to treat Alzheimer's disease? (3)

(i) cholinergic neurones in basal forebrain project to cortex and hippocampus
(ii) Cholinesterase inhibitors – delay symptoms
(iii) Cholinergic agonists/antagonists affect memory

Essay:

Hippocampal neurons are dissociated and placed in culture for 15 days. After 10 days in culture the neurons are then transfected with a construct that allows the expression of an inwardly rectifying potassium channel in a small number of the neuronal cells. The potassium channel acts to eliminate action potentials and ‘silences’ the cells in which it is expressed.

You suspect that over time, the synaptic connections between the potassium channel expressing cells and untransfected neurons may be modified compared to connections between untransfected neurons. What physiological parameters would you record? What morphological parameters would you quantify. Employing the Homeostasis Hypothesis, what physiological and morphological parameters would you predict would change and why?

OR

Discuss the function and workings of metabotropic receptors in the CNS