Midterm Questions

Test 2001

1. Describe the 3 different ways that G-proteins can open or close ion channels. You will get more credit if you can specify a transmitter, receptor, second messenger, and ions in each case, and comment on the speed of action of the effect.
2. Describe the stimuli and pathways that mediate the startle reflex. In what ways are the descending motor pathways for startle typical of the ventromedial pathways discussed in Bear. et. al.?
3. Dopamine neurons are said to be important for motivation and drug addiction in chapters 6 and 16. Describe the anatomy of he critical dopamine neurons involved in addiction, and comment on how drugs like nicotine and cocaine act on these dopamine neurons and receptors associated with dopamine neurons.

Test 2002

1. Why could Santiago Ramon y Cajal and Charles Scott Sherrington be called the "Parents of Neuroscience"? Review their most important experiments briefly, and discuss their key ideas that established the scientific basis for studying the organization of nervous system functions. In what ways did their ideas complement each other to create the new discipline?
2. Review evidence that a small set of genes are critical for maintaining and regulating circadian rhythms in fruit flies and mice. How are these genes believed to work together to produce a 24-hour activity cycle?
3. Describe the rich diversity of ion channels found in neurons. What are the advantages of each of the major families of ion channels for neural function, and what is the advantage of having many different signals for opening channels?

Test 2003

1. Review 19th century work using electrical stimulation and lesions. First, describe how these methods were used to show that electrical signals mediate neural mechanisms for movements. Next, describe how these studies showed the functional organization of the spinal cord and brain.
2. The superior colliculus is often described as a "visual reflex center". describe the anatomical and functional organization of the superior colliculus and explain how it encompasses more than just visual reflexes.
3. The nervous system is uses fast and slow signals in many ways. Review variations in signals in axons, synapse, and post synaptic cascades.

Answers

2003, Question 1

- First, Galvani, and excitation of nerve and muscles -> twitches; argued that NS includes electrical signals, which is what causes muscle actions.
- Bell and Mogendie then shown that muscles pass through SC; dorsal root carries sensory signal, ventral root carries motor signal out.
    - They suggested that AP is carried by these roots into/out of muscles.
- Germans showed that AP is electrical in nature:
    - Dubois Remond: block electricity = prevents AP;
    - Helmholtz: showed conduction of AP ~ 40 m/s.
    - Together they demonstrated necessity and sufficiency of AP
- Fluorens lesioned cerebellum and SC:
    - Found that cerebellum is for motor reflex/coordination and organization.
- Electrical stimulation was then used to study motor cortex -- became very common in the 2nd half of century.
    - Fritsch got the motor map.
    - Experiments also demonstrated that brain was electrical in nature.
- Hughs and Jackson: showed that lesions can result in seizures or lost of function -- neurological work.
- Broca: left hemisphere lesion = speech deficit; Wernickes: left parietal lesion = speech deficit as well.
- Near end of century: Sherrington stimulated pathways going into spinal cord; proposed that SC is integrative center for signals; proposed synapse -- functional centers of integrations between neurons.
- This is an A answer.

2003, Question 2

- Describe anatomy of sup. C.: superior structure on roof of midbrain.
    - Dorsa; layer have retinotopic map receiving input from retina.
    - Medial layer have output cell forming cross tectospinal pathway.
        - Activates CN III, IV, VI, XI and cervical nerves for orienting the head.
        - Input comes from inferior colliculus -- auditory as well.
        - Not much depth information -- just a bit (remember, no binocular integration here yet).

    - Have output containing map of face that are in register with visual map.
- Functions to orient eyes towards a stimulus.
- The same pathway can activate an avoidance reflex -- by cells in deep layer that form tectopontine uncrossed pathway.
- This is about a B-A answer
- Why not a visual reflex center? Eye movement, then head, then body movement -- so response is not just eye movement, but whole body.
    - Also, reflex triggered by somatosensation and auditory stimulus as well -- so not just vision.
- Important -- for this you should discuss the point that the maps are *in register*.

2003, Question 3

- Fast vs. slow axon:
    - Fast axon: 10 micron diameter axon -- A alpha, myelinated.
        - Largest myelinated axon have fastest conduction velocity.
        - Maybe say ~130 m/s
    - Slow axon: small and no myelin -- maybe ~0.1th m/s.
- Synapse: different types of receptors:
    - Fast: ionotropic receptors.
    - Slower: NMDA receptors -- need calcium.
    - Slowest: metabotropic receptors -- need G protein to couple to another ion channel.
    - Point out how they act in time range of millisecond to minutes.
    - Give examples -- nACh, mACh mGliuRs AMPA, NMDA, etc.
    - Fast axon used for fast escape reflexes.
    - Slow; diffuse ascending pathways, for modulating midbrain action.
- 2 levels of signaling: neurons and hormones.
- Postsynaptic cascade: the two types of G-protein cascades:
    - Shortcut: G-beta opens channel directly.
    - Second messenger cascade: uses second messengers, kinases, etc. for slower postsynaptic effects.
        - I.e. how does calcium produce fast (depolarization) and slow effects.
    - Speed depends on number of steps to go from initial metabotropic activation to end target process.
    - Provide one example per point.

2002, Question 1

- Together they figured out synapses and neurons are necessary for integration.
- Sherrington: studied SC pathways, showed the integrative action of the SC; showed delay in SC, inhibition and excitation occurring at connections between neurons -- he called these functional connections *synapses*,.
    - Timed between input/output to look at synaptic delay.
- Cajal looked at synapse in SC, said that connections are connections between neurons.
    - Saw boutons and spines -- so proposed that the connection occurs between those two structures.
    - Neuron doctrine: information go from bouton to dendrite via synapse -- unidirectional transfer.
    - Wiring diagrams of neural pathways can be elicited by looking at the synapses.
    - Used stains to propose wiring diagrams.
- Higher order functions result from connections between these neurons.
- They complemented each other because one showed function, while the other showed structure.
- Neuroscience: based on functional and anatomical connections.

2002 Question 3

- Talk about potassium channel, calcium, etc.
- Some are activated by depolarization and voltage change (Ca, K, Na).
- Some are activated by chemical signals -- i.e. Na channel -- nACh, potassium: GABA-b; Cl: GABA-a; Ca -- NMDA.
- NMDA: both V-gated and ligand-gated.

2001, Question 1

- Shortcut pathway: beta connects to ion channel in membrane -- a direct action of G protein on ion channel.
- Second messenger: cAMP/cGMP activates channels.
    - Or second messenger activates AC/GC, which makes cAMP/cGMP.

2001, Question 2

- Acoustic stimulus: intense noise.
    - Cochlear nucleus to giant neurons in caudal reticulopontine formation.
- Tactile stimulus: strong blow-like stimulus to face/body.

    - Trigeminal nerve to trigeminal n. to caudal reticulopontine formation.
- Vestibular stimulus: head acceleration.
    - VIIIth nerve: semicircular canal to vestibular nucleus to vestibulospinal pathway
- Vestibulospinal and reticulospinal converge to produce startle
- All activated when there is blow to head/body.
- Sum to produce startle response.
- Ventromedial pathway: all in ventromedial part of spinal cord; all 3 control movements of body axis; all directly activate motor neurons/interneurons in ventral spinal cord.
    - Vestibulospinal, reticulospinal, (didn't hear).

2001, Question 3

- Mesolimibic pathway from ventral tegmental to N. Acc
- Small contribution from nigrosubstantia pathway.
- Addiction:
    - Cocaine/amphetamine: DA terminals in N. Acc. -- increase release.
        - Cocaine: blocks DAT.
    - Nicotine: nAChRs on DA neurons in VTA.
        - nAChRs excite DA neurons to trigger DA release -- notice he didn't talk about cholinergic neurons.
    - Opiate: GABA neurons in VTA (opiate receptors -- neurons get disinhibited); GABA disinhibits DA.