MIDTERM 2
MCB 160, SPRING 2006
100 points
5 questions
5 pages

BE SURE TO PUT YOUR NAME AT THE TOP OF EVERY PAGE!!!!!!!!!!
CHECK THAT YOU HAVE FIVE QUESTIONS!!!
WRITE IN INK!!

Name __________________________________________________

SID # __________________________________________________

GOOD LUCK!!!
Do not write below this line (for grading purposes only).

1. /22
2. /20
3. /20
4. /20
5. /18

Total
1) During development, gradients of chemical cues are used to set up the final body plan. (22 points total)

A) Describe how a spatial gradient is formed and how it sets up different cell fates. Name one biological example discussed in class (7 points).

A spatial gradient is usually formed by diffusion of a morphogen from a point source. Cells at different distances receive different concentrations of the morphogen. Different concentrations of a morphogen set up different cell fates by activating the transcription of different target genes. Sonic hedgehog (SHH) is a morphogen released from notocord and floor plate that sets up ventral patterning in the spinal cord.

B) Describe how a temporal gradient is formed and how it sets up different cell fates over time (7 points).

A temporal gradient forms if a dividing cell has limiting quantities of a morphogen (or small molecule that determines cell fate). At each cell division, the concentration of this molecule is split into the daughter cells. With every cell division, the progeny have less and less of the morphogen. Different concentrations of the morphogen will set up different cell fates by activating transcription of different target genes.

C) The same chemical cue can set up different cell fates at different developmental times. BMP is involved in early neurulation as well as in later spinal cord development. In what tissue is BMP expressed in early, and what cell fate does it induce? In what tissue is it expressed later and what cell fate does it induce (8 points)?

Neurulation---BMP is in ectoderm (or epidermis), induces non-neural fate

Spinal cord---BMP is in roof plate, induces dorsal spinal cord cell fates
2). In Roger Sperry's classic experiment, he rotated the frog eye and examined retinal projections to the optic tectum. (20 points total)

A) Why does this experiment support the chemoaffinity hypothesis (6 points)?

Demonstrates that the axon recognizes the target independent of its position relative to the target. Argues that there are cues in the target that the axon recognizes.

B) The receptors and ligands that set up the topographic map from the retina to the tectum have now been identified. Name the receptor and ligand. (2 points)

ephrin receptor, ephrin ligand

C) Draw a schematic of the retina and tectum showing the gradients of receptor and ligand. Label the anterior and posterior retina and tectum and the low and high concentrations of receptor and ligand. Draw the projections from the anterior and posterior retina to the tectum. (6 points)

D) What would happen to retinal projections if the amount of receptor was decreased by 50% in each retinal ganglion cell? Draw the projections from the anterior and posterior retina to the tectum. Provide a brief explanation. (6 points)

The axons will shift to the posterior part of the tectum, because they will need to encounter more ligand to stop.
3) The sense of taste in mammals is composed of five taste modalities: sweet, bitter, sour, salty and umami (the taste of MSG). (20 points total)

A) What taste receptors recognize sugars? Bitter compounds? Umami? (6 points)

Sugar--T1R2+T1R3
Bitter--T2Rs
Umami--T1R1+T1R3

B) The molecules that detect sour have not been identified. Would an electrophysiology experiment that monitors taste cell depolarization to sour compounds distinguish whether a GPCR, an RTK or an ion channel detects sour taste? Why or why not? (4 points)

If the depolarization is very fast, this would indicate ion channel.
If the depolarization is slow, this would indicate either GPCR or RTK
Therefore, the experiment would allow you to distinguish ion channels versus RTK, GPCR but not whether it’s a GPCR or an RTK

C) If you could add a drug during the electrophysiology experiment to inhibit the action of one protein, what protein would you inhibit to distinguish whether a GPCR, an RTK or an ion channel detects sour? (4 points)

Inhibit the G protein. This would distinguish GPCR from RTK, and timing would distinguish ion channel.

D) If sour taste were mediated by RTK signaling, then blocking RTK signaling should block sour taste (turn lemons into lemonade). Name two ways in which a pharmaceutical company might try to block sour taste. (6 points)

Ligand antagonist
Receptor antagonist
Receptor dimerization blockers
Phosphorylation blockers
Antibodies against ligand or receptor
4) The growth cone of an axon contains the axon guidance receptors robo, DCC and Unc5. It takes a route from the dorsal root ganglion in the spinal cord to peripheral skin tissue. On its way, it first travels toward muscle A. Once it reaches muscle A, it rapidly moves away from it to synapse onto muscle B. (20 points total)

A) What axon guidance molecule would muscle A contain to attract the axon to it? (3 points)
netrin

B) What axon guidance molecule would muscle A contain to repel the axon? (3 points)
Netrin (or slit)

C) How could the axon first be attracted and then be repelled? (6 points)
If B is netrin, then the axon could turn on expression of Unc5 only once it has reached the target.

If B is slit, then axon could turn on Unc5 and robo only once it has reached the target. Or muscle could turn slit on and netrin off after the axon reaches it.

D) The axon reaches its final destination in the spinal cord. It dies by programmed cell death. Adding snake venom would have prevented death. Why? What is the signaling cascade that leads to cell death? (Name the proteins for either the worm or mammalian pathway, and draw regulatory arrows between the proteins to show whether they activate or inhibit the next protein.) (8 points)
Venom has NGF which is a neurotrophin

EGL1 inhibits CED 9 inhibits CED4 activates CED3
Or BH3 inhibits BCL2 inhibits APAF1 activates caspase
5) The senses of smell, taste, hearing and vision all use very different strategies to collect information about the outside world and relay it to the brain. (18 point total)

A) Name three strategies that rods in the eye use that allow them to produce measurable responses to single photons of light. (6 points)

- High amplification in the signal transduction cascade,
- Low background noise due to thermal stability of rhodopsin
- Rhodopsin is packed into discs to maximize surface area for light detection

B) What strategies does the auditory system use to adjust the hair cell’s response to sound? Name one transduction mechanism used by inner hair cells and one mechanism used by outer hair cells. (6 points)

- Transduction: adaptation motor physically moves ion channel, altering tension on the tip link, and closing channels
- Outer hair cells: hair cells mechanically stretch or contract changing the flexibility of the basilar membrane

C) How are 50,000 different smells detected by the olfactory system when there are only 1000 types of olfactory receptors? (6 points)

- Different combinations of receptors are activated by different odors