Rose
F13

Name KEY Biology 3330 Midterm #2, 2003

1. (11 pts) Match the sentence on the right with the corresponding term on the left: one letter per space.

K Rods	a. provide information about muscle force
D Meissner's corpuscle	b. temperature and pain sensation, tickle
H ommatidium	c. stretch receptors that signal disparities between expected and actual muscle length
E hair follicle receptors	d. sensitive to light touch, in hairless skin
B free nerve endings	e. sensitive to light touch , [redacted]
J neuromast	f. mediate color vision
C muscle spindle organs	g. vibration sensors
G Pacinian corpuscle	h. photoreceptive structure in insect eyes.
A Golgi tendon organs	i. pressure sensor, slowly adapting
I Ruffini's endorgan	j receptors in the lateral line of fishes
F Cones	k. Important for night vision.

2. (9 pts) Adaptation is not simply a 'deficiency' of the nervous system, but rather plays important roles in encoding stimulus information. For each case below, describe the mechanism and function of adaptation.

Site of adaptation	Mechanism	Function
Photoreceptors	2 Release of Ca^{+2} inhibition of Guanylate cyclase	1 maintain sensitivity to changes in light level
Olfactory receptors	2 PKA mediated phosphorylation of Receptor, Desensitizes.	1 maintain sens. to A's in [odor]
Pacinian Corpuscle	2 collapse of the Corpuscle lamellae (Fluid escapes from point of Pressure	1 Vibration sens. (changes in Pressure

3) (6 pts) The sharp frequency tuning of auditory nerve fibers and hair cells reflects the impressive selectivity of the peripheral auditory system for the frequency of sound.

a) What 3 factors give rise to this tuning? 2

2 1) mechanical tuning of Basilar Memb. 3) Bio mechanical via contraction of OHC's

2 2) Electrical tuning of Hair cells

b) Describe the evidence that supports the roles of these factors in generating frequency selectivity?

- measure vibration Ampl. @ various pts along B.M
- inject current into H.C - see 'ringing'
- Depol. OHC's measure contraction

3). (10pts) Pattern generation:

a) Historically, 2 theories were proposed as the neural basis of rhythmic behaviors. Briefly describe these two theories, making sure that you highlight how they differ from each other.

2 - Reflex chain ; requires sensory Feedback

2 - Central Pattern generating Network (all in the CNS - reciprocal inhibition

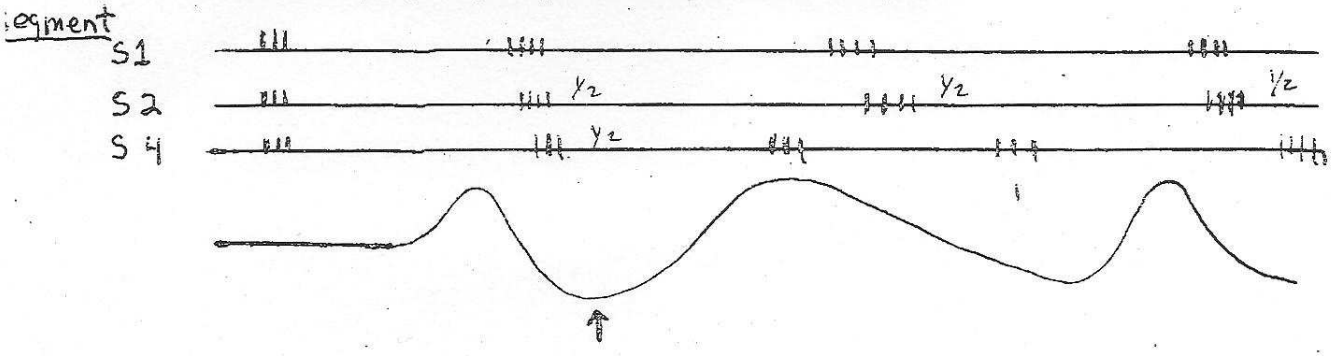
Sensory Feedback not required.

b) In studies of the lobster stomatogastric ganglion, what important experiment and discovery shaped current thinking about how rhythmic motor patterns are generated? (Hint: consider cellular vs. network roles in pattern generation)

3 Pacemaker neurons ; Laser ablate others to isolate individual neuron - Exhibits Endogenous Bursting properties.

c) From what you learned about the neural basis of dogfish (shark) swimming, draw the patterns of activity of motor neurons for spinal segments S2 and S4. Note that segment 4 has been deafferented at the time indicated by the arrow. Other experimental conditions are as described in the book. Briefly explain your placement of the bursts of spikes.

3



4. (4 pts) What 2 important principles have emerged from the study of neuromodulator effects on the lobster stomatogastric ganglion? Think of the effects of stimulating the 'PS' neuron.

2 • circuits are not 'hard-wired' - (not Fixed)

2 • Rhythm is modifiable - particular pattern generator participates in more than one behavior & can produce multiple Rhythms.

5. (12) The auditory cortex consists of a primary region that is tonotopically organized, and other areas in which neurons respond weakly to pure tones. Little is known concerning the functional role of 'non-primary' auditory cortical areas in most mammals. An exception is the bat auditory cortex.

a) What information is mapped in two of these 'non-primary' regions? In your answer describe what stimulus features activate neurons in these areas.

(1)

2 • Relative target velocity ; pulse & Doppler shifted echo

(1)

2 • TARGET Range ; pulse & echo w/ particular Delay (ΔT)

b) Discuss this organization of the bat auditory system with regard to the concepts of serial-hierarchical processing vs. parallel processing. (in your answer, explain what is meant by parallel processing and hierarchical processing).

2 parallel : Doppler shift & echo delay info processed in separate Regions.

2 Serial : Delay sens. emerges @ Cortex by combination sensitivity

c) Neuroscientists are still uncertain as to why computational maps (such as the ones in bat auditory cortex) exist. Describe two current theories that attempt to explain why computations are mapped.

(1) - Result of the mech. of performing the computation.

(1) - Required for efficient utilization of info. (eg. controlling motor Responses / Behavs)

6 a) 11.5pts. In the first part of the course, you saw a variety of 2nd –messenger pathways that function in synaptic transmission. Second-messenger signalling pathways are also important in stimulus transduction in the visual, gustatory, and olfactory systems. Using your knowledge of (2nd-mesenger mediated) processes whereby the sensory stimuli shown below are transduced, place the appropriate letter(s) in the blanks below. (Note: there can be more than one answer for each blank).

Stimulus	Enzymes activated by G protein	changes in 2nd-messenger effects	Action on channels	Change in Memb. Potential
Visual-light	J	A	L, K	E
Gustatory-sugar	C	F	M	N
-Bitter	I	H, D	G, O	N
Olfactory- Odour	C, I	F, H	P, B	N

Depol Hyperpol

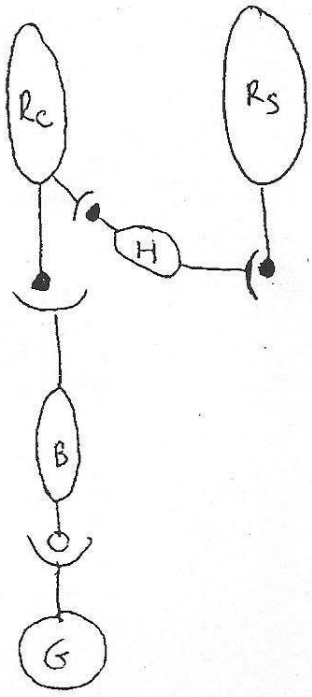
- A. Decreased cGMP
- B. Ca^{2+} channels open.
- C. Adenylyl Cyclase
- D Increased DAG
- E. Hyperpolarization
- F. Increased cAMP
- G. Increased Ca^{2+} release
- H. Increased IP_3
- I. PLC
- J. PDE
- K. Na^+ channels close
- L. decreased Na^+, Ca^{2+}entry
- M. PKA phosphorylates K^+ channel, closing it.
- N. Depolarization
- O. PKC phosphorylates K^+ channel, closing it.
- P. cyclic nucleotide gated channels open.

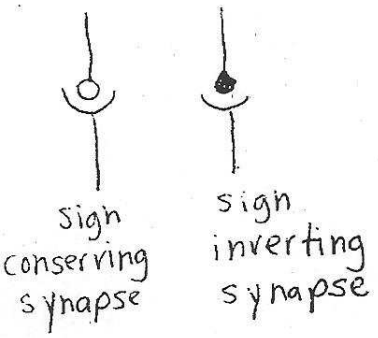
b) 2pts. How is 'Sour' in the gustatory system transduced?

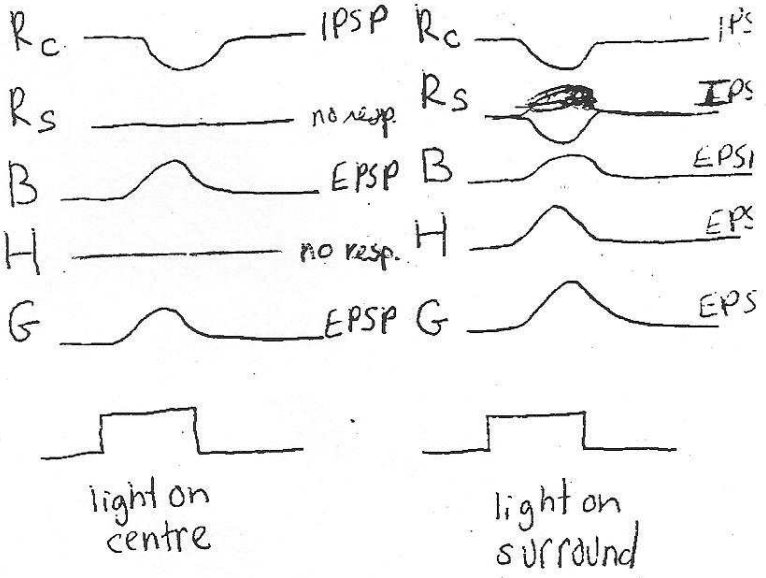
Sour is acidic → H+ ions dissociate and close K+ channels. K+ can't flow out of receptor cell, so depolarization occurs.

7 a) 5 pts. Draw, next to each letter below, the receptor potentials (EPSP or IPSP) that you would expect to record from each of the retinal cells in response to light.

3 = bipolar cell
r = ganglion cell
c = Receptor, Centre
s = Receptor, surround







b) 2 pts. Name one function of a centre-surround response in ganglion cells.

Edge detection, enhances contrast

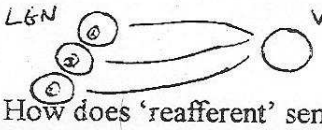
8) (4 pts) In the visual system, there are no yellow cones, and yet we have a distinct sensory perception of the colour yellow. Explain the neural basis of this perception. What kind of coding scheme does this represent?

'yellow' is a result of red and green cones being activated equally → population code.
This is a range fractionated coding scheme.

9) (4 pts) The difference in response properties of LGN vs. visual cortex neurons is an excellent example of serial, hierarchical processing. Describe these differences i.e., what is the effective stimulus for these neurons.

LGN responds to spots of light in a centre-surround fashion:

Visual cortex responds to bars of light at a particular orientation. This is due to input from many LGN neurons:



New info is being extracted at higher layers.

10) (6 pts) How does 'reafferent' sensory information differ from 'exafferent' sensory information? (in 2-3 sentences, define what these terms mean and give an example of each).

reafferent info: information (sensory input) resulting from one's own actions
eg. visual world moves because you're walking.

exafferent info: sensory input coming from outside world.
e.g. visual world moves because someone punches you in the head.

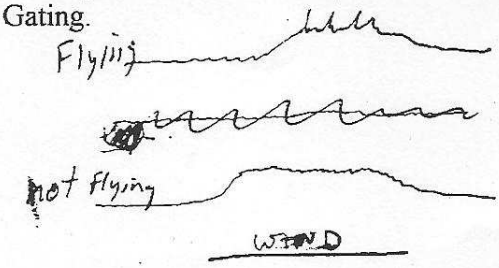
11. (6 pts) a) What is 'Muller's Doctrine'? What does it say about the neural basis of perception?

Muller's Doctrine → law of specific nerve energies. Perception is not due to a stimulus per se, but depends on the specific neurons that are activated.

b) What is Synesthesia? How does the condition of Synesthesia extend Muller's doctrine?

Synesthesia is a condition of inappropriate perception, eg. 'seeing music'. A given stimulus (i.e. music) activates inappropriate neurons (visual neurons). Reinforces idea that perception is a function of activated neurons.

12. (4 pts) Using insect flight as an example, describe what is meant by the term Reflex Gating.



eg The wind only elicits an abdominal steering response when the animal is actually Flying. Flying GATES the effects of wind

13. (4 pts) Vestibular system: During an ice-skating competition, a skater performs a 'double axle'. As the skater jumps into the air and starts spinning, what parts of the vestibular system are stimulated? In your answer, be sure to convey what the effective stimulus is for each organ.