Name: Key

Biology 3330, midterm#2, Fall 2011

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

f Cochlear N.

d Meissner's corpuscle

J inner hair cells

e hair follicle receptors

b free nerve endings

K scala media

C muscle spindle organs

g Pacinian corpuscle

a Golgi tendon organs

i Ruffini's endorgan

h inferior colliculus

a. provide information about muscle force

b. temperature and pain sensation, tickle

c. stretch receptors that signal disparities between expected and actual muscle length

d. sensitive to light touch, in hairless skin

e. sensitive to light touch

f. first-order central auditory nucleus

g. tactile vibration sensors, fast adapting

h. midbrain auditory region

i. pressure sensor, slowly adapting

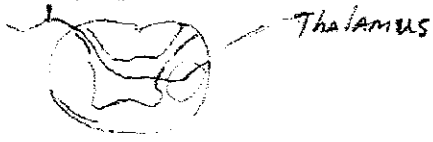
j transduce sound energy

k. contains the organ of Corti

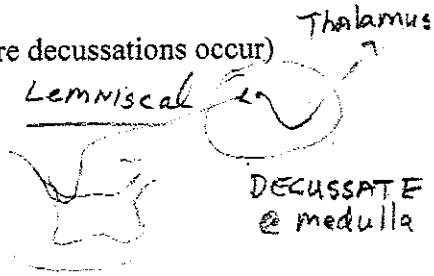
2) (8pts). Explain how the spinothalamic and lemniscal divisions of the somatosensory system differ in the following properties:

a) Anatomically (show pathways, paying particular reference to where decussations occur)

Spinothalamic: decussate @ spinal cord



Lemniscal



b) Effective stimuli.

pain, thermal

touch Pathway aka Vibration, pressure

3. (6 pts) We discussed in class the characteristics of individuals that have either Adrenogenital Syndrome or Androgen Insensitivity Syndrome. Are these individuals more male-like or female-like in their appearance and behavior? Explain how these conditions reveal the role of hormones in the sexual differentiation of the brain in the developing fetus. (Hint: what is the default sexual condition of the brain?)

	Genetic sex (XX, XY)	Appearance & Behavior
Adrenogenital syndrome:	XX (♀)	mainly ♀, Behaviorally ♂
Androgen Insensitivity Syndrome:		mainly ♀ (But have 'undescended' testes), Behaviorally ♀

4. Matching (5 pts)

C Red Nucleus	A. Project to spinal cord and oculomotor nuclei.
B Pontine and medullary reticular N.	B. Important for control of posture
A Vestibular Nuclei	C. Rigidity results if brainstem is transected below this region.
E Premotor cortex	D. Active prior to voluntary movements, particularly the hands and fingers.
D Primary motor cortex	E. Active during imagined movements

5. (8 pts) Central pattern generation.

a) What network property did Wilson predict to underlie rhythmic pattern generation? What experiments were done in the lobster and how did these prove his theory to be wrong?

Reciprocal inhibition

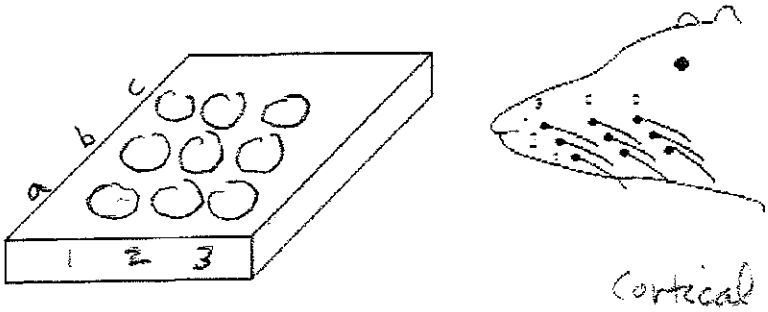
Individual neurons (Pacemaker) were found to have endogenous Bursting properties (Rhythmic Activity)

b) What cellular mechanisms underlie central pattern generation in both invertebrates and vertebrates?

- Voltage-dependent conductances (@) promote depolarization
- Ca^{+2}-dependent K^+ g Activates as Ca^{+2} builds up.

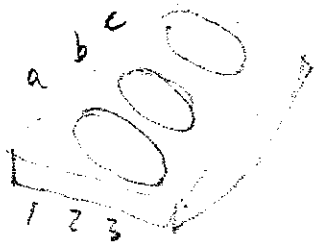
6. (8 pts) Shown below is the somatosensory cortex and head region of a rat.

a) Draw, using the picture below, the somatotopic organization of the cortical region (left) that represents the vibrissae (whiskers); that is, in your drawing show the regions that are activated by stimulation of each whisker.
b) How is this cortical organization similar to the olfactory bulb? (what is this organization called?).



Cortical barrels - similar to Glomeruli (Olfactory)

c) Draw the organizational pattern of somatosensory cortex that you would expect to see if the 3 wiskers in each group (a,b or c) were fused together, such that the associated receptors were activated synchronously. Explain your reasoning.



now whiskers of each group activate cortical neurons simultaneously

7. (6 pts.) The spatial receptive fields of neurons in the midbrain of the barn owl are derived from 2 principle types of computations. What information is computed, and what is the relation between that information and the sound source location? (this is related to the 'duplex theory' of sound localization).

ITD : Interaural time difference => Azmuith (Horizont) position

IID : Interaural (Intensity) Amplitude diff. => elevation cue

8. (10 pts.) The mammalian superior colliculus is mapped in 'motor coordinates'. It, therefore, represents a computational map for motor control (control of saccadic eye movements).

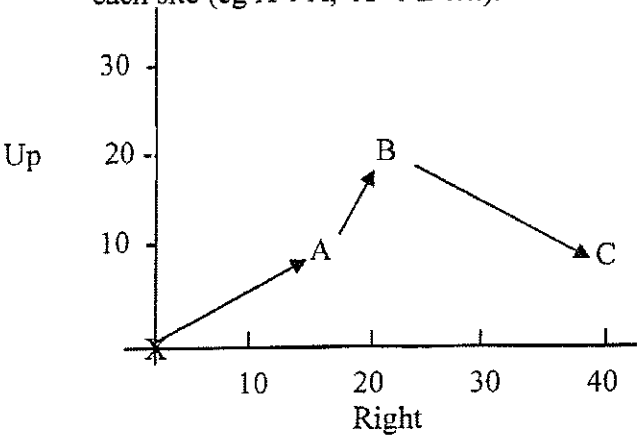
a) What computation is performed in the superior colliculus? As a result, the magnitude and direction of any particular saccade is determined by what factor?

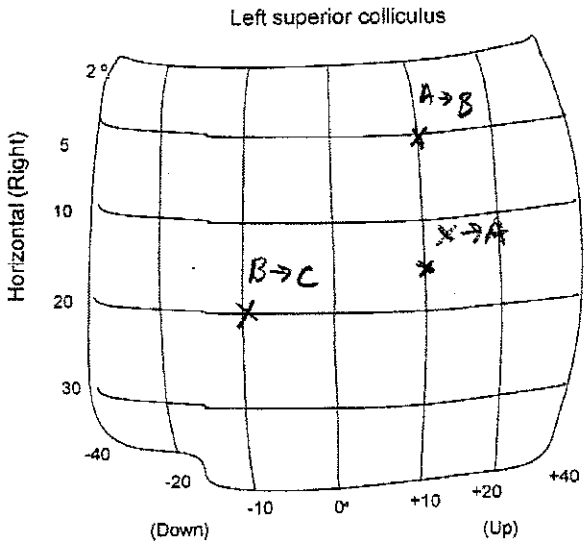
motor error = DESIRED eye position − CURRENT eye Position

site of Activity in S.C. (site of most Active Neurons determines saccade dir + MAG)

b) A monkey is trained to make the 3 saccades shown below. The animal shifts its gaze from point X→A, then from A→B, and finally from B→C. Thus the final position of the eyes is 10 degrees up & 40 degrees right.

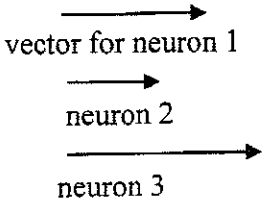
On the map below, indicate the sites of maximal activity prior to each of these 3 saccades; label each site (eg X→A, A-→B ….).





c) You now record from 3 neurons in motor cortex that have similar 'best directions of arm movement'. Using your understanding of the motor organization of the superior colliculus, speculate as to why the 'response' vectors shown below differ in length (the length of vectors represents the firing rate prior to movement in the best direction) .

What additional experiment could be done to test this hypothesis?

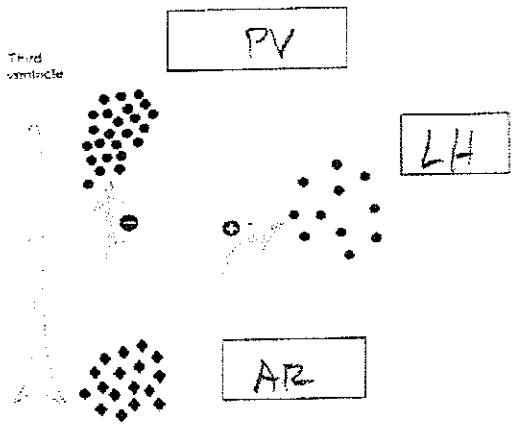


probably code for direction + magnitude of ARM movement

- test by training monkey to move ARM to various places, indicated by some positional marker eg light spot

9. (11) Regulation of feeding behavior:

PV	Paraventricular N.
LH	Lateral hypothalamus
AR	Arcuate N.



a) Label the hypothalamic regions shown above.

5

b) Where are receptors for leptin located, and what role does this peptide play in regulation of body weight? ARcuate N.

2 increase (↑) Leptin causes weight reduction by suppressing Feeding !

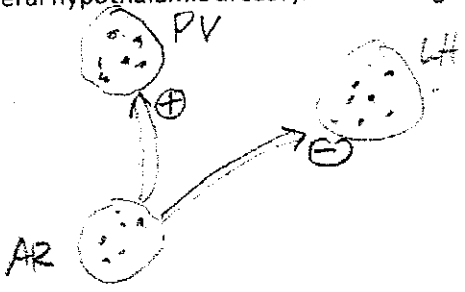
c) What primary roles do the PV and LH play in regulating body weight i.e., what do they do?

2 PV : - stim TSH release → Thyroxine ↑ metabolism
- ↑ sympathetic Activity

2 LH : Increases Feeding Behavior

d) The arcuate N. cells shown above release NPY & AgRP. What roles do the arcuate neurons that contain MSH & CART play (how does their activity influence the PV and lateral hypothalamic areas?). Use a diagram like the one shown above.

2



MSH/CART neurons : excited by Leptin, inhibit LH & decrease Feeding Behavior

: Activate PV cells to increase metabolism / sympathetic Activity

10. (6 1/2 pts) Complex motor behavior results from coordinated activity in several areas of the brain.

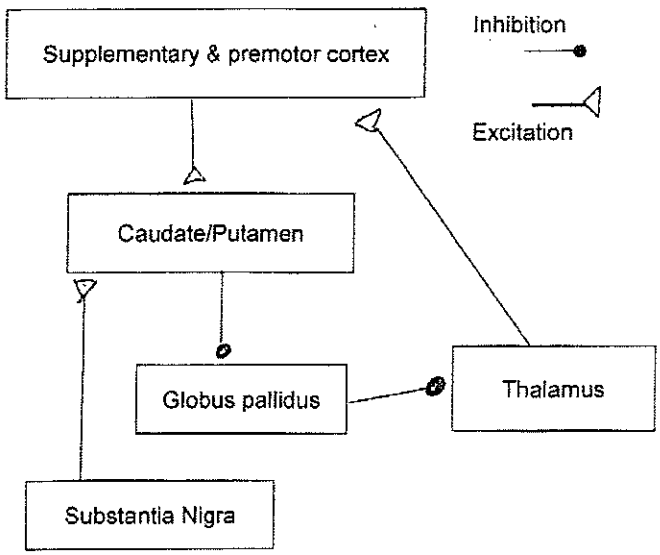
2 A

a) 'Mirror' neurons are believed to play an important role in complex motor function. Explain the basis of this name (under what conditions are these neurons active?).

Active when viewing a motor behavior

2½

b) Identify the connections (excitatory or inhibitory synapses) between structures shown below and explain the role of the basal ganglia, via their action on the thalamus, in complex motor behavior.



Based on this circuit, explain how the basal ganglia operate as a 'motor gate' (role that this circuit plays in initiating motor behavior).

2

Activity from Frontal Cx / suppl. + premotor cx ½ increases Caudate / Put inhibition of G.P., ½ which releases Thalamus from inhibition. ½ Thalamic excitation then opens the 'gate' ½ for cortical motor activity.

11. (9 pts) Matching:

H Locus coeruleus neurons

E Sympathetic nervous system

C Magnocellular cells, hypothalamus

B Raphe N. neurons

A Anterior pituitary

D Adrenal cortex

F Parasympathetic nervous system

G Intermediolateral gray neurons

I Ventral tegmental dopaminergic (mesocorticolimbic) system

A. Releases FSH, LH into portal circulatory system, triggered by 'releasing hormones'

B. Most active when alert, silent during sleep

C. Release oxytocin & vasopressin (ADH) in posterior pituitary

D. Releases cortisol in response to ACTH

E. Promotes 'fight or flight' behavior

F. Activity facilitates 'restorative' functions (e.g., aids digestion, slows heart rate...).

G. Preganglionic cells of the autonomic nervous system

H. Diffuse modulatory system of the brain. Uses NE as neurotransmitter and mediates behavioral arousal.

I. Activity related to reinforcement of Behavior

12. (6) Describe the roles that vasopressin & its receptors play in :

3 a) 'Affiliative' behavior and mating strategy in voles. Action of VASOpressin @ receptors on Ventral forebrain Neurons increases pair-bond formation → monogamy

3 b) Regulation of homeostasis. Vasopressin (ADH) is released by Ant. Pituitary ; acts to increase H_2O uptake in Kidneys.

13. (5 pts) a) Primary auditory cortex has a similar functional organization in all animals. What information is mapped in this region, and what is this type of map called?

2 Frequency is mapped ; tonotopic organization

b) Give an example of a computational map in nonprimary auditory cortex. What is the information that is computed and mapped?

3 Echo Delay (TARGET RANGE) : Time difference between pulse + echo