

BIO 3303 Animal Physiology I  
Midterm #2 A

Student #: \_\_\_\_\_  
Name: \_\_\_\_\_

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**70min**

**TOPICS: Nervous System and Endocrine System**

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*By signing below, you acknowledge that you have ensured that you are complying with the above statement.*

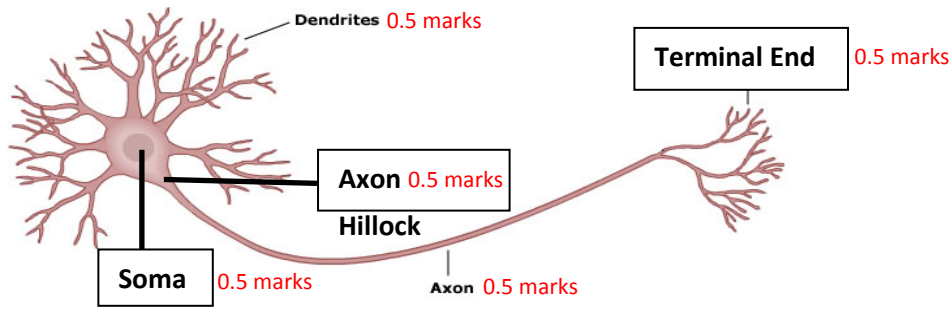
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**Answer on the question sheet in the space provided. This exam is out of 50 marks.**

**Read through the exam fully before starting as short answer and multiple choice questions are throughout.**

- (1 mark) True or **False** (circle one) Vertebrate endocrine cells have long axons that release chemical messengers into the blood.
- (5 marks) Draw a neuron and label the soma, dendrites, axonhillock, axon and terminal end. What is the function of each part with respect to passing a signal along the cell (signal processing)?

— A Typical Neuron —



Soma: the cell body of the neuron. This is where the graded potential occurs (0.5 marks)

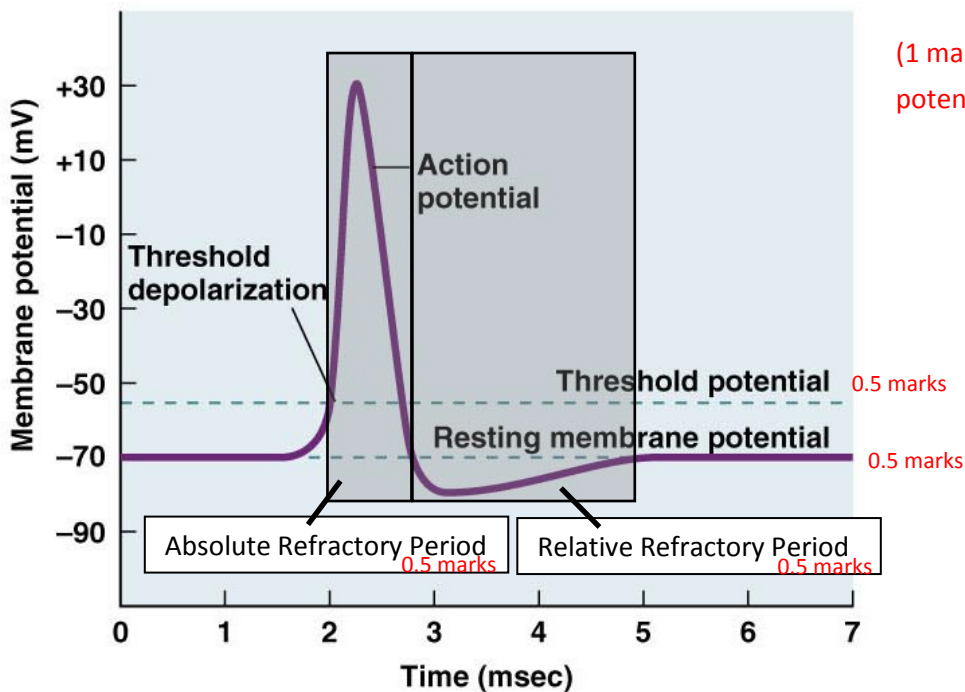
Dendrites: receive the incoming signal (which results in a membrane potential) (0.5 marks)

Axon Hillock: initiates action potentials (0.5 marks)

Axon: Carries the action potential to the terminal end (0.5 marks)

Terminal End: Once the AP reaches the terminal end, neurotransmitter is released (0.5 marks)

- (3 marks) Draw a single action potential on the below axes. Label the threshold potential and the resting membrane potential. Also note the absolute refractory period and the relative refractory period.



(1 mark) for the shape of the action potential

**(b) Suprathreshold graded potential**

- (1 mark) Myelination of nerves (pick one):

- a. Insulates the electrical current of the nerve and increases signal transmission speeds.
- b. Insulates the nerve and maintains a homeostatic temperature.
- c. Gives the nerve a grey appearance.
- d. Controls the action potential so the axon does not depolarize past -55mV.
- e. None of the above.

5. (2 marks) What is the difference between an action potential and a graded potential?

A graded potential can vary in magnitude and duration and decays with distance (0.5 marks). It occurs in the dendrites and soma of neurons (0.5 marks). An action potential (within a given cell type) is always the same magnitude and duration (i.e. all or none response) and can be transmitted across long distances (0.5 marks). It occurs in the neuronal axon (0.5 marks).

6. (1 mark) The peripheral nervous system (PNS) is made up of an efferent and an afferent branch. Pick the answer below that includes the ENTIRE peripheral nervous system:

- a. Enteric and somatic divisions.
- b. Motor and Autonomic divisions. + SENSORY DIVISION
- c. Sensory and sympathetic divisions.
- d. Sympathetic and Parasympathetic divisions.
- e. Sensory and Motor divisions.

7. (1 mark) An increase in the response to a gentle stimulus after exposure to a strong stimulus is called \_\_\_\_\_sensitization (1 mark)\_\_\_\_\_.

8. (2 marks) At the neuromuscular junction the action potential of the neuron causes \_\_\_\_voltage (0.5 marks)\_\_\_\_-gated  $\text{Ca}^{2+}$  channels to open allowing the release of the neurotransmitter \_\_\_\_acetylcholine(ACh) (0.5 marks)\_\_\_\_. The skeletal muscle contains **cholinergic/adrenergic (circle one)** receptors that are **ionotropic/metabotropic (circle one)** ion channels.

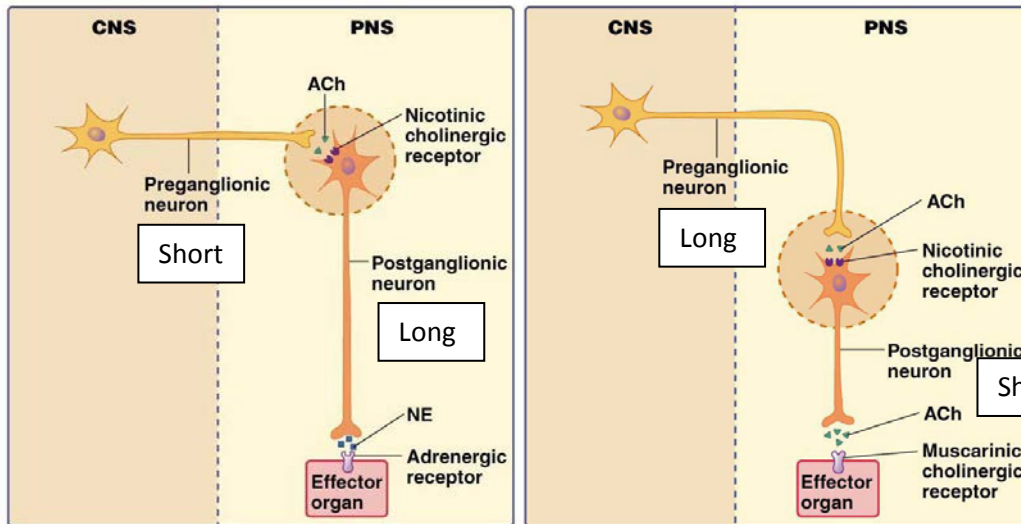
9. (3 marks) We discussed three ways the autonomic nervous system maintains homeostasis of the organism. List and briefly describe these three mechanisms.

Dual Innervation: The SNS and PNS are antagonistic circuits that both innervate the major organs (1 mark).

Antagonistic Action: The SNS (fight/flight; dominates during stress) and PNS (rest+digest; maintenance function and digestion) act antagonistically to maintain the appropriate balance of hormones and other signalling molecules to maintain homeostasis (1 mark).

Basal Tone: These organs receive continuous input (Basal Tone) under resting conditions (1 mark).

10.(4 marks) Both parts of the autonomic nervous system have similar anatomical structures with a pre-ganglionic neuron, a post-ganglionic neuron and an effector site. Guided by the diagrams below, draw and label a diagram for each branch that shows the three main differences between them. (Hint: Include anatomy, neurotransmitter and receptors.)



(1 mark) for the diagrams as a whole  
(1 mark) for descriptions of the relative lengths of the preganglionic and postganglionic neurons  
(1 mark) for proper identification of BOTH neurotransmitters in either system  
(1 mark) for proper identification of BOTH receptors in either system

(b) Sympathetic nervous system

(a) Parasympathetic nervous system

11.(3 marks) You are building a very simple new creature. It is going to use acetylcholine as a neurotransmitter. You have two neurons synapsing with two different effector cells. One of the effector cells you want to have a fast excitatory response and the other is to have a slow excitatory response. What kind of receptors should you use to ensure these differences in functionality?

For the fast excitatory response, you should use an ionotropic (nicotinic) receptor (0.5 marks). These channels are able to create rapid depolarization of the cell membrane and thus initiate the excitatory response right away (1 mark). For the slow excitatory response you should use a metabotropic (muscarinic) receptor (0.5 marks). These receptors elicit an excitatory response through a secondary messenger cascade (usually G-protein coupled) and so it takes longer for the signal to be passed (though it also lasts longer) (1 mark).

12.(1 mark) What is the major difference between alpha 1 and alpha 2 receptors?

Alpha 1 receptors are found on blood vessels of the skin, gut, kidneys and salivary glands and are involved in vasoconstriction/contraction of smooth muscle (i.e. open ion channels) (0.5 marks). Alpha 2 receptors are found on the membrane of adrenergic axon terminals and inhibit the release of NE (i.e. close ion channels) (0.5 marks).

13.(1 mark) In the context of cell receptors what is an antagonist?

A substance that binds to a receptor but does not stimulate a signalling event. They interfere with the binding of the natural ligand (1 mark).

14.(2 marks) What are the four chemical classifications of hormones?

Peptides and Proteins (0.5 marks), Steroids (0.5 marks), Eicosanoids (0.5 marks) and Bioamines (0.5 marks).

15.(2 marks) Pick one hormone type and explain how it is synthesized.

Up to 2 marks for any ONE of the following:

Peptide Hormones: synthesized using protein machinery in secreting tissues. Preprohormone is synthesized in the rough endoplasmic reticulum; the signal peptide is cleaved off and prohormone is packaged into secretory vesicles in the golgi apparatus; in the secretory vesicle prohormone is cleaved into active hormone and one or more other peptide fragments.

Biogenic Amines: enzymatic modification of precursor molecules e.g. Catecholamines synthesized by the Blaschko Pathway.

Steroid Synthesis: Synthesized on demand by enzymatic modification of cholesterol in smooth ER and mitochondria.

Eicosanoids: Synthesized by enzymatic modification of the arachidonic acid (cleaved from membrane phospholipids by phospholipase A2)

16.(1 marks) The action of a hormone depends on (circle all that are correct):

- a. The concentration of the hormone available at the effector tissue
- b. The concentration of the receptors in that tissue
- c. The affinity of those receptors to the hormone available
- d. The agonistic or antagonistic chemicals in the body
- e. The type of receptor present

17.(2 marks) What are chromaffin cells and what makes them unique?

Chromaffin cells are found in the adrenal medulla and are responsible for producing epinephrine and norepinephrine (1 mark). They are a part of the sympathetic nervous system and are unique because they are modified post-ganglionic neurons that dump neurotransmitter into the blood (1 mark).

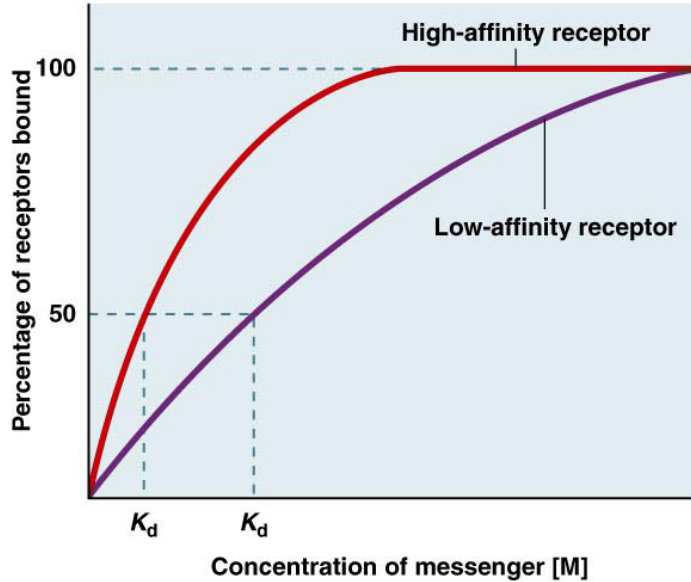
18.(1 mark) Lipid soluble hormones are hydrophobic, as a result they are very difficult to transport.

Lipid soluble hormones travel through the blood stream with the help of \_\_\_\_\_ carrier proteins (1 mark)\_\_\_\_\_.

19.(4 marks) The figure below illustrates the effect of receptor binding. Draw and label two lines on this figure, one for low affinity receptors and one for high affinity receptors. What is a  $K_d$ ? Mark

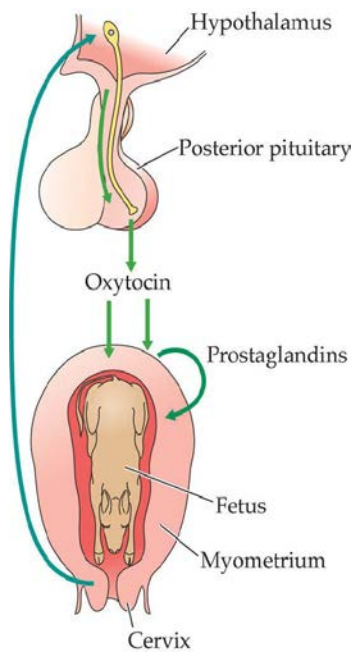
(1 mark) for the low affinity line  
(1 mark) for the high affinity line  
(1 mark) for the definition of  $K_d$  [ $K_d$  is the dissociation constant. It is the concentration of messenger that leads to half of the receptors being bound and is a

hypothetical  $K_d$  values on each line you have drawn.



**(b) Effect of receptor affinity**

20. (4 marks) The endocrine system combines with the nervous system in an integrative control system that uses positive and negative feedback loops to maintain function. Use mammalian parturition (giving birth) as an example to illustrate integrative control. Is it a positive or negative feedback system? Why? Please include hormone names, where they are released from, effector tissues and how the nervous system is involved.



Mammalian parturition is an example of positive feedback (0.5 marks) as there is a stimulatory effect on secretion of oxytocin (0.5 marks).

[See diagram beside if you like pictures better, but here it is in words] Myometrial contractions force the fetus against the cervix, stimulating mechanoreceptors that send action potentials to the hypothalamus. Oxytocin-secreting neuroendocrine cells (0.5 marks) in the hypothalamus (0.5 marks) become more active. Oxytocin (0.5 marks) is secreted into the general circulation in the posterior pituitary (0.5 marks) at an increased rate. Blood oxytocin concentration increases. Oxytocin stimulates myometrial smooth muscle to contract and stimulates smooth muscle (0.5 marks) to secrete prostaglandins (0.5 marks) which also stimulate contraction. Strengthening contractions increase mechanoreceptor stimulation and so the cycle repeats.

21.(2 marks) What are the two hormones involved in the antagonistic regulation of blood glucose and where are they made (be specific by cell type).

Insulin: secreted by the B cells in the pancreas. (1 mark)

Glucagon: secreted by the a cells in the pancreas. (1 mark)

22.(2 marks) The pituitary is divided into an anterior and a posterior section. List two differences between the two parts (think development and interaction with the nervous system).

The anterior pituitary is derived from ectoderm of the oral cavity (0.5 marks) while the posterior pituitary is derived from neural ectoderm (0.5 marks). Neurons secrete neurohormones into the median eminence which then stimulate endocrine cells in the anterior pituitary to release hormone (0.5 marks). Neurons project from the hypothalamus to the posterior pituitary and stimulate release of neurohormone directly into the blood (0.5 marks).

23. (2 marks) What is the difference between chronic and acute stress? What is the evolutionary or survival consequence for each?

Acute stress is a short term stress while chronic stress is a long term stress (0.5 marks). They physiological responses to short term stress allow the animal to respond immediately to a threatening situation (i.e. mobilize blood/glucose/NE/E in fight/flight response) (0.5 marks) and so are adaptive and increase survival and fitness (0.5 marks). The physiological responses to short term stress, if maintained for a long period of time, become chronic stress. These responses become maladaptive and decrease reproduction, growth, survival and fitness (0.5 marks).