

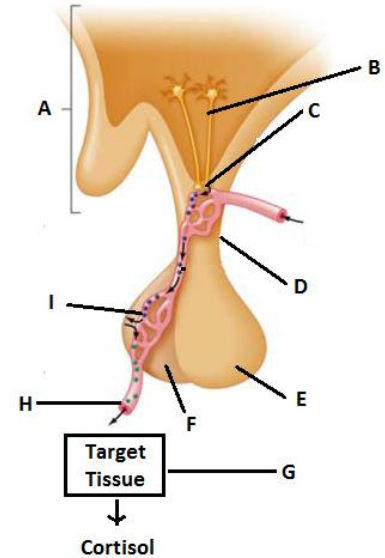
BIO 3303 Study Problems

1. Fill in the blanks based upon cortisol being the end product of the pathway:

- a. (the structure): **Hypothalamus**
- b. (the neurons): **Magnocellular neurosecretory tracts**
- c. (the hormone): **Corticotrophic releasing hormone (CRH)**
- d. (the structure): **Median eminence**
- e. (the structure): **Neurohypophysis (Posterior pituitary)**
- f. (the structure): **Adenohypophysis (Anterior pituitary)**
- g. (the gland): **Adrenal cortex**
- h. (the hormone): **Adrenocorticotropic hormone (ACTH)**
- i. (the hormone): **CRH**

j. Cortisol is a **steroid** (chemical type?) hormone whose mode of action in receptive cells includes 1) binding to a receptor found in the **cytosol** of the cell; 2) this cortisol-receptor complex travels to the **nucleus** where 3) it binds to specific regions of the DNA to initial specific gene **expression**.

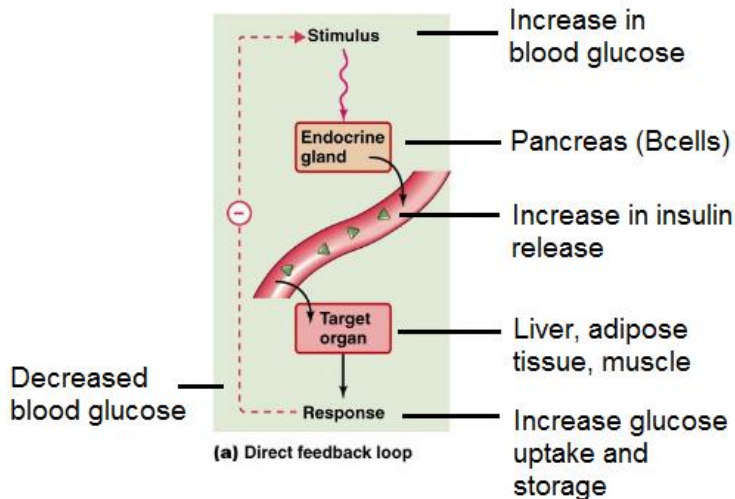
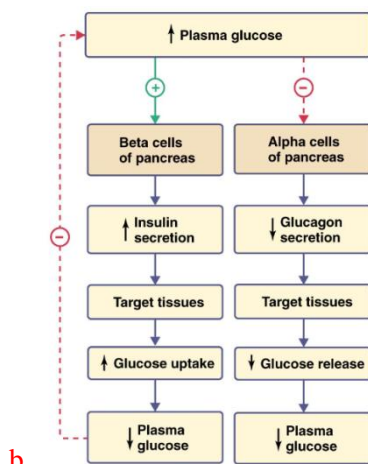
k. The hormone-type noted in c. (above) is called a **tropic** hormone as it induces endocrine tissue to release another hormone.



2. Insulin is a classic protein hormone critical in humans (other mammals) to regulate levels of blood glucose; its absence results in diabetes. Answer the following questions related to insulin.

- a. Name the Canadian duo who first isolated insulin then used their product to treat a diabetic individual?
- b. Insulin acts by what is called a ‘direct endocrine loop’; diagram this feedback loop showing the stimulus for release, the endocrine tissue involved, the body tissue effected, and the response.

a. **Frederick Banting and Charles Best**



- 3a. Nicotine is an agonist of what specific receptor found within the peripheral nervous system?
b. Specifically state the **three** locations within the peripheral nervous system where this receptor is found?
c. One characteristic of nicotine intake is an increase in heart rate but this increase can be blocked (eliminated) by applying a β -blocker (for example propranolol) at the same time as nicotine; explain?

a. Nicotinic acetylcholine receptor

b. Sympathetic peripheral ganglia (chain/collateral ganglia), parasympathetic peripheral ganglia, neuromuscular junctions

c. Activation of the sympathetic branch of the autonomic nervous system relies in the sequential activation of receptors at the ganglionic and postganglionic synapses. Activation of the sympathetic preganglionic neurons causes acetylcholine release and activation of nicotinic acetylcholine receptors on postganglionic neurons. This stimulates the sympathetic postganglionic neurons to release adrenergic neurotransmitters (epinephrine and norepinephrine) on target tissues that express adrenergic receptors. These receptors can be α -adrenergic or β -adrenergic receptors, which have antagonistic effects. Stimulation of β -adrenergic receptors on the heart leads to an increase in heart rate.

Nicotine is a potent agonist of the nAChR; it activates sympathetic postganglionic neurons. However, β -blockers prevent nicotine induced increases in heart rate because they act as a β -adrenergic receptor antagonist.

4. True or False: circle appropriate response

a. The posterior pituitary (or neurohypophysis or neural lobe) is composed of endocrine cells that release the tropic hormone oxytocin into the blood. **True or False**

b. The vagus or Xth cranial nerve is the longest parasympathetic nerve innervating basically all visceral organs of the body. **True or False**

c. The Na^+, K^+ -ATPase found on the axon membrane is responsible for membrane repolarization following the propagation of an action potential. **True or False**

d. All (known?) neurohormones of the hypothalamus are peptide hormones with the exception of prolactin-inhibiting hormone which is a catecholamine. **True or False**

e. Ben Johnson was 'busted' based upon high levels of testosterone found in his urine as the synthetic androgen stanozolol acted as an agonist on skeletal muscle to increase muscle mass.

True or False

5. What defines a cell as an afferent neuron?

- A) It has the capacity to respond to environmental stimuli.
- B) It is located at the periphery.
- C) It has an axon that carries information to integrating centers.**
- D) It has receptor proteins in its membrane.

6. Advantages of populations of receptors, as opposed to individual receptors, include

- A) improved sensory discrimination**
- B) improved stimulus intensity
- C) improved signal firing rate

D) all of the above

7. In olfactory receptor cells, signal transduction cascades often follow this order:

- A) receptor binding → G-protein activation → cAMP → cell depolarization
- B) cell depolarization → increased intracellular Ca^{2+} → adenylate cyclase activation
- C) receptor binding → opening ion channels → G protein activation → cell depolarization
- D) cell depolarization → adenylate cyclase → G-protein activation → conformational change

8. Which of the following lists is in the correct order? Sweet tastes are processed in the following way:

- A) receptor binding, gustducin activated, adenylate cyclase activated, K^+ channels close.
- B) receptor binding, Na^+ channels open, cell depolarizes.
- C) gustducin activated, Ca^{2+} channels close, cell hyperpolarizes.
- D) transducin activated, PLC activated, Ca^{2+} levels rise, neurotransmitter released.

9. Merkel's disks are used by the visually impaired for reading Braille. One quality of the receptor that allows this is

- A) a phasic firing
- B) small receptive field
- C) a special sensitivity to deep pressure on the skin
- D) a large dendritic tree

10. How does the mammalian eye focus an image? In your description, name the important physical structures in image formation, define the focal point, and explain what accommodation is and why it is important.

To create a clear image, light entering the eye must converge on a single point called the focal point, and this focal point must fall on the retina. However, light rays entering the eye are not always entering from the same direction. That is, light rays entering from a distant object are parallel when they strike the eye, but light rays entering from a nearby object are not parallel but are instead divergent. These light rays are bent once they hit the cornea and lens, and the light rays will converge. However, based on the difference in angles between distant and nearby objects, the light rays converge at different points beyond the lens. Light rays from distant objects have a short focal length (focal length: the distance from the center of a lens to its focal point). Light rays from nearby objects have a long focal length. In order to adjust the focal length and force the focal point onto the retina, a process called accommodation, the lens must change shape.

Additional information:

- The cornea and the lens have a convex shape, which causes light rays to bend toward each other. While both of these structures contribute to image formation, the cornea is not capable of changing shape to fine-tune image formation.
- The point where the light converges after passing through the lens is called the focal point.
- Accommodation is the process by which the eye changes its focal length to ensure that the focal point falls on the retina. In mammals, this happens when the lens changes shape. This change is a function of the contraction or relaxation of the ciliary muscles of the eye, to cause the lens to become more rounded or flattened, respectively.

11. If all sensory signals are eventually transduced into the common action potential, then how do receptors encode stimulus modality? Give an example.

One way in which sensory systems can code for stimulus modality is described by the theory of labelled lines. Since most sensory receptors are maximally sensitive to only one type of stimulus, and a sensory receptor is part of (or synapses with) a particular afferent neuron, signals in that afferent neuron must represent a specific stimulus modality. In other words, nociceptive afferent neurons are active ONLY in response to nociceptive stimuli, and thermal afferent neurons are active ONLY in response to thermal stimuli. In a common example, we know that the optic nerve transmits the signal "light" whenever the eye is stimulated, even if the stimulus is pressure on the eyeball ("seeing stars").

The assumption with the labelled-line theory is that there is a discrete pathway from a sensory cell to the integrating center, but sensory connections are not always this simple. For example, polymodal receptors (e.g., ampullae of Lorenzini), which are sensitive to a variety of different stimuli, cannot code in the basic way laid out by the labelled-line theory. In this case, the afferent neuron may discriminate modality based on the firing pattern (e.g., high-frequency bursts instead of tonic firing). Additionally, neighbouring polymodal receptors, with slightly different sensitivities to the various stimuli, may work together to send a coded signal to the afferent neuron.

12. Which of the following pumps is specifically used to return Ca^{2+} to the sarcoplasmic reticulum?

- A) Ca^{2+} ATPase
- B) NaCaX
- C) parvalbumin
- D) SERCA

13. Smooth and striated muscle share many common features, including

- A) organization of filaments into sarcomeres.
- B) use of actin and myosin in contraction.
- C) a ratio of 2:1 thin to thick filaments.
- D) dependence on T-tubules for spread of depolarization.

14. Muscle fiber types can be changed in response to

- A) activity levels
- B) temperature
- C) thyroid hormone levels
- D) all of the above

15. Dihydropyridine receptors (DHPR) are also called _____ because of their large Ca^{2+} conductance.

- A) T-type Ca^{2+} channels
- B) N-type Ca^{2+} channels
- C) L-type Ca^{2+} channels
- D) $\text{Na}^+ / \text{Ca}^{2+}$ exchangers (NaCaX)

16. Muscle fiber types may be termed glycolytic or oxidative in reference to

- A) the amount of myoglobin
- B) the speed of contraction
- C) the metabolic processes

D) the myosin heavy chain isoforms used

17. Most of the Ca^{2+} stored in the sarcoplasmic reticulum is bound to

- A) parvalbumin
- B) troponin
- C) calsequestrin
- D) ryanodine