

KEY

**NROSCI/BIOSC 1070 and MSNBIO 2070
FINAL EXAM
December 12, 2016**

Total POINTS: 100	20% of grade in class
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- 1) A patient reports to the emergency room during a panic attack that is associated with three hours of hyperventilation. A blood draw is taken, and the analysis includes the ionized Ca^{2+} levels in the plasma. Would you expect ionized Ca^{2+} levels to be normal, high (hypercalcemia) or low (hypocalcemia) in the patient? Provide a brief explanation for your answer. **(5 points)**.

Following the period of hyperventilation, metabolic alkalosis would occur. As a result, H^+ is displaced from albumin, opening binding sites for cations. Thus, ionized calcium in the plasma drops (as more Ca^{2+} attaches to albumin), and hypocalcemia occurs.

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2) Another patient reports to the emergency room, and it is found that they have both elevated levels of parathyroid hormone and hypercalcemia.

a) What is the most likely cause of this condition? **(5 points)**.

The only likely explanation is a parathyroid hormone secreting tumor. Normally, levels of Ca^{2+} and parathyroid hormone are inversely related (hypercalcemia is associated with low parathyroid hormone). Since the effects of Ca^{2+} on parathyroid hormone secretion are disrupted, the normal control mechanisms are missing, likely because of a malignancy secreting PTH.

b) Would heart rate likely be higher or lower than normal in this patient? Provide a brief explanation for your answer. **(5 points)**.

Heart rate increases. High Ca^{2+} levels block sodium movement through voltage-gated sodium channels. The reduced depolarization of cardiac myocytes shortens repolarization time, so the Q-T interval is reduced, and heart rate increases. In addition, Ca^{2+} entry during phase 2 of the cardiac action potential is facilitated during hypercalcemia. This affects the closing kinetics of the L-type Ca^{2+} channel, such that the plateau phase of the cardiac action potential is abbreviated and repolarization occurs earlier.

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- 3) A woman has been pregnant for 43 weeks, and her obstetrician decides to induce labor. What two drugs are most likely to be administered for this purpose? **(5 points)**.

Oxytocin (2.5 pts)

Prostaglandins (2.5 pts)

- 4) GnRH antagonists have been proposed as hormonal contraceptives for men. Although effective, such drugs also produce a number of undesirable side effects. Discuss the nature of these side effects, and how they can be abolished by combining the GnRH antagonist with another drug (name the drug that must be combined with the GnRH antagonist). **(5 points)**.

GnRH antagonists would result in a loss of testosterone secretion (since LH production is diminished), eliminating the positive effects of testosterone (increased muscle growth, male sex drive, etc.). This could be addressed by combining the GnRH antagonist with the administration of testosterone.

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5) A young man received radiation exposure in a series of medical treatments. Several years later, he comes to you (his physician) for an evaluation because he is about to marry and wants to know if he is fertile. The blood work you do reveals normal levels of testosterone and markedly elevated FSH. Answer the following questions about this individual, providing a brief explanation for each answer.

a) What is the most likely reason that FSH levels are elevated in this individual? **(5 points)**.

The elevation of FSH with normal testosterone levels suggests that inhibin is absent (which inhibits the secretion of FSH, but not LH). Inhibin is secreted by Sertoli cells, which must have been damaged by the radiation.

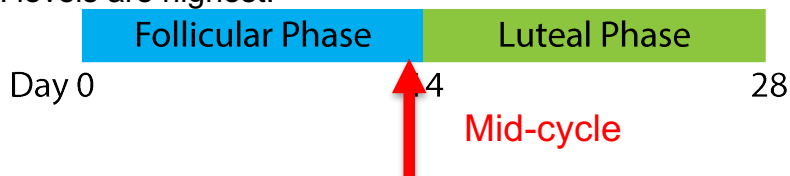
b) Is the man fertile? If not, could any treatment restore fertility? Provide a brief explanation for your answer. **(5 points)**.

The man is sterile, and this cannot be reversed. Sertoli cells are critical for sperm production, and spermiogenesis is lost if Sertoli cells are damaged.

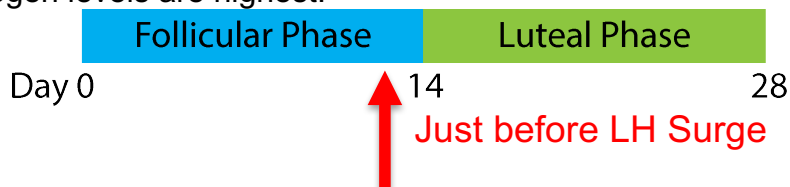
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- 6) The diagrams below indicate the phases of the ovarian cycle. Indicate (with an arrow or circle) when each of the following occur during the cycle. **(2 points each; 10 points total)**. See diagram on next page for more info about the answers.

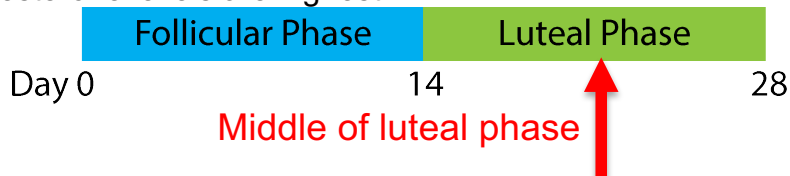
- a) LH levels are highest:



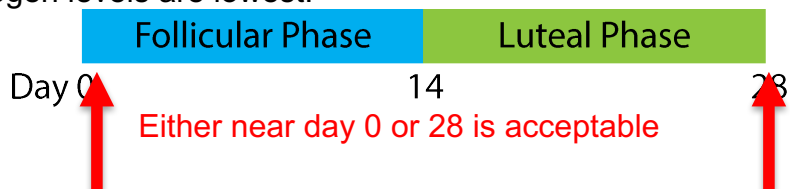
- b) Estrogen levels are highest:



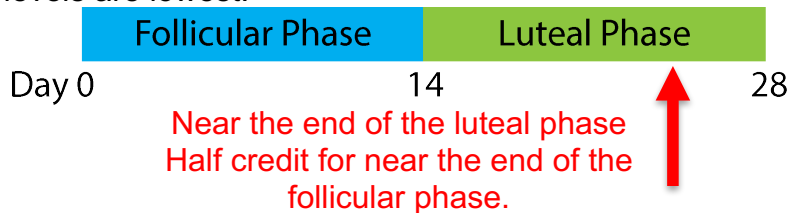
- c) Progesterone levels are highest:



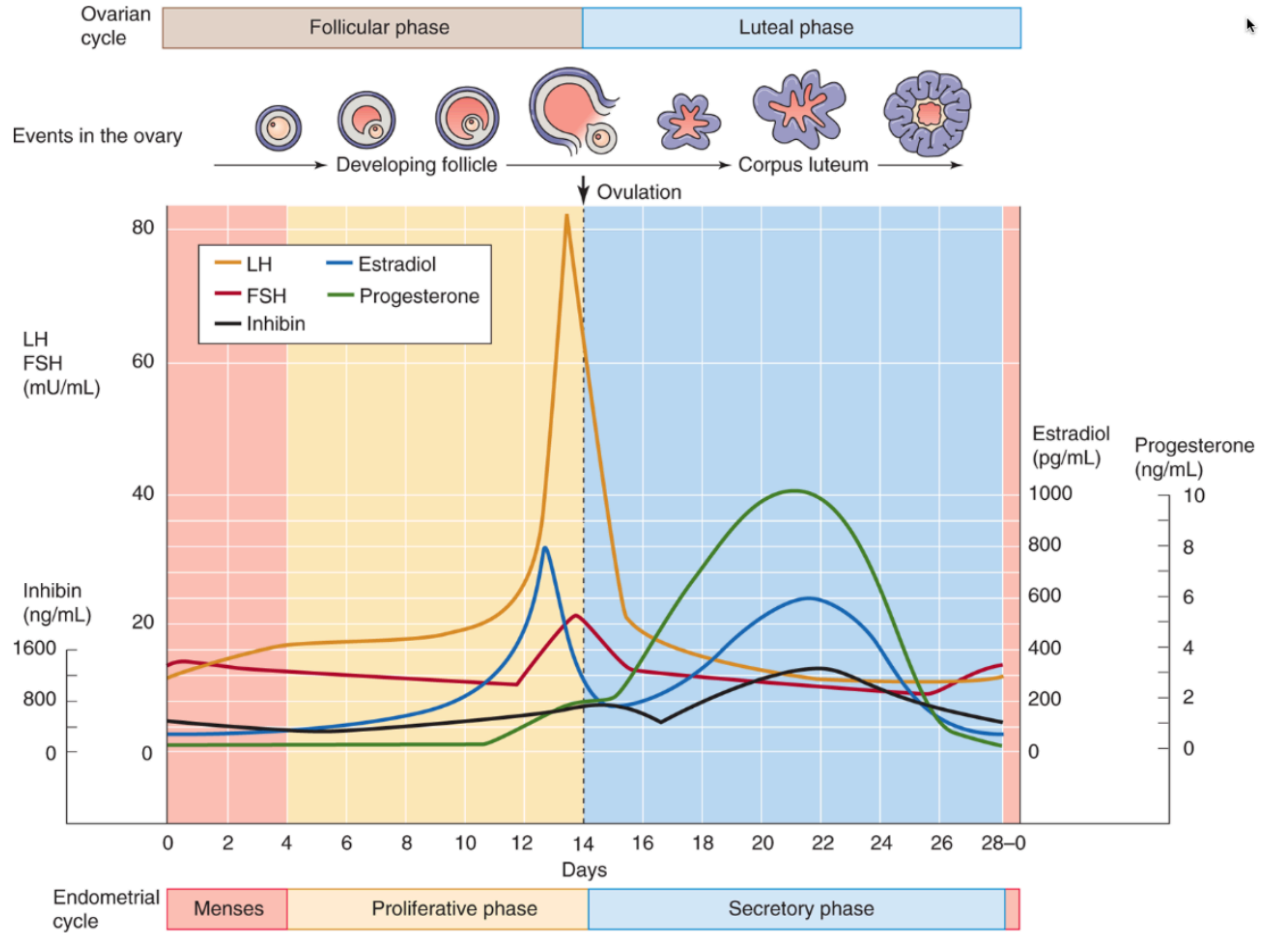
- d) Estrogen levels are lowest:



- e) FSH levels are lowest:



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- 7) A premature infant is born without adequate quantities of surfactant in the alveoli. What drug can be given to promote surfactant secretion in the infant? **(3 points)**.

Cortisol (glucocorticoid)

- 8) A woman in the third trimester of pregnancy has a fever of 102°F. Her physician advises that she take Tylenol to treat the fever, but to avoid the use of aspirin. Why was Tylenol favored as a treatment for fever in this case? **(4 points)**.

Fever is triggered by prostaglandins synthesized in the posterior hypothalamus; these prostaglandins are synthesized via the Cox-2 enzyme. Other prostaglandins synthesized via the Cox-1 enzyme are critical to maintain patency of ductus arteriosus. Both Tylenol and aspirin inhibit Cox-2, but aspirin also strongly inhibits Cox-1. Thus, taking aspirin raises the risk of closing ductus arteriosus, and causing cardiac damage in the fetus.

- 9) Is pulse pressure larger or smaller in an average 80 year-old than in an average 20 year-old? If pulse pressure changes with aging, why does this occur? **(3 points)**.

Pulse pressure is higher in the 80 year-old, due to stiffening of the arteries during aging (loss of arterial compliance).

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- 10) Blockers of L-type calcium channels are commonly used to treat heart arrhythmias and high blood pressure. One of the most common side effects of these drugs is constipation. Briefly describe the mechanism through which L-type calcium channel blockers lead to constipation. **(5 points)**.

L-type calcium channels open at the peak of the slow waves in GI smooth muscle, allowing Ca^{2+} to enter the cells and triggering contraction. Blockage of L-type Ca^{2+} inhibits Ca^{2+} entry into the smooth muscle cells, reducing motility in the colon and leading to constipation.

- 11) Gastroenterologists make common use of the secretin stimulation test. During this test, secretin is injected intravenously and the presence of fluids in the gastrointestinal tract is monitored. What diseases are diagnosed with the use of the secretin stimulation test? **(5 points)**.

Pancreatic diseases. Secretin stimulates pancreatic secretions, particularly bicarbonate. If there is little increase in GI secretions following secretin administration, the pancreas must be damaged.

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- 12) The amount of insulin secreted into the bloodstream is larger when a certain quantity of glucose is administered orally than when it is provided intravenously. Why does oral consumption of glucose lead to a larger insulin release? **(5 points)**.

Oral glucose leads to a secretion of GIP in the small intestine, which triggers insulin release. Once the glucose is absorbed, a further increase in insulin secretion occurs. Thus, the substrate and intestinal phases of insulin secretion are additive. When glucose is provided IV, the intestinal phase is missing, so the overall insulin secretion is lower.

- 13) Treatment of a patient with the glucocorticoid analog dexamethasone does not result in extensive water retention, while treatment with cortisone often does. What are the differences in the actions of these drugs, such that cortisone results in more water retention than dexamethasone? **(5 points)**.

Cortisone has affinity for both glucocorticoid and mineralocorticoid (aldosterone) receptors, while dexamethasone has affinity for only the glucocorticoid receptor. Thus, through its actions on the aldosterone receptor, cortisone results in water retention.

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14) Lack of iodine in the diet of an expecting mother can result in serious birth defects.

a) Describe the most prominent birth defect that results from an iodine deficiency. **(5 points)**.

Cretinism, or nervous system dysfunction (reduced intellectual capacity)

b) An expectant mother with iodine deficiency likely has a highly-evident indicator of their condition, which can be identified during a physical examination. Describe this indicator of iodine deficiency. **(5 points)**.

Goiter, or a swelling in the neck due to the enlarged thyroid gland.

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15) Cushing's disease results from an ACTH-secreting tumor.

- a) Patients with Cushing's disease often have muscle weakness. Describe why Cushing's disease causes muscle wasting. **(5 points)**.

Cushing's disease is associated with a large production of cortisol, which triggers gluconeogenesis. During the process of gluconeogenesis, skeletal muscle breaks down to provide a substrate for glucose production.

- b) Patients with Cushing's disease often have increased urination. Why does this occur? **(4 points)**.

Blood glucose levels rise in Cushing's disease, often resulting in glucosuria (exceeding the transport capacity for glucose in the nephron). Water follows the glucose, leading to excessive urination.

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- 16) Several hormones that circulate in the blood have been implicated in the control of satiety. List three of these hormones, and whether an increase in the hormone results in an increase or decrease in hunger. **(6 points)**.

Insulin: an increase would reduce hunger

Gherlin: normally secreted when the stomach is empty, so an increase would increase hunger.

Leptin: an increase would reduce hunger.

Other possible answers:

CCK: an increase would reduce hunger.

We also mentioned a number of peptides that affect hunger like NPY and orexin. These peptides do not circulate, and thus are not hormones. Half credit if one of the peptides is provided as an answer.