Exam Key

NROSCI/BIOSC 1070 and MSNBIO 2070
FINAL EXAM
December 11, 2017

Total POINTS: 100 20% of grade in class

1. Emily, who is 45 years old, asked her physician when she should expect to enter menopause. The physician asked her if she had ever taken oral contraceptives on a regular basis. When Emily told him she had taken combination birth control pills for 10 consecutive years beginning at age 30, her physician told her that she should not expect to undergo menopause until her late 50s because she didn't recruit any follicles while she was on oral contraceptives.

Did the physician provide accurate information to Emily (yes or no)? Provide a brief justification for your answer. ***(5 points).***

No. Oral contraceptives do inhibit LH and FSH secretion, and thus eliminate all/most follicle growth that is dependent on FSH and LH (early antral – Graafian follicles). If one considers the fact that women have ovulatory menstrual cycles from about the age of 12 thru about 50 years, ovulate roughly 1/month = ~456 ovulations per life time against a follicle cohort at birth of about 500,000. Primordial follicles continue to enter the proliferating pool throughout oral contraceptive use – but all of those follicles become atretic when they reach the FSH dependent stage of growth. The blockade of ovulation by OCs has no impact on the age at which menstrual cycles cease (menopause).

Key points: Information was wrong (1 pt). Contraceptives suppress FSH (2 points). Follicles continue to be recruited as normal when a contraceptive is taken, but without FSH they do not develop (2 points).

Exam Key

2. You are a scientist at a pharmaceutical company, and hypothesize that a drug that blocks the actions of the P450 aromatase enzyme would serve as an effective contraceptive for women.

a) Would a blocker of the aromatase enzyme prevent pregnancy in women (yes or no)? Provide a brief rationale for your answer. ***(5 points).***

It will prevent fertility (1 point). By blocking estradiol synthesis, (but not FSH), ovaries will show big follicles, but without estradiol there will be no LH surge (4 points), so no ovulation.

It is also OK to indicate that estrodiol-mediated proliferation of the endometrium will not occur, so even if ovulation is induced, no implantation (alternate 4 points).

b) Would levels of FSH be altered by the aromatase enzyme blocker? If so, would they increase or decrease? Provide a brief explanation of your answer. ***(3 points).***

Yes--estradiol levels are low, and there is no negative feedback to lower FSH secretion. FSH thus remains high, and the LH surge never occurs.

Key point: FSH is high (2 points) due to lack of negative feedback from estradiol (1 point).

Exam Key

3. Activating mutations in the luteinizing hormone receptor (LHR) gene are one of the most common mutations found in the gonadotropin receptor genes. The LH receptor is active from birth in individuals with this condition, as though high levels of LH were always present. The following questions relate to individuals with this condition.

a) What physiological differences (if any) would be noted in an 8 year-old boy with an activating mutation of the LH receptor, relative to a boy without such mutations? ***(5 points).***

The premature activation of the LH receptor will result in precocious puberty in the boy.
Key point: Secondary sexual characteristics will appear very early (5 points).

b) This individual matures to adulthood, and wants to become a father. Is it likely this is possible (yes or no)? Discuss the rationale for your answer. ***(5 points)***.

No--High levels of testosterone in the individual will suppress GnRH, LH, and FSH secretion. The lowered FSH secretion likely will cause a low sperm count.

Key point: Cannot father a child (1 point), as FSH is not present which is needed to support spermatogenesis (4 points).

c) What physiological changes (if any) would be noted in an 8 year-old girl with an activating mutation of the LH receptor, relative to a girl without such mutations? ***(5 points).***

Little physiological change would be expected in the girl: since there isn't any FSH secretion, the androstenedione won't be converted to estradiol, so secondary sexual characteristics won't occur.

Key points: Female won't show secondary sexual characteristics (1 point), as there is no FSH (2 points) which is needed for estradiol production (2 points).

It is also OK to indicate that androgenizing of the female will occur, as androgen production induced by the LH receptor mutation won't be converted to estradiol.

4. A 40 year-old patient with Graves' disease develops exophthalamos, or protrusion of the eyeballs. How would the levels of the following hormones likely differ in this patient from those in a normal individual? ***(2 points each; 4 points total).***

T3 and T4

Normal	High	Low

Thyroid-stimulating hormone (TSH)

Normal	High	Low

5. Pregnancy tests detect the presence of the hormone human chorionic gonadotropin (hCG) in the blood or urine.

a) List two tissues (or structures) that produce hCG in pregnant women. ***(4 points).***

Blastocyst (2 points)
Placenta (2 points)

b) Which receptor type does hCG bind to in pregnant women? ***(2 points).***

LH Receptor (2 points)

6. A patient has a parathyroid tumor, such that their levels of parathyroid hormone are drastically elevated. How do the following parameters differ in this patient from a normal individual? ***(2 points each; 10 points total*).**

Q-T interval of ECG

Normal	Shortened	Lengthened

Blood volume

Normal	Increased	Decreased

Na^+ entry into excitable tissues

Normal	Enhanced	Reduced

Stomach acid secretion

Normal	Increased	Decreased

Plasma phosphate levels

Normal	Increased	Decreased

7. Another patient is diagnosed with low plasma albumin (hypoalbuminemia) due to liver damage. How do the following parameters differ in this patient from a normal individual? ***(2 points each; 4 points total*).**

Heart rate

Normal	Low	High

Excitability of peripheral nerves

Normal	Low	High

8. Circle the best answer to each question below. ***(2 points each; 10 points total).***

The migrating motor complex (migrating action potential complex) in the gastrointestinal system:

a) Is regulated by the parasympathetic nervous system

b) Occurs at 15-minute intervals after a meal to aid in peristalsis

c) Is abolished by injection of the ganglionic blocker hexamethonium

d) Is facilitated by a calcium channel blocker

e) Occurs during fasting

In the intestine the layer of nerve cells known as the submucosal plexus (Meissner's plexus) is located:

a) Between the circular muscle layer and the muscularis mucosae

b) Between the longitudinal and circular muscle layers

c) Directly below the serosa

d) In the circular muscle itself

e) Under the mesentery

Which phase of gastric acid secretion is abolished by vagotomy?

a) Cephalic

b) Gastric

c) Interdigestive

d) Intestinal

e) All of the above

Secretin is released in response to which of the following stimuli?

a) Acid in the duodenum

b) Hypertonic chyme in the duodenum

c) Hypotonic chyme in the duodenum

d) Lipid in the duodenum

e) Amino acids in the duodenum

Which of the following digestive enzymes is <u>not</u> activated by trypsin?

a) Colipase

b) Chymotrypsin

c) Lactase

d) Phospholipase

9. The process of gluconeogenesis plays a major role in maintaining adequate blood glucose levels. Answer the following questions regarding gluconeogenesis.

a) List two nutrients that provide a substrate for gluconeogenesis ***(4 points).***

Some amino acids (2 points)
Glycerol (2 points)

Also acceptable: pyruvate, lactate, alanine, and glutamine. (2 points each).

Alternate answers: lipids (1 point, not specific enough); proteins (1 point, not specific enough).

b) List two hormones that **stimulate** gluconeogenesis ***(4 points).***

Glucagon (1 point)
Glucocorticoid or cortisol or corticosteroid (1 point)

c) List the major hormone that **inhibits** gluconeogenesis ***(2 points).***

Insulin (2 points)

10. An unfortunate patient with stomach cancer undergoes a total gastrectomy, or complete removal of the stomach. As a consequence of the surgery, the esophagus is joined directly to the small intestine.

Would it be necessary to inject any nutrients into the patient following a total gastrectomy because they can no longer be absorbed? If so, indicate the nutrient(s) and briefly explain why absorption is now impossible. ***(5 points).***

Vitamin B12 (3 points); intrinsic factor made by parietal cells is critical for B12 absorption in the intestine (2 points).

Alternate answers:
Proteins (2 points); patient can consume amino acids

11. Circle the best answer to the question below. ***(2 points).***

A potential side effect of long-term treatment with cortisol analogs is:

a) Stronger bones
b) Enhanced ability to develop muscle mass
c) Weight loss
d) Darkening of the skin through increased deposition of melatonin
e) High blood glucose levels

12. Indicate how the levels of the following hormones differ from the fasting state at 30 minutes following the consumption of a large, traditional Thanksgiving meal. ***(2 points each; 6 points total).***

Ghrelin

Same	Lower	Higher

Insulin

Same	Lower	Higher

Glucagon

Same	Lower	Higher

13. A patient with Vitamin D deficiency develops secondary changes in parathyroid hormone levels. Indicate whether parathyroid hormone levels are low or high during Vitamin D deficiency; provide a brief justification for your answer. **(5 points*).***

Parathyroid hormone levels will be high (2 points), since vitamin D deficiency results in low plasma Ca^{2+} (or hypocalcemia)(3 points).

Exam Key

14. It is not uncommon for newborn infants to develop yellow discoloration of the skin. Briefly describe the physiological reason for this skin discoloration. Your answer should include a discussion of the particular substance that causes the skin discoloration, and why this substance can be in high concentration in the blood of a newborn. ***(10 points).***

The yellow coloration of the skin and eyes is due to high plasma bilirubin (5 points). This is a result to poor liver function in the newborn (5 points), as the liver is responsible for clearing damaged red blood cells and hemoglobin from the blood. Bilirubin is a breakdown product of hemoglobin, and is normally excreted in the bile when the liver is functioning properly.