PHYSIOLOGY EXAMINATION
Unit Exam #4
February 16, 2000
1:00-4:00 PM

Directions: Select the one best answer and fill in the space below the corresponding letter on the answer sheet.

Gastrointestinal Physiology

1. The migrating motility complex:
   A. Is triggered by ingestion of a meal
   B. Originates in the jejunum
   C. Originates in the ileum
   D. Is triggered during fasting
   E. Occurs only in the colon

2. The motility pattern primarily responsible for the propulsion of chyme is:
   A. The migrating motility complex
   B. Peristaltic waves
   C. Mass movement
   D. Haustations
   E. Segmentation

3. In a meal containing glucose, glucose absorption would be increased to the greatest degree by:
   A. Injection of somatostatin
   B. Drinking isotonic saline
   C. Drinking a solution containing fructose
   D. Injection of glucagon
   E. Drugs that inhibit Na⁺-K⁺ ATPase

4. Which one of the following is a primary bile acid?
   A. Muricholic acid
   B. Deoxycholic acid
   C. Chenodeoxycholic acid
   D. Lithocholic acid
   E. Ursodeoxycholic acid

5. During gastric acid secretion, the pH of the parietal cell is maintained primarily by the movement of:
   A. Water into the lumen of the stomach
   B. Bicarbonate ions out of the cells into plasma
   C. Potassium ions into the cells
   D. Na⁺ via the Na⁺-K⁺ ATPase
   E. Chloride ions out of the cells

6. The stimulus for an enzyme-rich pancreatic secretion is due PRIMARILY to:
   A. The autocatalytic action of trypsin
   B. Increased duodenal acidity
   C. Increased bile acid concentration in the duodenal lumen
   D. The presence of enterokinase in the small intestinal lumen
   E. The presence of protein and fat digestion products in the duodenum
7. Pernicious anemia is caused by the lack of:
   A. iron absorption
   B. transferrin in the circulation
   C. bile salts in the lumen of the small intestine
   D. intrinsic factor
   E. Na⁺-K⁺ ATPase

8. A Na⁺-dependent active transport system is necessary for the intestinal absorption of all of the following EXCEPT:
   A. Amino acids
   B. Di- and Tripeptides
   C. Glucose
   D. Galactose
   E. Fructose

9. The formation of micelles is necessary for the absorption of:
   A. Bile salts
   B. Iron
   C. Alcohol
   D. Cholesterol
   E. Vitamin B₁₂

10. Which one of the following is not involved in acid secretion by the parietal cell?
    A. Carbonic acid
    B. Carbonic anhydrase
    C. H⁺, K⁺-ATPase
    D. Cl⁻/HCO₃⁻ exchange
    E. Na⁺, H⁺-ATPase

11. Over 90% of the lipids in the diet are triglycerides. Triglycerides are hydrolyzed by pancreatic lipase to form:
    A. Diglyceride and fatty acid
    B. One molecule of 2-Monoglyceride and one molecule of fatty acid
    C. One molecule of 2-Monoglyceride and two molecules of fatty acids
    D. Glycerol and 2 molecules of fatty acids
    E. None of the above

12. Which one of the following is not a normal component of human saliva?
    A. Lactoferrin
    B. Muramidase
    C. Amylase
    D. Colipase
    E. Immunoglobulins

13. Which one of the following statements regarding pancreatic secretion is incorrect?
    A. Secretin stimulates a pancreatic secretion rich in bicarbonate ions
    B. CCK stimulates a pancreatic secretion rich in enzymes
    C. During active pancreatic secretion, the blood from the pancreas is acidic
    D. CCK potentiates the action of secretin on pancreatic secretion
    E. GIP potentiates the action of CCK on pancreatic secretion
14. Oral rehydration therapy is an effective means of managing cholera because in these patients:

A. Enterocyte cAMP levels are low
B. Enterocyte Na⁺, K⁺-ATPase is poisoned
C. Active intestinal glucose absorption is intact
D. Active intestinal sodium absorption (electrogenic sodium absorption) is stimulated
E. Chloride secretion by the crypt cells has been inhibited

15. Pancreatic trypsinogen is first converted to the active enzyme trypsin by:

A. Exposure to pepsin
B. Exposure to gastric acid
C. Exposure to enterokinase
D. Acetylcholine
E. Intrinsic factor

16. Galactose absorption by the small intestine:

A. Occurs by facilitated diffusion
B. Inhibits intestinal glucose absorption
C. Requires bile salts
D. Occurs via a paracellular route only
E. Is enhanced by increasing the secretion of chloride ions

17. Total removal of the pancreas would result in all of the following changes EXCEPT:

A. Increased intestinal absorption of fat soluble vitamins
B. A rise in blood glucose level
C. Steatorrhea (excretion of fat in stool)
D. Decreased intestinal absorption of proteins
E. Decreased intestinal absorption of triglycerides

Use the following answers for questions # 18 - 22 (answers may be used once, more than once, or not at all):

A. Na⁺, K⁺-ATPase
B. cAMP
C. Na⁺-H⁺ exchanger
D. Esophageal varices
E. Intracellular calcium concentration
F. cGMP
G. Emulsification
H. Transferrin
I. Lactoferrin
J. Motilin
K. Glycine
L. Glucuronic acid
M. Xanthine oxidase
N. None of the above

18. The alpha subunit of cholera toxin increases this second messenger in crypt cells

19. Is necessary for the secretion of a hypotonic salivary fluid

20. Some bile acids are conjugated with ______

21. Is present in salivary secretion and binds to iron

22. An enzyme present in the brush border membrane involved in the digestion of α-limit dextrans
Endocrine Physiology

Use the following list to answer questions 23-30 (answers may be used once, more than once, or not at all).

A. Thyrotropin-Releasing Hormone  
B. Somatostatin  
C. Gonadotropin-Releasing Hormone  
D. Corticotropin-Releasing Hormone  
E. Dopamine  
F. Growth Hormone Releasing Hormone  
G. Vasopressin  
H. Oxytocin

23. Inhibits secretion of growth hormone, insulin, and glucagon.

24. Secretion increases prior to waking during a normal sleep-wake cycle.


26. Synthesized in magnocellular neurosecretory neurons and stimulates Adrenocorticotrophic Hormone (ACTH) secretion.

27. Undetectable (or abnormally low) in Graves Disease, due to presence of thyroid-stimulating immunoglobulin (TSI).

28. Stimulates contractions of myoepithelial cells in breast.

29. Stimulates prolactin secretion.

30. Hypoglycemia decreases secretion of this hormone.

31. Hepatic gluconeogenesis in the postabsorptive state is stimulated by

A. growth hormone  
B. glucagon  
C. epinephrine  
D. a high insulin/glucagon ratio  
E. fatty acid β oxidation

32. This protein is a transcription factor that increases Growth Hormone (GH) gene expression.

A. Stat5  
B. Jak2  
C. Glucocorticoid receptor  
D. Thyroid Hormone receptor  
E. Calmodulin
33. Based on the physiology of thyroid hormone metabolism and action, which of the following interventions would be beneficial during "thyroid storm" (acute, life-threatening, thyrotoxicosis)?

A. Destruction of the thyroid gland by radiotherapy.
B. Administering a potent β-adrenergic antagonist.
C. Administering an inhibitor of thyrotropin releasing hormone (TRH).
D. Reducing iodine in the diet.
E. Administering thyrotropin releasing hormone (TRH).

34. An individual suffers from an inactivating mutation of the vitamin D receptor. What would you expect the pattern of hormones in the circulation to be?

A. elevated 1, 25 dihydroxy Vitamin D, elevated calcitonin, and decreased parathyroid hormone (PTH) secretion.
B. elevated 1, 25 dihydroxy Vitamin D, decreased calcitonin, and elevated parathyroid hormone (PTH) secretion.
C. decreased 1, 25 dihydroxy Vitamin D, elevated calcitonin, and decreased parathyroid hormone (PTH) secretion.
D. decreased 1, 25 dihydroxy Vitamin D, decreased calcitonin, and elevated parathyroid hormone (PTH) secretion.
E. elevated 1, 25 dihydroxy Vitamin D, decreased calcitonin, and decreased parathyroid hormone (PTH) secretion.

35. A 70 kg individual with approximately 15% body fat was imprisoned and went on a starvation protest, taking only water. This person had a fully nutritious diet before beginning starvation. When would the complete deficiency of dietary iodine begin to cause metabolic problems in this individual?

A. immediately, because iodine is an essential nutrient.
B. after stored thyroglobulin was depleted (nearly 3 months).
C. after the pool of circulating thyroid hormones was metabolically cleared (about 2 weeks).
D. never, because the body conserves iodine efficiently.
E. never, because this individual would die before experiencing symptoms of thyroid gland deficiency.

36. Glycoprotein hormones, such as Thyroid Stimulating Hormone, Luteinizing Hormone and Follicle Stimulating Hormone activate G-protein coupled receptors by virtue of the hormones’ ability to

A. increase tyrosine kinase activity.
B. diffuse through the plasma membrane.
C. bind to the C-terminal portion of the receptor.
D. bind to the N-terminal portion of the receptor.
E. bind to the alpha subunit of the heterotrimeric G-protein.

37. In pregnancy Thyroxine Binding Globulin levels increase. As a consequence, which one of the following statements is true?

A. total circulating thyroxine increases so that the free hormone concentration is normal.
B. plasma corticosteroid binding globulin levels decrease so that there is no net change in hormone carrier proteins.
C. the concentration of free thyroxine decreases, resulting in gestational hypothyroidism.
D. a T3 resin uptake analysis would be characterized by a much higher resin uptake value.
E. plasma albumin decreases, because this is the alternative thyroxine carrier protein.
For questions 38 – 43, match the following list of hormones with characteristic features of their molecular mechanism (answers may be used once, more than once, or not at all).

A. Insulin  
B. Triiodothyronine  
C. Glucagon  
D. Cortisol  
E. Growth hormone

38. This hormone activates a cascade of protein phosphorylation in the liver by virtue of its ability to promote cyclic AMP synthesis.

39. The receptor for this hormone associates with a cytoplasmic heat shock protein.

40. The receptor for this hormone is a nuclear protein, which inhibits transcription in the absence of hormone, and stimulates transcription when hormone is bound to it.

41. The receptor for this hormone has seven membrane-spanning alpha helices.

42. The receptor for this hormone associates with a tyrosine kinase named Janus kinase (Jak).

43. The receptor for this hormone has intrinsic tyrosine kinase enzymatic activity.

44. An individual was found to suffer from secondary hypercortisolism (Cushing's Syndrome), and an ACTH-secreting tumor was discovered in the lung. Which profile of hormones would most likely be present in this individual?

A. suppressed insulin, elevated melanocyte-stimulating hormone, elevated Corticotropin Releasing Hormone, suppressed epinephrine  
B. elevated insulin, elevated melanocyte-stimulating hormone, suppressed Corticotropin Releasing Hormone, suppressed epinephrine  
C. elevated insulin, suppressed melanocyte-stimulating hormone, elevated Corticotropin Releasing Hormone, elevated epinephrine  
D. suppressed insulin, suppressed melanocyte-stimulating hormone, suppressed Corticotropin Releasing Hormone, suppressed epinephrine  
E. elevated insulin, elevated melanocyte-stimulating hormone, elevated Corticotropin Releasing Hormone, elevated epinephrine

45. A mutated, low affinity form of corticosteroid binding globulin (Transcortin, CBG) was discovered in an individual. Which of the following physiological responses would not be observed?

A. Faster renal clearance of cortisol.  
B. Elevated synthesis of aldosterone in the adrenal glands.  
C. Elevated synthesis of cortisol in the adrenal glands.  
D. Elevated ACTH secretion from the pituitary gland.  
E. Elevated hepatic sulfation of cortisol.

46. In a euthyroid individual the daily intake of iodine was decreased from 500 to 425 µg/day. Prior to the change the daily flux of hormone-bound iodine was 75 µg/day (steady state) and biliary excretion was 15 µg/day. Following the change in iodine intake you should expect:

A. a compensatory increase in the efficiency of intestinal absorption of iodine such that the plasma iodide concentration was kept constant.  
B. fecal iodine elimination to decrease by 75 µg/day  
C. urinary iodine excretion to decrease by 75 µg/day  
D. iodination of thyroglobulin to decrease by 15% (75 µg/d out of 500 µg/d)  
E. iodine content of the thyroid to decrease from 7500 µg to 6750 µg over a period of 10 days
47. The pancreatic β-cell glucose transporter is
   A. GLUT1  
   B. GLUT4  
   C. insulin-dependent  
   D. insulin-independent  
   E. Na\(^+\)-independent

Reproductive Physiology

48. A 25-year old female suffered a vertebral fracture with permanent damage to her spinal cord in a skiing accident 3 years ago. Since that time, her clitoris does not become erect in response to tactile stimulation. Damage to what portion of the spinal cord would account for this lack of erection?
   A. T10-L2  
   B. C3-C5  
   C. S2-S4  
   D. C10  
   E. T2-T4

49. An 18 year old, 6 foot tall, 180 pound male has a small penis for his size. Rectal examination reveals that his prostate is also abnormally small. He has a normal male karyotype (46, XY), normal bone growth and closure of the epiphyses and normal facial, pubic and axillary hair. Puberty occurred around age 10. Semen analysis reveals that he has an abnormally low concentration of spermatozoa in his semen (oligospermia) and an abnormally low volume of semen. His plasma FSH, LH and testosterone levels are normal. What could account for these findings?
   A. androgen receptor defect  
   B. 17β-hydroxysteroid dehydrogenase deficiency  
   C. inactivating mutation of the LH receptor  
   D. 21-hydroxylase deficiency  
   E. 5α-reductase deficiency

50. A sexually mature adult female with an “activating” mutation of the LH receptor (LH receptor is continuously active) would be expected to have increased activity of all of the following ovarian enzymes EXCEPT:
   A. cholesterol esterase  
   B. 17β-hydroxysteroid dehydrogenase  
   C. HMG CoA reductase  
   D. cytochrome P450 side chain cleavage enzyme  
   E. cytochrome P450 17-hydroxylase

51. Which one of the following steroid hormones has the largest percentage in the free (unbound) state in normal plasma?
   A. estradiol  
   B. cortisol  
   C. aldosterone  
   D. progesterone  
   E. testosterone
52. An adult female with normal secondary sex characteristics who began to have irregular menses about two years ago and ceased ovulating completely (amenorrhea) about one year ago has a regular milky discharge from her breasts (galactorrhea). She is found to have low plasma FSH levels, low plasma estradiol levels typical of the early follicular phase of the menstrual cycle, elevated plasma prolactin levels, and elevated plasma TSH levels. What disorder could explain these findings?

A. primary hypothyroidism
B. primary hyperthyroidism
C. prolactin-secreting pituitary tumor
D. secondary hypothyroidism
E. hypothalamic chronic anovulation

53. A newborn infant rapidly becomes dehydrated and is urinating excessively. The pediatrician noted that the infant has both an enlarged phallus which appears to be a penis and a vaginal opening. Testing reveals that the infant is a 46,XX female with abnormally elevated plasma androgens, abnormally elevated plasma potassium and abnormally low plasma levels of aldosterone. Which of the following could account for these findings?

A. 17-hydroxylase deficiency
B. 11-hydroxylase deficiency
C. 21-hydroxylase excess
D. 17β-hydroxysteroid dehydrogenase deficiency
E. aromatase excess

54. Which one of the following would directly or indirectly increase estradiol synthesis in granulosa cells of the ovarian follicle during the follicular phase of the menstrual cycle?

A. increased ovarian inhibin synthesis
B. increased pituitary follistatin synthesis
C. decreased FSH synthesis
D. increased ovarian activin synthesis
E. decreased androstenedione synthesis

55. An adult female has had normal sexual development and normal menstrual function. She now has a brain tumor that has destroyed neurons with cell bodies in the arcuate nucleus of the medial basal hypothalamus and in the preoptic-anterior hypothalamic area. In addition to other effects, which of the following would most likely be an effect on the reproductive system?

A. increased GnRH secretion
B. increased estrogen biosynthesis
C. no change in LH secretion
D. decreased prolactin
E. decreased FSH secretion

56. Compared with the average adult female, the average adult male has which of the following?

A. greater peripheral conversion of circulating androgens to estrogens
B. lower production of erythropoietin by the kidneys
C. higher production of androgens by the adrenal glands
D. lower rates of protein anabolism
E. higher plasma levels of testosterone-estradiol binding globulin

57. In the middle of the luteal phase (day 19-23) of the menstrual cycle, a female would have which of the following compared with other times during the cycle?

A. the lowest plasma inhibin levels
B. high plasma FSH levels
C. peak basal body temperature
D. peak spinnbarket values
E. thin, watery, voluminous cervical mucus
58. A 55-year old female who had normal reproductive function until the age of 50 is in the postmenopausal period. Compared with the premenopausal period, she would be experience all of the following EXCEPT:

A. atrophy of the genital tract  
B. decreased elastic tissue of skin  
C. hot flushes  
D. increased growth hormone secretion  
E. osteoporosis

59. Which one of the following statements regarding the combined oral contraceptive pill is INCORRECT?

A. Menstruation is not prevented  
B. Gonadotropin secretion from the pituitary is increased  
C. The extracellular fluid volume is increased  
D. Thyroid Binding Globulin (TBG) concentration in blood is increased  
E. They are contraindicated in women with a history of thromboembolic disorders

60. Which one of the following variables of pregnancy would indicate that a fetus was alive and sufficiently mature to survive outside of the mother?

A. maternal plasma concentration of placental lactogen  
B. maternal urine concentration of pregnanediol glucuronide  
C. amniotic fluid ratio of lecithin to sphingomyelin  
D. maternal plasma estriol  
E. maternal plasma concentration of chorionic gonadotropin

61. High levels of prolactin in the maternal circulation do not result in secretion of milk by the mammary glands during pregnancy because:

A. high levels of estrogens and progestins inhibit milk formation  
B. the posterior pituitary gland has not begun to secrete oxytocin  
C. the mother has not resumed menstrual cyclicity  
D. the mother lacks stimulation of her nipples by her infant  
E. high levels of cortisol inhibit milk formation

For questions 62-66, select the correct answer from the following list (A-J). Each answer may be used once, more than once, or not at all.

A. oxytocin  
B. estradiol  
C. placental lactogen  
D. androstenedione  
E. LH  
F. testosterone  
G. FSH  
H. activin  
I. chorionic gonadotropin  
J. progesterone

62. Acts on hypothalamic neurons to decrease the amplitude of GnRH pulses

63. Increases synthesis of the β subunit of FSH in the pituitary

64. Increases in maternal plasma in proportion to the size of the placenta

65. Increases development of the lobulo-alveolar system in the mammary glands

66. Increases exponentially in plasma during the follicular phase of the menstrual cycle
The Physiology of Energy Balance and Temperature Regulation

67. An unclothed person was sitting in an insulated dry room at a temperature of 80°F. If the room temperature was reduced gradually (over a few hours), at which of the following room temperatures (degrees F) would core body temperature begin to fall?

A) 75  
B) 70  
C) 65  
D) 60  
E) 50

68. While performing light work, if the total energy utilized was 400 units, which of the following would most closely approximate the units of external work performed?

A) 100  
B) 400  
C) 25  
D) 250  
E) 300

69. Which one of the following statements best characterizes the basal metabolic state?

A) Rate of heat production = chemical energy of food intake  
B) Rate of heat production = rate of chemical energy utilization  
C) The chemical energy consumed approximates the work energy output  
D) The input of chemical energy and the thermal energy produced are held constant  
E) None of the above

70. Which one of the following is arranged in the correct order in terms of the greatest amount of heat produced when one liter of oxygen is used to oxidize each of the major foodstuffs?

A) protein > fat > carbohydrate  
B) fat > protein > carbohydrate  
C) carbohydrate > fat > protein  
D) protein > carbohydrate > fat  
E) fat > carbohydrate > protein

71. Which one of the following is true?

A) The oxidation of 1g of carbohydrate requires less oxygen to be consumed than carbon dioxide produced.  
B) The respiratory quotient (RQ) for a person on an ordinary mixed diet is greater than that for a person consuming a pure carbohydrate diet.  
C) The RQ for carbohydrate > fat > protein  
D) For a person consuming only protein, fat or carbohydrate, if 100 liters of oxygen are consumed and 80 liters of carbon dioxide produced, the foodstuff being oxidized is most likely fat.  
E) None of the above is true.

72. A person eating a mixed diet has a total body surface area of 1.8m² and a normalized basal metabolic rate (BMR) of 41.7 kcal/m²/hour. Using the simplified indirect method, which one of the following most closely approximates their oxygen consumption?

A) 156.6 liters of oxygen/hr  
B) 15.6 liters of oxygen/m²/hr  
C) 15.6 liters of oxygen/hr  
D) 23.2 liters of oxygen/m²/hr  
E) 23.2 liters of oxygen/hr
73. Which one of the following is false?

A) Non-evaporative heat loss mechanisms can also become avenues of heat gain.
B) Heat stores such as muscle and fat are very good heat conductors and are poor insulators; therefore they provide minimal insulation when exposed to cold temperatures.
C) Humans have thermoregulatory mechanisms that are designed primarily to promote heat loss rather than heat gain.
D) In a person with a core temperature of 37°C and a mean shell temperature of 33°C, at a room temperature of 24°C, mean body temperature would be 35.68°C.
E) All of the above are true

74. In humans, heat loss from the body via evaporation of water

A) occurs whether or not the ambient temperature exceeds or is less than core body temperature
B) equals 58 kcal for each gram of water vaporized
C) is independent of the ambient humidity
D) is not quantified in the “direct method” of measuring metabolic rate
E) is calculated by knowing the energy equivalent of oxygen

75. In regard to factors affecting metabolic rate under normal living conditions, which of the following is true?

A) the normalized metabolic rate of non-pregnant females is lower than that of males of the same size and age
B) skeletal muscle activity has minor influences
C) pregnancy and lactation have minor influences
D) the contribution of the specific dynamic action of foods (SDA) is greater than physical activity
E) thyroxin is highly calorigenic and much faster in stimulating metabolism than are catecholamines

76. Which one of the following is true regarding evaporative heat loss and sweating?

A) In the acclimatized person more sodium and chloride are lost in sweat than in the unacclimatized person
B) The composition of the primary secretion of sweat glands is identical to that of plasma
C) The reabsorption of sodium and chloride in the sweat gland duct is independent of the rate of sweating.
D) The composition of sweat appearing at the epithelial surface is the same as that leaving the sweat gland
E) For every gram of water vaporized from sweat, 0.58 kcal of heat is lost from the body

77. Sensory thermoreceptors

A) are located only in the skin and monitor only shell temperature
B) do not specifically monitor cold or warmth
C) in the skin that monitor cold are more numerous than those that monitor warmth
D) are uniformly distributed over the body and monitor only shell temperature
E) increase their firing rate in response to both cold and warmth

78. Which one of the following predominates in the early stages of fever?

A) a failure in the feedback control of body temperature
B) core temperature exceeds the hypothalamic set point temperature
C) the hypothalamic set point of the integrator is increased and sweating occurs
D) the body attempts to conserve heat
E) heat loss via peripheral vasodilation and sweating
KEY

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26g 27a 28h 29a 30b 31b 32a 33b 34b 35e 36d 37a 38c 39d 40c 41c 42e 43ª 44b 45b 46c 47d
48c 49e 50b 51c 52a 53c 54d 55e 56a 57c 58d 59b 60c 61a 62b 63h 64c 65j 66b 67e 68ª 69b
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