PHYSIOLOGY EXAMINATION
Unit Exam #4
February 18, 1999
9:00-12:00AM

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

Gastrointestinal Physiology Questions

1. During the esophageal phase of swallowing, contractions of the posterior pharyngeal wall initiate:
   A. Haustral contractions
   B. Migrating motor complexes
   C. Mass movements
   D. Peristaltic contractions
   E. Segmentation

2. Spike potentials recorded in gastric musculature are:
   A. Inhibited by the presence of food in the stomach
   B. Enhanced by gastric secretion of HCl
   C. Independent of the basic electrical rhythm
   D. Prolonged by isosmolar gastric juice
   E. Increased by acetylcholine

3. The regulation of intestinal motility in a fasting state involves primarily:
   A. G.I. hormones
   B. Vagal tone
   C. Intestinal volume
   D. Myogenic responses
   E. Gastric emptying

4. Following a meal, the primary determinant of the rate of gastric emptying is:
   A. Sympathetic tone
   B. Gastric pH
   C. Volume of food in the stomach
   D. Parasympathetic tone
   E. Osmolality of gastric contents

5. The evidence for a cephalic phase of gastric secretion is that:
   A. Anger and hostility can lead to peptic ulcer disease
   B. Acetylcholine is released from parasympathetic nerves in the fundic portion of the stomach in response to stretch of the stomach
   C. CCK is released by the duodenum in response to stretch of the antral portion of the stomach
   D. Determined by the fact that rate of gastric emptying is under CNS control
   E. Only demonstrated during a prolong fast

6. Oral rehydration therapy is an effective means of managing cholera because in these patients:
   A. Active intestinal Na⁺ transport has been stimulated
   B. Active intestinal glucose absorption is intact
   C. Intestinal chloride secretion has been inhibited
   D. Enterocyte cAMP levels are low
   E. Enterocyte Na⁺-K⁺-ATPase is poisoned
7. In the laboratory setting, you are analyzing pancreatic secretion collected from a catheter inserted in the pancreatic duct. Your lab assistant injects an unknown substance into the femoral vein of the preparation resulting in a clear, isosmolar, slightly basic secretion from the pancreas. You correctly conclude that the unknown substance consists of:

A. Acetylcholine alone
B. Acetylcholine and CCK
C. CCK alone
D. Secretin and CCK
E. Secretin alone

8. The most important determinant of intestinal iron absorption is the:

A. amount of iron presented to the absorbing cells
B. amount of iron delivered to the bone marrow
C. rate of hematopoiesis
D. total pool of iron in the body
E. rate of hemoglobin degradation in the liver

9. Mixed micelles in the small bowel lumen are:

A. Composed of bile acid-triglyceride complexes
B. Cleaved by colonic bacteria
C. A storage site for lipolytic enzymes
D. Easily visible in suspension
E. A source of lipid-soluble vitamins for absorption

10. The up-regulation of pancreatic enzyme secretion is brought about by the presence of:

A. Phospholipase A₂ in the jejunum
B. Intrinsic factor in gastric juice
C. Peptides in the duodenum
D. HCl in the stomach
E. HCO₃⁻ in bile

11. Galactose absorption by the small intestine:

A. Occurs by facilitated diffusion
B. Shares a carrier molecule with glucose
C. Requires the presence of micelles
D. Is enhanced by increasing the secretion of Cl⁻
E. Occurs via a paracellular route only
12. You are studying intestinal lipid absorption in two patients, A and B. Using a double-lumen tube, you administer two doses of triglyceride on two different days to the upper duodenum and collect for analysis samples of intestinal contents over a 25cm segment of small intestine in each patient. The results are shown in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th></th>
<th>Day 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patient A</td>
<td>Patient B</td>
<td>Patient A</td>
</tr>
<tr>
<td>Triglyceride load (gm)</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Lipid Absorbed (mg/min/cm)</td>
<td>0.9</td>
<td>300</td>
<td>2.1</td>
</tr>
</tbody>
</table>

You repeat this experiment 3 times in each patient and get quantitatively similar results. You conclude from your study that:

A. Patient A may have impaired bile acid synthesis
B. The small intestine of patient B is deficient in secretin production
C. Patient A requires no further work-up
D. Patient B cannot synthesize chylomicrons
E. The small bowel in both patients is normal

13. The ultimate demise of hepatic function in diseases of the liver is **primarily** attributed to:

A. Changes in plasma protein levels
B. Defects of coagulation
C. Esophageal varices
D. Alterations in hepatic blood flow
E. Hepatomegaly

14. Chronic mucosal-submucosal inflammation of the terminal ileum may result in:

A. Fecal bile acid levels rendered undetectable
B. A marked reduction in hepatic bile acid synthesis
C. An increased serum phospholipid concentration
D. No change in lipid digestion
E. A reduced mixed micelle level in the jejunum

15. Which of the following statements most closely represents a common feature of the digestion and absorption of both dietary carbohydrates and triglycerides? These substances:

A. Require the presence of bile acids for digestion.
B. Are naturally soluble in the bulk water phase
C. Utilize a luminal phase of digestion
D. Trigger the secretion of enterokinase
E. Require the presence of mixed micelles for absorption

16. The pharmacologic suppression of gastric acid secretion with a proton pump inhibitor for a prolonged period would be expected to:

A. Damage to villous architecture of the stomach
B. Cause gastrin secretion to increase
C. Cause choleresis brought on by achlorhydria
D. Increase secretion of intrinsic factor
E. Increase gastric emptying
Use the following answers for questions # 17-21 (answers may be used once, more than once, or not at all).

A. Na\(^+\)-K\(^+\) ATPase  
B. Na-Cl cotransporter  
C. Na\(^+\)-glucose cotransporter  
D. Intracellular calcium concentration  
E. cAMP  
F. CFTR chloride channel  
G. cGMP  
H. Na\(^+\)-H\(^+\) exchanger  
I. None of the above

17. The alpha subunit of cholera toxin increases this second messenger

18. Increases as a result of nitric oxide stimulation

19. Is located on the apical (luminal) membrane of crypt cells in the small intestine

20. Is located on the basolateral membrane of parietal cells in the stomach and accounts for the "alkaline tide" following a meal

21. Is the second messenger for acetylcholine induced changes in pancreatic acinar cells

Endocrine Physiology Questions

22. Hypersecretion of this hormone has many implications; among them, metabolic changes include insulin resistance, lipid mobilization, and an increase in the ratio of lean body mass to total body mass.

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

23. In a patient with a tumor that synthesizes pro-opiomelanocortin (POMC), which of the following would NOT be expected to be elevated in the plasma.

A. cortisol  
B. melanocyte-stimulating hormone  
C. β-endorphin  
D. aldosterone  
E. ACTH

24. Which of the following defects would result in a syndrome that includes rickets, and is not relieved by administering active vitamin D hormone (1, 25 OH-D3).

A. hyperparathyroidism.  
B. a genetic defect in 1 α-hydroxylase.  
C. a genetic defect in the vitamin D receptor.  
D. hypersecretion of parathyroid hormone related peptide (PTHrP).  
E. primary hyposecretion of calcitonin.
25. An autoimmune disease directed towards this protein would be expected to cause a disease indistinguishable from Type I diabetes mellitus.

A. GLUT1  
B. glucagon  
C. GLUT2  
D. GLUT4  
E. glycogen synthase

Use the following list to answer questions 26 - 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

26. This hypothalamic factor declines following suckling stimulation of the breast.

27. This hypothalamic factor increases prior to stress-induced glucocorticoid secretion.

28. This hypothalamic factor stimulates secretion of two glycoprotein hormones.

29. This hypothalamic factor is controlled by the activity of the enzyme tyrosine hydroxylase.

30. This hypothalamic factor is inhibited by high levels of thyroid-stimulating immunoglobulin (TSI, LATS).

31. Which of the following enzymes is thought to be the "glucose sensor" that controls insulin secretion from β-cells of the pancreas?

A. Protein kinase A.  
B. Adenylyl cyclase.  
C. Glycogen synthase.  
D. Glucokinase.  
E. Phosphofructokinase

32. Which of the following would cause the greatest increase of plasma insulin concentration if given as equal caloric value?

A. oral glucose.  
B. intravenous glucose.  
C. intravenous branch chain amino acids.  
D. a high protein meal.  
E. a high fat meal.

33. The daily rise of cortisol secretion (normally in the morning) is due, in part, to

A. decreased SRIF (somatostatin) secretion.  
B. elevated corticotropin releasing factor secretion.  
C. reduced cholesterol side-chain cleavage enzyme activity in the adrenal gland.  
D. release of stored cortisol that is synthesized during the night.  
E. decreased responsiveness of the adrenal cortex to ACTH.
34. The receptor for this hormone activates tyrosine phosphorylation by virtue of its interactions with Janus kinase 2 (Jak2)?

A. Vitamin D hormone  
B. Thyroxine (T4)  
C. Growth hormone  
D. Cortisol  
E. Insulin

35. Based on the physiology of thyroid hormones, which of the following interventions would have the most value in the immediate therapy for acute thyrotoxicosis, or "thyroid storm"?

A. reducing iodine in the diet.  
B. administering a potent β-adrenergic antagonist.  
C. administering a potent β-adrenergic agonist.  
D. destruction of the thyroid gland by radiotherapy.  
E. administering thyrotropin releasing hormone (TRH).

36. In an individual who is incapable of converting 25-OH-vitamin D to 1, 25-OH-vitamin D one should expect which of the following physiological aberrations?

A. elevated calcitonin and decreased parathyroid hormone (PTH) secretion.  
B. decreased intestinal calcium absorption and increased PTH secretion.  
C. increased calcitonin and increased PTH secretion.  
D. increased intestinal calcium absorption and decreased PTH secretion.  
E. decreased renal calcium reabsorption and increased calcitonin secretion.

37. Insulin infusion in a normo-glycemic (non-diabetic) individual would cause which profile of endogenous hormone secretion rates?

A. ↑ cortisol, ↑ insulin, ↓ epinephrine, ↑ growth hormone, ↓ glucagon  
B. ↓ cortisol, ↓ insulin, ↑ epinephrine, ↓ growth hormone, ↓ glucagon  
C. ↓ cortisol, ↓ insulin, ↓ epinephrine, ↓ growth hormone, ↓ glucagon  
D. ↑ cortisol, ↓ insulin, ↑ epinephrine, ↑ growth hormone, ↑ glucagon  
E. ↓ cortisol, ↓ insulin, ↑ epinephrine, ↑ growth hormone, ↑ glucagon

38. During exercise-induced hypoglycemia, glucagon

A. falls dramatically to prevent glucose wasting.  
B. does not change.  
C. is markedly elevated to stimulate glucose mobilization.  
D. rises only if a high protein meal has been eaten.  
E. stimulates glycogen synthesis.

39. An individual with a genetic lesion that prevents synthesis of the glycoprotein hormone α-subunit would not be expected to have a deficiency in

A. Follicle stimulating hormone (FSH)  
B. Growth hormone.  
C. Thyroid stimulating hormone (TSH).  
D. Luteinizing hormone (LH).  
E. Chorionic gonadotropin (HCG).
Use the following list to match the hormones in questions 40 - 44 with their target tissue signaling pathway. (Answers may be used once, more than once, or not at all).

A. Gs protein
B. Nuclear receptor
C. Tyrosine kinase
D. Gi protein
E. Cytoplasmic receptor

40. Insulin
41. Triiodothyronine
42. Glucagon
43. Growth hormone
44. Cortisol

45. In an individual with primary pituitary dwarfism, one should expect low circulating levels of
   A. insulin-like growth factor-II (IGF-II)
   B. thyroid hormones
   C. insulin-like growth factor-I (IGF-I)
   D. growth hormone releasing factor
   E. prolactin

46. An individual with a genetic anomaly that caused a deficiency in the enzyme tyrosine hydroxylase would be expected to have what hormone synthesis profile?
   A. ↑ epinephrine, ↓ norepinephrine, ↓ prolactin
   B. ↓ epinephrine, ↑ norepinephrine, ↑ prolactin
   C. ↓ epinephrine, ↓ norepinephrine, ↑ prolactin
   D. ↑ epinephrine, ↑ norepinephrine, ↑ prolactin
   E. ↓ epinephrine, ↓ norepinephrine, ↓ prolactin

47. In Grave's Disease, which of the following hormones would you expect to be abnormally low in the serum?
   A. Triiodothyronine (T3).
   B. vitamin D hormone (1, 25 dihydroxycholecalciferol).
   C. Thyroid stimulating hormone (TSH).
   D. Calcitonin.
   E. Parathyroid hormone (PTH).

48. A pregnant patient presents with abnormally high total T4 levels, but otherwise no symptoms of thyrotoxicosis. You might expect to observe
   A. Thyroid Stimulating Immunoglobulin in the plasma.
   B. suppressed iodine uptake in the gut.
   C. decreased T3 Resin Uptake values.
   D. increased T3 Resin Uptake values.
   E. high free T3 in the plasma.
49. Gut hormones such as cholecystokinin amplify the release of insulin from the pancreas because they
A. decrease intracellular Ca^{2+}.
B. increase intracellular Ca^{2+}.
C. increase tyrosine kinase activity.
D. stimulate the glucose receptor.
E. increase glucokinase activity.

50. A traumatic injury that damages the hypothalmic-hypophyseal portal blood system would be expected to lead to increased secretion of
A. ACTH.
B. FSH.
C. Growth hormone.
D. Prolactin.
E. β−lipotropin.

51. Testotoxicosis (precocious puberty associated with abnormally high plasma testosterone) might be a consequence of an activating mutation (a mutation that results in sustained activity) of
A. the follicle stimulating hormone receptor.
B. Jak2.
C. a G_s protein.
D. a G_i protein.
E. cAMP phosphodiesterase.

52. In a euthyroid individual the daily intake of iodine was increased from 425 to 475 µg/day. Prior to the change the daily flux of hormone-bound iodine was 75 µg/day (steady state) and biliary excretion was 18 µg/day. Following the change in iodine intake you should expect:
A. a compensatory decrease in the efficiency of intestinal absorption of iodine
B. fecal iodine to increase by 50 µg/day
C. circulating flux of hormone-bound iodine to fall to 50 µg/day
D. urinary iodine to increase by 50 µg/day
E. thyroid iodine to increase from 7500 to 8000 µg over a period of 10 days

Reproductive Physiology Questions

53. Which of the following can be precursors of estradiol in the ovarian follicle?
A. progesterone, pregnenolone sulfate, testosterone
B. acetyl coenzyme A, esterified cholesterol, 11-deoxycorticosterone
C. estradiol, dihydrotestosterone, androstenedione
D. hydroxymethylglutaryl coenzyme A, androstenedione, pregnenolone
E. estrone glucuronide, estriol, dehydroepiandrosterone sulfate

54. An adult genetic female (46,XX) with amenorrhea has excessive facial hair. She has abnormally elevated levels of both testosterone and dehydroepiandrosterone (DHEA). Administration of corticotropin (ACTH) results in a rise in plasma androgens several fold greater than that typical of normally menstruating adult females. What could account for the abnormal androgen response to corticotropin?
A. 20,22-hydroxylase (side chain cleavage) deficiency
B. ovarian failure
C. 21-hydroxylase deficiency
D. stress
E. aromatase deficiency
55. A 40-year old male is injured in an automobile accident. Fracture of his vertebral column results in destruction of the spinal cord between segments S1-S6. Which of the following could be expected to result from the injury?

A. inability to produce spermatozoa in the testes
B. inability to ejaculate in response to electrical stimulation of the reproductive viscera
C. inability to achieve penile erection in response to tactile stimulation of the penis
D. decreased plasma concentrations of testosterone
E. decreased plasma concentrations of luteinizing hormone (LH)

56. Chronically high secretion of which of the following alone would result directly or indirectly in decreased plasma LH concentrations in a normally menstruating genetic female?

A. thyrotropin (TSH)
B. thyrotropin-releasing hormone (TRH)
C. activin
D. corticotropin (ACTH)
E. inhibin

57. Which one of the following would be higher at the time of labor than at the beginning of the third trimester of pregnancy?

A. synthesis of relaxin in the uterine myometrium
B. the ratio of progesterone to estradiol (P/E ratio) in the maternal plasma
C. synthesis of prostaglandin E₂ in the chorion of the placenta
D. oxytocin receptors in the uterine myometrium
E. maternal plasma concentrations of chorionic gonadotropin (hCG)

58. A female who has a voluminous thin, watery cervical mucus containing few cells and a spinnbarkeit of 10 cm (high stretchability) could be in which reproductive state?

A. third trimester of pregnancy
B. early follicular phase of the menstrual cycle
C. late luteal phase of the menstrual cycle
D. menses
E. the ovulatory phase of the menstrual cycle

59. Which of the following would be associated with use of pharmacologic doses of androgens to build body mass in a normal 18-year old male?

A. decreased concentration of spermatozoa in the ejaculate
B. increased plasma concentrations of FSH
C. increased testicular production of inhibin
D. negative nitrogen balance
E. decreased hematocrit

60. Of those listed below, which is the most common cause of amenorrhea?

A. stress
B. exercise
C. addiction to narcotics
D. hyperprolactinemia
E. pregnancy
61. A 21-year old phenotypic female has never menstruated. She has well developed breasts but no axillary or pubic hair. Her clitoris is that of a normal female of her age but her vagina ends in a blind pouch. She has elevated plasma testosterone and LH levels. What defect could explain these findings?

A. a 21-hydroxylase deficiency
B. a 17-hydroxylase deficiency
C. a non-functional LH receptor
D. a non-functional androgen receptor
E. an aromatase deficiency

For questions 62-68, select the correct answer from the following list of disorders in an adult female (A-J). (Each answer may be used once, more than once, or not all.)

A. primary hypothyroidism
B. inhibin-secreting granulosa cell tumor
C. primary hyperthyroidism
D. ovarian failure
E. hypothalamic amenorrhea (hypothalamic chronic anovulation)
F. 21-hydroxylase deficiency
G. activating mutation (a mutation that results in sustained activity) of the FSH receptor
H. prolactin-secreting pituitary tumor
I. a non-functional LH receptor
J. secondary hypothyroidism

62. Normal TSH, normal prolactin, low estradiol, elevated FSH, low androstenedione

63. Elevated TSH, elevated prolactin, low estradiol, low FSH, low androstenedione

64. Normal TSH, normal prolactin, normal estradiol, low FSH, elevated androstenedione

65. Normal TSH, normal prolactin, low estradiol, low FSH, low androstenedione

66. Low TSH, elevated prolactin, low estradiol, low FSH, low androstenedione

67. Normal TSH, normal prolactin, elevated estradiol, low FSH, elevated androstenedione

68. Low TSH, normal prolactin, normal estradiol, normal FSH, normal androstenedione
For questions 69-73, select the correct answer from the following list (A-J). (Each answer may be used once, more than once, or not at all.)

A. testosterone  
B. prolactin  
C. inhibin  
D. estradiol  
E. prostaglandin E₂  
F. oxytocin  
G. chorionic gonadotropin  
H. luteinizing hormone  
I. chorionic somatomamotropin  
J. activin

69. Elevated in the plasma of postmenopausal females
70. Acts on hypothalamic neurons to decrease GnRH pulse frequency
71. Amplifies the FSH-stimulated aromatization of androgens to estrogens in granulosa cells
72. Synthesized in abnormally elevated quantities in individuals with 21-hydroxylase deficiency
73. Stimulates contraction of myoepithelial cells of the breast, resulting in expulsion of milk

The Physiology of Energy Balance and Temperature Regulation

74. Over which range of ambient temperatures (in degrees F) can an unclothed person (at rest in a room containing dry air for one hour) maintain a core temperature between 97°F and 100°F?
   A. 80 to 100  
   B. 70 to 110  
   C. 60 to 120  
   D. 55 to 130  
   E. all of the above

75. In an isolated, actively contracting skeletal muscle preparation, the total energy utilized was determined to be 100 arbitrary units of energy/hour. Which of the following would most likely approximate the external work performed (in arbitrary units of work/hour)?
   A. 35  
   B. 50  
   C. 75  
   D. 15  
   E. 10

76. Which of the following best characterizes the “basal state” of metabolism?
   A. Fasting and standing  
   B. Rate of heat production = rate of chemical energy utilization  
   C. Moderate exercise  
   D. Rate of heat production = chemical energy of food intake  
   E. Energy input = energy output
77. Which of the following groups are arranged in the correct sequence in terms of the greatest amount of heat produced/liter of oxygen consumed in their combustion?
   A. fats > proteins > carbohydrate
   B. fats > carbohydrates
   C. proteins > carbohydrates
   D. carbohydrates > fats > proteins
   E. proteins > fats

78. Heat loss from the body by 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

79. In regard to factors affecting metabolic rate (MR),
   A. the MR 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 influence
   D. the contribution of the specific dynamic action of foods is greater than physical activity
   E. thyroxin is highly calorigenic and much faster in stimulating metabolism than are the catecholamines

Use the following data obtained from a fasting person at rest to answer question # 80:

Body surface area = 1.8m²
O₂ consumption = 15.625 L O₂/hour

80. Which of the following most closely approximates the normalized BMR using the simplified indirect method?
   A. 14.2 kcal/hour
   B. 75 kcal/hour
   C. 41.7 kcal/m²/hour
   D. 75 kcal/m²/hour
   E. 41.7 kcal/m²

81. At a comfortable room temperature of 70°F, under conditions of dry air and no significant air currents, which of the following is true for a normal, unclothed subject at rest?
   A. Skin temperatures would vary little (<1 degree C) between skin areas.
   B. The mean skin temperature would be greater than core temperature.
   C. The temperature of skin covering the head and back would be > that covering the hands and feet.
   D. The heat loss (in kcal/m²/hour) from skin covering the head is > that covering the hands.
   E. None of the above
A)
B)
C)
D)
E)

82. Represents a mechanism for heat loss but not heat gain.

83. Most likely to be operative shortly (30 min) after the onset of fever.

Use the following answers for questions # 84-85 (answers may be used once, more than once, or not at all).

A)
B)
C)
D)
E)
F)
G)
H)

84. Most likely represents the final agent responsible for altering the internal set point for temperature regulation during the pathogenesis of fever.

85. During fever, circulating cytokines are monitored by neurons in or near this region.