Gastrointestinal Physiology

1. Gastric emptying is:
   A. Accelerated by the presence of acid in the duodenum
   B. Faster for liquid than for solid particles
   C. Slower for isotonic liquids than for hypo- or hypertonic liquids
   D. Slowed by gastric distension
   E. Slower for liquid than for solid particles

2. Which of the following can occur without brain stem coordination?
   A. Chewing
   B. Swallowing
   C. Primary esophageal peristalsis
   D. Vomiting
   E. Intestinal segmentation

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

4. Which secretion is almost exclusively under neural control?
   A. Gastric secretion
   B. Intestinal secretion
   C. Pancreatic secretion
   D. Salivary secretion
   E. Biliary secretion

5. Which phase of stimulation of gastric acid secretion is responsible for the bulk of acid secretion?
   A. Cephalic
   B. Esophageal
   C. Gastric
   D. Intestinal
   E. Colonic
6. The chief cells of the stomach secrete:
   A. Intrinsic factor
   B. Hydrochloric acid
   C. Pepsinogen
   D. Gastrin
   E. Cholecystokinin (CCK)

7. Which hormone stimulates pancreatic secretion that is rich in bicarbonate?
   A. Somatostatin
   B. Secretin
   C. Cholecystokinin (CCK)
   D. Gastrin
   E. Peptide YY

8. All of the following are a function of the liver except:
   A. Albumin synthesis
   B. Urea production
   C. Chylomicron production
   D. Very-low-density lipoprotein production
   E. Conjugation of bilirubin with glucuronic acid

9. Consequences of interruption of the enterohepatic circulation of bile acids by ileal disorder or resection include all of the following except:
   A. Decreased serum triglyceride concentration
   B. Excessive fecal bile acid loss
   C. Vitamin C deficiency
   D. Fat and fat soluble vitamin deficiency
   E. Increased risk of gall stones and kidney stones

10. All of the following are normal components of bile except:
    A. \( \text{HCO}_3^- \)
    B. Phosphatidylcholine
    C. Cholesterol
    D. Lipase
    E. Bile Salts
11. Galactose absorption by the small intestine:
   A. Occurs by facilitated diffusion
   B. Inhibits intestinal glucose absorption
   C. Requires bile salts
   D. Occurs only via a paracellular route
   E. Is enhanced by increasing the secretion of chloride ions

12. Lactase hydrolyzes lactose to form:
   A. Glucose
   B. Glucose and galactose
   C. Glucose and fructose
   D. Galactose and fructose
   E. Fructose

13. 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

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

15. Pernicious anemia is caused by lack of:
   A. iron absorption
   B. transferrin in the circulation
   C. bile salts in the lumen
   D. intrinsic factor
   E. Na⁺-K⁺ ATPase

16. Crypt cells secrete chloride ions. The outwardly directed Cl⁻ gradient in crypt cells is maintained by:
   A. A NaCl cotransporter on the brushborder membrane
   B. The CFTR chloride channel located on the basolateral membrane
   C. A Na⁺ - K⁺ - 2Cl⁻ cotransporter on the basolateral membrane
   D. A Cl⁻ - HCO₃⁻ exchanger located on the brushborder membrane
   E. A Cl⁻ - HCO₃⁻ exchanger located on the basolateral membrane

17. 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. The secondary 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
### Endocrine Physiology

Use the following list to answer questions 18-27. Answers may be used once, more than once, or not at all.

<table>
<thead>
<tr>
<th></th>
<th>Hormone</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Thyrotropin-Releasing Hormone</td>
</tr>
<tr>
<td>B</td>
<td>Vasopressin</td>
</tr>
<tr>
<td>C</td>
<td>Somatostatin</td>
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<tr>
<td>D</td>
<td>Oxytocin</td>
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<tr>
<td>E</td>
<td>Growth Hormone.</td>
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<tr>
<td>F</td>
<td>Adrenocorticotrophic Hormone</td>
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<tr>
<td>G</td>
<td>Dopamine</td>
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<tr>
<td>H</td>
<td>Gonadotropin-Releasing Hormone</td>
</tr>
<tr>
<td>I</td>
<td>Corticotropin-Releasing Hormone</td>
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<tr>
<td>J</td>
<td>Follicle Stimulating Hormone</td>
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<tr>
<td>K</td>
<td>Growth Hormone Releasing Hormone</td>
</tr>
<tr>
<td>L</td>
<td>Prolactin</td>
</tr>
<tr>
<td>M</td>
<td>Thyroid Stimulating Hormone</td>
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<tr>
<td>N</td>
<td>Luteinizing Hormone</td>
</tr>
</tbody>
</table>

18. The pituitary hormone that is secreted at abnormally low levels in primary hyperthyroidism.

19. The hypothalamic peptide that is secreted in adaptation to cold stress.

20. The hypothalamic peptide that controls ovarian follicular development and steroid secretion.

21. Is synthesized in the parvicellular neurosecretory neurons and stimulates Adrenocorticotrophic Hormone (ACTH) secretion.

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

23. Is a proteolytic product of pro-opiomelanocortin.

24. Inhibits lactotroph proliferation.

25. Stimulates contractions of myoepithelial cells in breast.


27. Secretion increases in response to rising plasma osmolality.
28. This is a transcription regulatory protein that binds cortisol.

A. Stat5  
B. Jak2  
C. Glucocorticoid receptor  
D. Heat shock protein 90  
E. Calmodulin

29. Based on the metabolism and action of thyroid hormones, which of the following interventions would be **beneficial** during "thyroid storm" (an acute, life-threatening, thyrotoxicosis)?

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

30. An individual suffers from a mutation of the thyroid hormone receptor that makes the receptor completely non-functional. What would you expect to be the pattern of hormone secretion?

A. Elevated Thyroid Stimulating Hormone, decreased Thyroxine, decreased Thyrotropin Releasing Hormone.  
B. Elevated Thyroid Stimulating Hormone, elevated Thyroxine, decreased Thyrotropin Releasing Hormone.  
C. Decreased Thyroid Stimulating Hormone, decreased Thyroxine, elevated Thyrotropin Releasing Hormone.  
D. Elevated Thyroid Stimulating Hormone, elevated Thyroxine, elevated Thyrotropin Releasing Hormone.  
E. Decreased Thyroid Stimulating Hormone, elevated Thyroxine, elevated Thyrotropin Releasing Hormone.

31. The pancreatic β-cell secretes insulin when

A. Intracellular ATP levels increase.  
B. Potassium exit from the cell is inhibited.  
C. Cholecystokinin secretion increases.  
D. Intracellular calcium concentration increases.  
E. None of the above is correct.  
F. A-D are correct.
Use the following diagrams to answer questions 32 – 35. The figures depict a physiological effect (plotted on the ordinate) as a function of the hormone concentration (plotted on the abscissa). The middle solid curves correspond to the "normal" state whereas curves A and B, and C and D reflect changes in the physiological response; points E - H (with corresponding dotted lines covering the responses) refer to plasma concentrations of the hormone (the hormone scale is the same on both plots). Answers may be used once, more than once, or not at all.

32. Some forms of diabetes referred to as "Maturity-Onset Diabetes of the Young" (MODY) are caused by genetic abnormalities that decrease the number of insulin receptors on target cells. Which curve (lettered A-D) would correspond to the predicted dose-response for insulin in such individuals?

33. Which letter corresponds to a minimum hormone concentration that causes maximum target tissue reaction in an individual expressing an increased number of functional hormone receptors?

34. If the thyroid receptor is mutated in the DNA binding domain but present at a normal level in target cells, which curve depicts the predicted dose-response relationship?

35. Which curve corresponds to the predicted dose-response relationship for glucose uptake in skeletal muscle cells that express higher than normal levels of GLUT4 protein?

In questions 36 – 40, pair one of the following hormones (A-F) with the characteristic feature of its 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  
F. Epinephrine

36. This hormone stimulates glucose conversion to glycogen in liver and skeletal muscle.

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

38. 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.

39. The receptor for this hormone is expressed in heart muscle, and has seven membrane-spanning alpha helices.

40. In a healthy individual, this hormone activates the "hormone-sensitive lipase" of adipose tissue, causing lipolysis.
Reproductive Physiology

41. An adult female is having difficulty becoming pregnant. You wish to know if she ovulates. Which one of the following compounds would increase in urine after ovulation due to a functional corpus luteum?

A. Dehydroepiandrosterone sulfate  
B. Estradiol  
C. Pregnanediol glucuronide  
D. Androstenedione  
E. Progesterone

42. A 17-year old male with a normal 46,XY karyotype has a deficiency in the 17-hydroxylase (P450,17) enzyme. Which of the following would be associated with his enzyme deficiency compared with an unaffected male?

A. Elevated urinary dehydroepiandrosterone sulfate  
B. Decreased urinary dehydroepiandrosterone sulfate  
C. Decreased production of 17-hydroxyprogesterone in the zona glomerulosa  
D. Increased conversion of testosterone to estrone in muscle  
E. Elevated urinary excretion of sodium

43. Which of the following enzymatic conversions occurs in the placenta?

A. 17-hydroxyprogesterone to androstenedione  
B. Androstenedione to estrone  
C. 17-hydroxypregnenolone sulfate to dehydroepiandrosterone sulfate  
D. Estriol to estradiol  
E. Progesterone to aldosterone

44. A 14-year old female is brought to your clinic by her mother because she has not begun to menstruate (primary amenorrhea). Physical examination reveals that the patient has female external genitalia and moderate breast development (Tanner stage 3) but a blind vagina and bilateral undescended testes. She does not have a uterus. Her serum and urinary electrolytes are normal. Her karyotype is 46,XY (genetic male). Her plasma testosterone level is that of a normal male but her plasma LH is elevated. What is a possible diagnosis?

A. 5α-reductase deficiency  
B. 21-hydroxylase deficiency  
C. 11-hydroxylase deficiency  
D. 17-hydroxylase deficiency  
E. Androgen insensitivity

45. A 5-year old male is brought to your clinic by his parents because he has external genitalia that resemble those of a 20-year old male. He has facial, pubic and body hair typical of an adult male, his musculature is overly developed for a youth his age, and he exhibits abnormally aggressive behavior for a youth of his age. Analysis of his serum electrolytes indicates that he is hypokalemic (low serum potassium) but not hyponatremic (low serum sodium). What is a possible diagnosis?

A. 5α-reductase deficiency  
B. 21-hydroxylase deficiency  
C. 11-hydroxylase deficiency  
D. 17-hydroxylase deficiency  
E. Androgen insensitivity
46. An 11-year old female entering puberty suddenly begins to experience growth of testes and growth of her phallus into a small penis. History and physical examination reveal that the girl was born with external genitalia typical of a female infant. Her karyotype is 46,XY. Now she/he has serum testosterone levels typical of a normal pubertal male and she ejaculates small amounts of semen containing spermatozoa from her functional penis. What could account for these findings?

A. 5α-reductase deficiency
B. 21-hydroxylase deficiency
C. 11-hydroxylase deficiency
D. 17-hydroxylase deficiency
E. Androgen insensitivity

47. Chronic use of high doses of anabolic, androgenic steroids would result in which of the following in a normal adult male?

A. Elevated plasma levels of LH
B. Increased rate of mitosis in spermatogonia
C. Decrease in libido and sexual function
D. Decreased GnRH secretion
E. Increased sensitivity of pituitary gonadotropes to inhibin

48. Tactile stimulation of the clitoris of a normal adult female results in which of the following?

A. Constriction of the arteries and relaxation of the veins of the clitoris
B. Increased parasympathetic efferent impulses from spinal cord segments S2-S4
C. Increased secretion of estradiol by the ovary
D. Increased secretion of androstenedione by the ovary
E. Decreased secretion of mucus from Bartholin’s glands

49. Which of the following is a direct or indirect result of fertilization of an oocyte by a spermatozoa in the female reproductive tract?

A. Synthesis and secretion of chorionic gonadotropin (hCG)
B. Increased frequency of menses
C. Decreased maternal plasma cortisol levels
D. Decreased maternal plasma progesterone levels
E. Increased hypothalamic GnRH secretion

50. Which of the following is associated with the middle of the luteal phase of the menstrual cycle compared with other phases of the menstrual cycle?

A. Thick, highly secretory endometrium
B. Low basal body temperature
C. Peak plasma LH levels
D. Thin, watery cervical mucus
E. Maximally contracting myometrium

51. Suckling results directly or indirectly in which of the following?

A. Increased dopamine secretion in the hypothalamus
B. Relaxation of myoepithelial cells of the breast
C. Increased synthesis of milk proteins
D. Inhibition of oxytocin secretion
E. Increased GnRH secretion
52. Which of the following is an effect of estrogens in a normally menstruating adult female?

A. Stimulate bone resorption
B. Amplify the action of FSH on granulosa cells
C. Decrease the synthesis of contractile proteins in the myometrium
D. Increase the amplitude of GnRH pulses
E. Decrease the number of GnRH receptors on pituitary gonadotrophs

53. When are spinnbarkeit and ferning of cervical mucus maximal in an adult female?

A. The early follicular phase of the menstrual cycle
B. Pregnancy
C. The late luteal phase
D. The periovulatory period
E. During hypothalamic chronic anovulation due to stress

54. A 30-year old female presents with amenorrhea of more than one year duration. Analysis of plasma TSH and thyroid hormone reveals that she has severe primary hypothyroidism. What hormonal imbalance would you expect to be associated with her amenorrhea?

A. Increased secretion of FSH
B. Increased secretion of prolactin
C. Decreased secretion of TRH
D. Increased production of ovarian androgens
E. Increased secretion of GnRH

55. Which of the following methods of birth control is most likely to prevent transmission of sexually transmitted diseases?

A. Intrauterine device
B. Oral contraceptive pill
C. Vaginal spermicide
D. Condom
E. Tubal ligation

56. Which of the following would be characteristic of a 60-year old postmenopausal female compared with a 20-year old premenopausal female?

A. Equal numbers of ovarian follicles
B. Elevated plasma levels of inhibin
C. Decreased sensitivity of GnRH neurons to estradiol
D. Increased vaginal lubrication
E. Decreased ovarian production of androstenedione
For questions 57-61, select the correct answer from the following list (A-J). Each answer may be used once, more than once or not at all.

A. activin  
B. testosterone  
C. dopamine  
D. inhibin  
E. epinephrine  
F. oxytocin  
G. luteinizing hormone  
H. progesterone  
I. β-endorphin  
J. acetylcholine

57. Acts on gonadotrophs of the anterior pituitary to decrease synthesis of the β-subunit of FSH

58. Amplifies the response of granulosa cells to FSH

59. Circulates in plasma primarily bound to albumin

60. Mediates the vasocongestive reaction in erectile tissues of the male and female genitalia

61. Maintains the uterine myometrium in a quiescent state, i.e., inhibits contractions

The Physiology of Energy Balance and Temperature Regulation

62. The energy liberated during the breakdown of an organic molecule can be used to ______ and/or be released as ______.
   
   A. Perform biological work and water  
   B. Form water and work  
   C. Perform biological work and heat  
   D. Form Proteins and water  
   E. None of the above

63. In terms of whole body metabolism during light muscular work, if the total energy converted was 500 units, which of the following would most likely approximate the units of heat formed?
   
   A. 125  
   B. 375  
   C. 475  
   D. 250  
   E. 75

64. Which one of the following best describes the events occurring in the basal metabolic state?
   
   A. The work energy output approximates the chemical energy consumed.  
   B. Chemical energy of food intake = rate of heat production.  
   C. Rate of chemical energy utilization = rate of heat production.  
   D. The output of thermal energy and the input of chemical energy are held constant.  
   E. A constant level of food intake is balanced by an equal output of work energy.
65. Which one of the following is true?

A. Indirect calorimetry requires knowing the heat lost from the subject due to water evaporation.
B. Basal metabolic rate (BMR) is normalized by multiplying the BMR by the average body surface area.
C. The respiratory quotient (RQ) is a reliable index of oxidative metabolism of food even if the subject is exercising.
D. 0.58 kcal (Cal) of heat are lost from the body for every gram of water vaporized.
E. Direct calorimetry requires only the measurement of oxygen consumption, carbon dioxide production and urinary nitrogen excretion.

66. Which one of the following is arranged in the correct order for the greatest volume of oxygen needed to metabolize one gram of the foodstuff?

A. Fat > protein > carbohydrate
B. Fat > carbohydrate > protein
C. Carbohydrate > fat > protein
D. Carbohydrate > protein > fat
E. Protein > fat > carbohydrate

67. In a subject with a body surface area of 2.0 m$^2$, O$_2$ consumption was 16.5 L O$_2$/hr under basal conditions. Using the simplified method, what is the basal metabolic rate (BMR)?

A. 39.6 kcal/m$^2$/hr (normalized)
B. 79.2 kcal/hr
C. Both A and B
D. Neither A or B
E. Cannot be calculated

68. Which one of the following is false? The BMR

A. is obtained under conditions in which the input of chemical energy and the output of work energy are held constant
B. of males is 6 to 10% lower than that of females of the same size and age
C. of lactating females of child-bearing age is higher than that of adolescent males
D. can be estimated by multiplying oxygen consumption (in L/hr) times 4.8 kcal of heat produced per liter of oxygen consumed
E. decreases with age in both males and non-pregnant females

69. A healthy, unclothed person at rest with a core body temperature of 98.5°F was placed in a room containing very dry air at 98.5°F. The room temperature was then changed to a new value and the resulting core temperature was recorded at the new steady state. Which of the following is most likely (temp in °F)?

A. At room temp = 120; core temp = 105
B. At room temp = 130; core temp = 110
C. At room temp = 80; core temp = 90
D. At room temp = 60; core temp = 85
E. The person could withstand more cooling than warming and still maintain a relatively constant core temperature between 97 and 100.

70. In a comfortable room environment (22°C, dry air and minimal air currents) which one of the following is true for a normal unclothed subject at rest?

A. The heat loss (in kcal/m$^2$/hr) from skin covering the back is greater than that covering the forearms.
B. The temperature of the skin covering the head is greater than that covering the hands.
C. The temperatures of skin throughout the body are approximately equal (< 1°C difference).
D. Skin areas with the highest temperatures have the highest heat loss per unit surface area.
E. None of the above.
71. Which one of the following is false?

A. The proportion of body mass at core and shell temperatures changes with changes in ambient temperatures.
B. Mean skin temperature for the average person at a comfortable room temperature is about 33°C.
C. Thermoregulatory mechanisms in the human are primarily designed to conserve heat.
D. Body heat stores such as fluids, fat and muscle are good insulators and poor conductors of heat.
E. Metabolic enzymatic activity changes about 25% for every 1°C change in core body temperature.

72. Which one of the following is false in regard to sweat/sweating?

A. Stimulation of the preoptic anterior hypothalamus by excess heat initiates the sweating response.
B. The normal person has approximately 2.5 million sweat glands that collectively represent a high-capacity secretory organ capable of producing sweat at about 4 liters/hr while exercising or working in conditions of high ambient heat and humidity.
C. Sweat, appearing at the skin surface, is a hypotonic solution.
D. The degree of reabsorption of sodium and chloride in the sweat duct is strongly dependent on the rate of sweating.
E. Over the ambient temperature range of 24-33°C, evaporation of sweat is the primary mechanism by which core temperature is maintained.

73. At the end of a febrile episode when the febrile agent is no longer effective or present,

A. peripheral vasoconstriction ensues
B. non-evaporative heat loss is reduced
C. there continues to be a failure in the feed back control of core temperature
D. hypothalamic integration centers now recognize that core temperature is too warm relative to the set point
E. shivering ceases
### KEY

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1b 2e 3d 4d 5c 6c 7b 8c 9c 10d 11b 12b 13c 14d 15d 16c 17c 18m 19a 20h 21i 22c 23f 24g 25d
26e 27b 28c 29b 30d 31f 32b 33e 34d 35c 36a 37e 38b 39f 40f 41c 42b 43b 44e 45c 46a 47d 48b
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71c 72e 73d
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