Gastrointestinal Physiology

1. The migrating motor (motility) complex:
   A) is triggered by ingestion of a meal
   B) originates in the esophagus
   C) originates in the ileum
   D) occurs only during fasting
   E) occurs only in the colon

2. Which one of the following bile acids is a primary bile acid?
   A) Taurolithocholic acid
   B) Deoxycholic acid
   C) Chenodeoxycholic acid
   D) Lithocholic acid
   E) Ursodeoxycholic acid

3. A Na⁺-dependent, secondary active transport system is necessary for intestinal absorption for all of the following **EXCEPT**:
   A) amino acids
   B) bile acids
   C) glucose
   D) galactose
   E) fructose

4. The formation of micelles is necessary for absorption of:
   A) bile salts
   B) iron
   C) alcohol
   D) fatty acids
   E) vitamin B12
5. Oral rehydration in cholera patients is an effective therapy because:

A) enterocyte cAMP levels are low
B) enterocyte Na⁺, K⁺-ATPase is poisoned
C) 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

6. 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

7. Over 90% of 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 acid
D) glycerol and 2 molecules of fatty acid
E) none of the above

8. Which one of the following statements regarding salivary secretion is **INCORRECT**?

A) It is always isotonic
B) The chloride concentration increases with increasing secretion rate
C) It is predominantly under the control of the parasympathetic nervous system
D) The sodium concentration of saliva increases to a plateau with increasing secretion rate
E) The bicarbonate concentration of saliva increases to a plateau with increasing secretion rate

9. Which one of the following **IS NOT** a component of human saliva?

A) Lactoferrin
B) Muramidase
C) Amylase
D) Colipase
E) Immunoglobulins

10. Gastric acid secretion is stimulated by several phases associated with the ingestion and digestion of a meal. Which phase stimulates the bulk of acid secretion?

A) Cephalic
B) Esophageal
C) Gastric
D) Intestinal
E) Colonic
11. Which hormone stimulates pancreatic secretion that is rich in bicarbonate?
   A) Somatostatin  
   B) Secretin  
   C) CCK  
   D) Gastrin  
   E) Insulin  

12. A patient suffering from Zollinger-Ellison Syndrome would be expected to have which of the following symptoms?
   A) Reduced acid secretion by the stomach  
   B) Excessive secretion of CCK causing continuous contraction of the gallbladder  
   C) A gastrin-secreting tumor of the pancreas causing excessive stomach acid secretion resulting in ulceration of the upper GI tract  
   D) Failure by the liver to secrete VLDLs resulting in very low plasma lipid levels  
   E) Failure to secrete a bicarbonate-rich pancreatic secretion  

13. Maltase hydrolyzes maltose to form:
   A) glucose  
   B) glucose and galactose  
   C) glucose and fructose  
   D) galactose and fructose  
   E) galactose  

14. After a meal of pizza, dietary lipid is absorbed by the small intestine and transported in the lymph mainly as:
   A) VLDLs  
   B) free fatty acids bound to albumin  
   C) chylomicrons  
   D) LDLs  
   E) HDLs  

15. A patient went to his physician not feeling well. He looked jaundice, and his liver enzymes were elevated. Which function would NOT be affected by his illness?
   A) Albumin synthesis  
   B) Urea production  
   C) Intestinal glucose absorption  
   D) VLDL  
   E) The conjugation of bilirubin with glucuronic acid
16. Surgical removal of the ileum would most likely lead to:

A) iron deficiency anemia
B) vitamin B-12 deficiency
C) vitamin A deficiency
D) deficient absorption of conjugated bile acids
E) all of the above

The figures below (A and B) depict the concentrations of major ions in pancreatic juice compared to the rate of stimulation of secretion.

17. Which lines in Graph A represent pH and osmolality, respectively?

A) Line 1 is pH and line 3 is osmolality
B) Line 2 is pH and line 3 is osmolality
C) Line 1 is pH and line 2 is osmolality
D) Line 3 is pH and line 1 is osmolality

18. Which answer correctly matches the relationship between specific ions and the secretion rate in Graph B?

A) Line 1 represents sodium and line 2 chloride
B) Line 4 represents potassium and line 2 chloride
C) Line 2 represents bicarbonate and line 3 chloride
D) Line 1 represents chloride and line 2 bicarbonate
E) Line 4 represents sodium and line 2 chloride
19. In a patient with an ectopic tumor that synthesizes high levels of pro-opiomelanocortin, which of the following should **NOT** be elevated in the plasma?

A. Cortisol  
B. Melanocyte-stimulating hormone  
C. β-endorphin  
D. Renin  
E. ACTH

20. A 35 year-old male individual who is lean and exercises vigorously on a daily basis should be expected to secrete **LESS** of which hormone, compared with another who is obese and leads a sedentary lifestyle?

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

21. High levels of 25-OH cholecalciferol in an individual with a low plasma [Ca^{2+}] could be caused by

A. hyperparathyroidism  
B. primary hypersecretion of calcitonin  
C. a genetic defect of 1α-hydroxylase  
D. hypersecretion of parathyroid hormone-related peptide (PTH-rP)  
E. primary hyposecretion of calcitonin

22. Circulating thyroid-stimulating immunoglobin (TSI, LATS) can be a cause of

A. Myxedema  
B. Exophtalmos  
C. Cretinism  
D. Hasimoto's thyroiditis  
E. Diabetes mellitus

23. 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.

24. In a normal individual with intact Islets, which of the following would have the greatest stimulatory effect on insulin secretion?

A. Oral glucose (500 g)  
B. Intravenous glucose (500 g)  
C. A high fat meal  
D. A high protein meal  
E. Fatty acids by injection
25. Which one of the following enzymes is activated by association with a GTP-binding protein, and inhibited by somatostatin?
   A. Protein kinase C.
   B. Adenylyl cyclase.
   C. Glycogen synthase.
   D. Glucokinase.
   E. Phosphofructokinase

26. Which of the following hormones is activated by an enzyme in its target cells?
   A. Vitamin D hormone
   B. Thyroxine (T₄)
   C. Growth hormone
   D. Cortisol
   E. Insulin

27. 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. Radioablation of the thyroid gland.
   E. Administering thiourea.

28. An individual with hypocalcemia, elevated parathyroid hormone (PTH) levels and low circulating 1, 25 OH D₃ is said to have "pseudohypoparathyroidism". This might be caused by a defect in
   A. calcitonin secretion.
   B. the stimulatory α(alpha) subunit of G-protein (Gₐ).
   C. insulin secretion.
   D. aldosterone synthesis.
   E. the βγ subunits of G-protein.

29. 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. Ghrelin (growth hormone secretagogue).

30. 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.
31. In an individual with a genetic lesion that prevents synthesis of the glycoprotein hormone α-subunit would **NOT** be expected to have deficiencies in which of the following hormones?

A. Follicle stimulating hormone (FSH)
B. growth hormone.
C. Thyroid stimulating hormone (TSH).
D. Luteinizing hormone (LH).
E. Chorionic gonadotropin (HCG).

32. Insulin-induced hypoglycemia

A. results from an increased muscle glucose production.
B. results from lower glucose utilization by adipocytes.
C. causes a reduction of epinephrine secretion from the adrenal medulla.
D. results in excessive protein glycosylation and membrane damage.
E. is caused in part by elevated glucose uptake into skeletal muscle cells.

**Use the following list to match the hormones in questions 33 - 35 with their signaling pathway (answers may be once, more than once, or not at all).**

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

33. Insulin

34. Glucagon

35. Aldosterone

36. Following complete radioablation of the thyroid, which of the following hormones will be given to an individual to compensate for the loss of an essential function of the thyroid gland?

A. 3, 3', 5'-Triiodothyronine (reverse T3).
B. 3, 5, 3', 5'-Tetraiodothyronine (T4).
C. Thyroid stimulating hormone (TSH).
D. Calcitonin.
E. Thyrotropin releasing hormone (TRH).

37. The pancreatic β-cell glucose transporter is

A. GLUT1.
B. GLUT4.
C. insulin dependent.
D. insulin independent.
E. Na⁺-dependent.
38. 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.

39. In a euthyroid individual (i.e., one whose thyroid function is normal) the daily intake of iodine was decreased from 450 to 400 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 increase in the efficiency of intestinal absorption of iodine
B. fecal iodine to decrease by 50 µg/day
C. circulating flux of hormone-bound iodine to fall to 50 µg/day
D. urinary iodine to decrease by 50 µg/day
E. thyroid iodine to decrease from 8000 to 7500 µg over a period of 10 days

40. A tumor that impedes the flow in 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.

41. The synthesis of vasopressin takes place in

A. pituicytes.
B. the neurohypophysis.
C. the intermediate lobe of the pituitary gland.
D. the supraoptic nucleus of the hypothalamus.
E. the adenohypophysis.

Reproductive Physiology

42. A 45-year old male with a history of severe and persistent alcoholism for the past ten years has abnormally large breasts (gynecomastia). Diagnostic tests reveal that the patient has cirrhosis of the liver. Which of the following could be a cause of his abnormal breast development?

A. Decreased synthesis of sex hormone-binding globulin (SHBG or TeBG)
B. Increased ratio of free estradiol to free testosterone in plasma
C. Increased binding of estradiol to SHBG
D. Increased renal clearance of estradiol
E. Increased conversion of estradiol to estrone glucuronide in the liver
43. A 20-year old female comes to your office because she has not started to menstruate (primary amenorrhea). Physical examination reveals that she has partially developed external genitalia (Tanner stage 3) and partially developed breasts (Tanner stage 3). However, she has no pubic, axillary or facial hair. Her reproductive tract consists of a blind vagina with no internal genitalia. What is the most likely diagnosis?

A. Androgen insensitivity syndrome (nonfunctional androgen receptor)
B. Aromatase deficiency (nonfunctional aromatase enzyme)
C. 21-Hydroxylase deficiency (nonfunctional 21-hydroxylase enzyme)
D. Mullerian inhibiting hormone receptor defect (nonfunctional MIH receptor)
E. Inactivating mutation of the FSH receptor (nonfunctional FSH receptor)

44. A 16-year old female comes to your office because she has not started to menstruate (primary amenorrhea). Physical examination reveals that she has a normal female reproductive tract, undeveloped breasts (Tanner stage 1), poorly developed external genitalia (Tanner stage 1) but some pubic hair. The history reveals that she has been a competitive gymnast since the age of 7, practicing gymnastics for 5 hours each day. You suspect that she has exercise-induced amenorrhea. Which of the following would positively confirm your diagnosis?

A. Elevated plasma levels of hCG
B. Elevated levels of plasma and urinary androgens
C. Elevated plasma levels of FSH
D. Increase in plasma FSH in response to administration of GnRH
E. Elevated plasma levels of TSH

45. Which one of the following would you be more likely to see in a 65-year old postmenopausal female who has not had any medical treatment as compared with a 25-year old normally menstruating female?

A. Increased plasma levels of androstenedione
B. Increased bone mineral density
C. Impaired responsiveness of pituitary gonadotropes to GnRH
D. Decreased plasma levels of inhibin
E. Decreased plasma levels of FSH and LH

46. A 21-year old female is pregnant with her first child. Levels of estriol in maternal urine have increased normally throughout her pregnancy. The L/S ratio in amniotic fluid exceeds the minimal level of 2.0 for fetal pulmonary maturation. In her 40th week of gestation, she begins to have uterine contractions. The contractions continue for more than a day but do not increase sufficiently in frequency or amplitude to expel the fetus. What hormone could you administer to enhance uterine contractions?

A. Progesterone
B. Relaxin
C. Oxytocin
D. Prolactin
E. Aspirin

47. A couple is disturbed because their 4-year old son has pubic hair, testicles and a penis similar in size and development to those of their 15-year old son. In addition, his voice has lowered and he is larger in body size than 99% of boys his age. What could account for this “precocious puberty”?

A. 5α-Reductase deficiency
B. Inactive mutant androgen receptor
C. Hyperprolactinemia
D. 3β-Hydroxysteroid dehydrogenase deficiency
E. Constitutively active (always on) mutant LH receptor
48. A newborn genetic female (46,XX) has bilateral ovaries and no testes. She has a fully formed female reproductive tract but also a partially developed internal male reproductive tract and ambiguous external genitalia, including an enlarged phallus approximately 2 cm in length. The infant is severely hyponatremic (low blood sodium). Which of the following could be the diagnosis?

A. Complete deficiency of steroid acute regulatory protein (StAR)
B. Complete deficiency of 21-hydroxylase
C. Complete deficiency of 17-hydroxylase
D. Complete deficiency of aromatase
E. Constitutively active (always on) mutant LH receptor

49. A 22-year old female who has normal breast, genital and pubic and axillary hair development for her age, and no evidence of abnormal facial or body hair, presents to you because she has not had menses in two months. What test would you perform to rule out the most common cause of amenorrhea?

A. Serum or plasma FSH
B. Serum or plasma TSH
C. Serum or plasma prolactin
D. Spinnbarkeit
E. Urine pregnancy test

50. A 30-year old female who had regular menstrual function up until 9 months ago presents in your office with unexplained amenorrhea. She does not think that she is under a particular job or family stress. You order tests for serum FSH, TSH and prolactin. The results indicate that TSH and prolactin are normal but that the FSH is elevated approximately 10-fold, to greater than 40 mIU/ml. What is the most likely cause of her amenorrhea?

A. premature ovarian failure
B. galactorrhea (abnormal production of a milky secretion by the mammary glands)
C. primary hypothyroidism
D. abnormally low secretion of GnRH
E. congenital adrenal hyperplasia

51. Which method of contraception blocks ovulation but maintains bone formation?

A. rhythm
B. RU486 (mefipristone, “morning after pill”)
C. oral contraceptive containing an estrogen and a progestin
D. intrauterine device
E. condom
For questions 52-62 refer to Figure 1 and then select the **BEST** answer from the list below. Your answer should be the compound which has been **PROVEN WITHOUT QUESTION** to exert the indicated action. Each answer may be used once, more than once, or not at all.

A. Estradiol  
B. Progesterone  
C. Aldosterone  
D. Oxytocin  
E. LH  
F. FSH  
G. Prolactin  
H. GnRH  
I. β-endorphin  
J. Prostaglandin F<sub>2α</sub>  
K. Inhibin  
L. TSH  
M. Growth hormone  
N. Human chorionic somatomammotropin  
O. Androstenedione

**Figure 1**
Key

1d 2c 3e 4d 5e 6e 7c 8a 9d 10c 11b 12c 13a 14c 15e 16e 17c 18e 19d 20b 21c 22b 23b 24a 25b 26b 27b 28b 29c 30c 31b 32e 33c 34a 35b 36b 37d 38c 39d 40d 41d 42b 43a 44d 45d 46c 47e 48b 49e 50a 51c 52i 53h 54e 55a 56k 57a 58b 59b 60g 61a 62o