

DEPARTMENT OF PHYSIOLOGY AND BIOPHYSICS
SCHOOL OF MEDICINE AND THE GRADUATE SCHOOL

HUMAN PHYSIOLOGY

FINAL EXAMINATION

THURSDAY, MARCH 31, 1994

Instructions for Use of Optical Scan Answer Sheet

1. **DO NOT** bend fold or tear answer sheet in any way.
2. Use **ONLY** a #2 pencil. **DO NOT** use a pen.
3. **DO NOT** make any marks along the edge with the black lines. The computer will not be able to grade your sheet if you do so.
4. Print your name (last name first) in the boxes provided on the sheet.
5. **Darken** the blanks which correspond to each letter in your name and initial.
6. In the box marked "Student I.D. Number" write your **5-digit identifying number** given to you by the Registrar's Office at the beginning of the year. **Darken** the corresponding number box below.
7. For each question, **darken** the letter blank which corresponds to the correct answer. **DO NOT** write in more than one answer – **the computer will reject your answer sheet and it will be marked wrong (i.e. no credit)**. Erase thoroughly any mismarked blanks.
8. **NO EXTRA TIME WILL BE ALLOWED TO TRANSCRIBE ANSWERS ONTO THE ANSWER SHEET.**
9. **IF YOU DO NOT FOLLOW THE ABOVE INSTRUCTIONS, IT WILL NOT BE POSSIBLE TO GRADE YOUR EXAM.**

1. Which of the following is NOT a function of the kidneys?
 - A. regulation of extracellular osmolality
 - B. regulation of acid/base balance
 - C. excretion of end-products of muscle metabolism
 - D. activation of antidiuretic hormone
 - E. activation of vitamin D

2. Inulin can be used to measure the glomerular filtration rate because
 - A. essentially all of the inulin delivered to the kidney is filtered.
 - B. essentially all of the inulin delivered to the kidney is excreted.
 - C. inulin is neither filtered nor reabsorbed by the kidney.
 - D. the amount of inulin excreted is equal to the amount of inulin filtered.
 - E. the clearance of inulin is greater than the clearance of creatinine.

3. Through diet and metabolism, a child accumulates 100 mOsm/day of solute, which must be excreted by the kidneys. If this child has a defect in urine concentration and can only produce urine with a maximum osmolality of 200 mOsm/kg H₂O, what is the minimum volume of water that must be ingested daily to prevent a rise in plasma osmolality? Assume that daily insensible water loss is 500 ml and that water losses in sweat and feces are negligible.
 - A. 0.5 liter
 - B. 1.0 liter
 - C. 1.5 liter
 - D. 2.0 liter
 - E. 2.5 liter

4. Of the following changes in afferent or efferent arteriolar resistances (at constant perfusion pressure), which would result in a decrease in renal blood flow but an increase in filtration fraction?

Afferent Arteriolar Resistance	Efferent Arteriolar Resistance
A. ↔	↓
B. ↓	↔
C. ↑	↔
D. ↓	↓
E. ↑	↑

USE THE VALUES BELOW FOR QUESTIONS 5-7.

$HP_{GC} = 49 \text{ mm Hg}$

$\pi_{GC} = 20 \text{ mm Hg}$

$K_f = 5 \text{ ml/min/mm Hg}$

$HP_{BS} = 11 \text{ mm Hg}$

$\pi_{BS} = 0 \text{ mm Hg}$

$RBF = 720 \text{ ml/min}$

$HCT = 50\%$

HP_{GC} = hydrostatic pressure

K_f = coefficient of filtration

π = oncotic pressure

RBF = renal blood flow

GC = glomerular capillary

HCT = hematocrit

BS = Bowman's space

5. Calculate the net filtration pressure from the above data:
- A. 11 mm Hg
 - B. 12 mm Hg
 - C. 18 mm Hg
 - D. 35 mm Hg
 - E. 40 mm Hg
6. Using the data given above, calculate the glomerular filtration rate.
- A. 80 ml/min
 - B. 90 ml/min
 - C. 100 ml/min
 - D. 115 ml/min
 - E. 125 ml/min
7. Using the data given above, which of the following might occur during subsequent administration of an angiotensin II receptor antagonist?
- A. $GFR = 75 \text{ ml/min}$
 - B. $RBF = 500 \text{ ml/min}$
 - C. $HP_{BS} = 10 \text{ mm Hg}$
 - D. $K_f = 4 \text{ ml/min/mm Hg}$
 - E. filtration fraction = 20%
8. In an isolated perfused kidney, if perfusion pressure was increased from 120 mmHg to 145 mmHg,
- A. there will be a decrease in afferent arteriolar resistance.
 - B. the clearance of PAH would increase by about 25% at the new steady state.
 - C. renin secretion from the kidneys would increase.
 - D. the glomerular filtration rate would decrease by about 10% at the new steady state.
 - E. urinary sodium excretion would increase.

9. The fasting plasma glucose concentration in a patient is found to be 160 mg%. If the GFR is 125 ml/min and the renal transport maximum for glucose in this patient is 300 mg/min, at what rate is glucose being excreted in the urine?
- A. 0 mg/min
 - B. 100 mg/min
 - C. 200 mg/min
 - D. 300 mg/min
 - E. 400 mg/min
10. If the plasma glucose concentration in the above patient rises to 400 mg% (and the GFR remains constant), what would be the rate of urinary glucose excretion?
- A. 0 mg/min
 - B. 100 mg/min
 - C. 200 mg/min
 - D. 300 mg/min
 - E. 400 mg/min
11. Which of the following does NOT contribute to the formation of maximally concentrated urine?
- A. active NaCl transport in the proximal convoluted tubule
 - B. active NaCl transport in the thick ascending limb of the loop of Henle
 - C. impermeability of the thick ascending limb of the loop of Henle to water
 - D. low blood flow in the vasa recta
 - E. presence of urea in the inner medullary interstitium of the kidney
12. An increase in which of the following will result in enhanced urinary sodium excretion?
- A. intrarenal angiotensin II formation
 - B. vasopressin secretion
 - C. circulating catecholamine levels
 - D. renal interstitial hydrostatic pressure
 - E. peritubular capillary oncotic pressure
13. After eating a diet low in sodium for a period of 5 days, which of the following would NOT occur?
- A. Urinary sodium excretion on day 5 will be less than on day 1.
 - B. Renal sympathetic nerve activity will be elevated on day 5.
 - C. The extracellular fluid volume will be reduced on day 5.
 - D. Intrarenal angiotensin II levels will be elevated on day 5.
 - E. The plasma sodium concentration will be reduced on day 5.

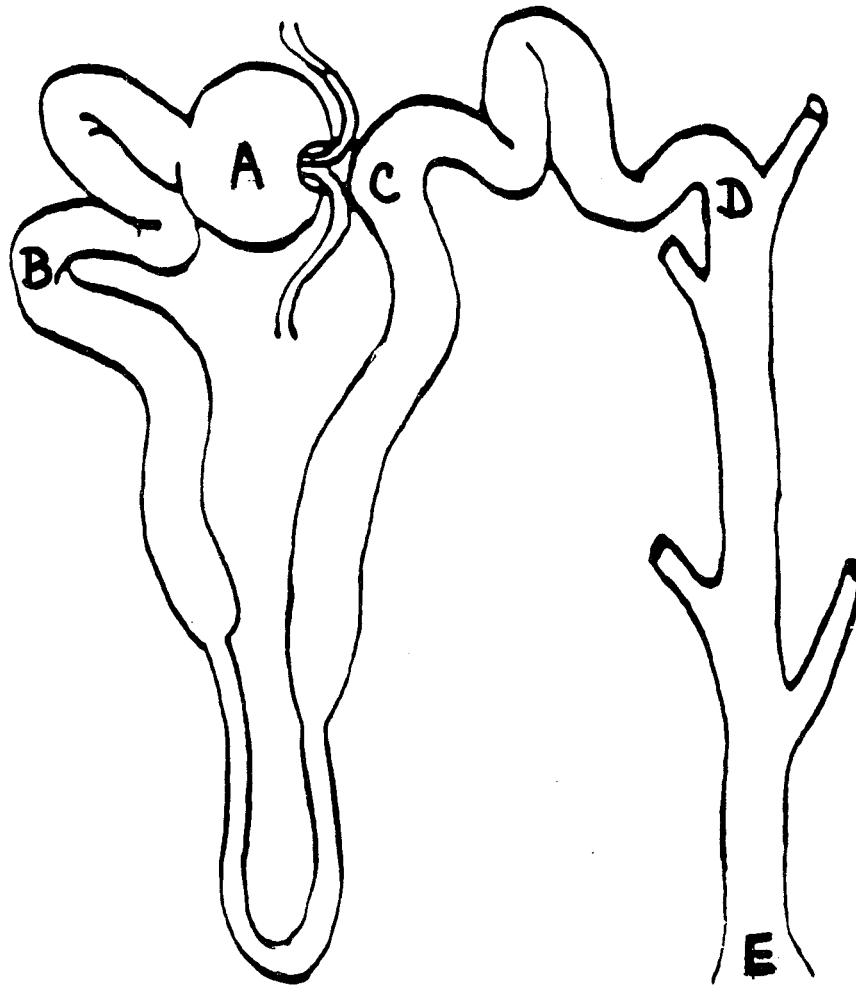
Questions 14-16 refer to the information below:

A renal micropuncture experiment is performed on an anesthetized rat in which fluid is obtained with glass micropipettes from a specific segment of the nephron. Analyses of the tubular fluid and the rat's plasma reveal the following:

	Tubular Fluid	Plasma
Inulin	100 mg%	50 mg %
Sodium	150 mM	150 mM
Chloride	143 mM	110 mM

14. Using the above information, from which nephron segment was the fluid obtained?
- A. Bowman's space
 - B. Proximal convoluted tubule
 - C. Thick ascending limb of the loop of Henle
 - D. Cortical collecting tubule
 - E. Information is insufficient to determine nephron site
15. The rate of tubular fluid flow at the point of puncture was found to be 15 nl/min. Using the above information, the single nephron glomerular filtration rate (SNGFR) is:
- A. 15 nl/min
 - B. 30 nl/min
 - C. 50 nl/min
 - D. 100 nl/min
 - E. 100 ml/min
16. Using the above information, what percent of the filtered chloride load was reabsorbed up to the point of puncture?
- A. 0%
 - B. 25%
 - C. 35%
 - D. 50%
 - E. 65%
17. Select the FALSE statement.
- A. Parathyroid hormone increases renal calcium reabsorption.
 - B. Parathyroid hormone decreases renal phosphate reabsorption.
 - C. An increase in dietary phosphate decreases the T_m for phosphate reabsorption.
 - D. Most of the filtered calcium is passively reabsorbed.
 - E. Most of the filtered phosphate is passively reabsorbed.

For Questions 18-23. The illustration below represents a nephron of a person who has been water restricted for 12 hours and fed a normal diet. Answer questions 16-21 by selecting the most appropriate nephron site. Each segment may be used once, more than once, or not at all.



18. Which segment is permeable to water but not urea in the presence of ADH?
19. Which segment is the primary site of water reabsorption?
20. At which site would the tubule fluid creatinine concentration be **LOWEST**?
21. At which site would the tubule fluid osmolality be **LOWEST**?
22. Which segment participates in the feedback regulation of GFR by sensing changes in the composition of tubular fluid?
23. Which segment is the primary site of action of aldosterone?

For Questions 24-28. A renal function study was performed on a patient. At 8:00 a.m. a continuous intravenous infusion of inulin, PAH, substance X, and substance Y was begun. At 9:00 a.m. the patient emptied her bladder, urinating 180 ml. At 10:30 a.m. a venous blood sample was obtained and measurements are made of the four substances. At noon the patient again empties her bladder completely, urinating 360 ml. The following results were obtained.

	<u>Urine Concentration</u>	<u>Plasma Concentration</u>
Inulin	2,000 mg %	40 mg %
PAH	500 mg/ml	2 mg/ml
Substance X	240 mEq/L	4 mEq/L
Substance Y	1.5 mM	2.5 mM

24. The rate of excretion of Substance X is:
 - A. 0.02 mEq/min
 - B. 0.24 mEq/min
 - C. 0.48 mEq/min
 - D. 14.4 mEq/min
 - E. 240 mEq/min
25. Assuming Substance X is freely-filtered, the clearance of Substance X is:
 - A. 50 ml/min
 - B. 60 ml/min
 - C. 100 ml/min
 - D. 120 ml/min
 - E. 480 ml/min
26. Select the **FALSE** statement regarding Substance X.
 - A. The clearance of Substance X is greater than the clearance of inulin.
 - B. The clearance of Substance X is less than the clearance of PAH.
 - C. The amount of Substance X excreted exceeds the amount filtered.
 - D. Substance X underwent net reabsorption.
 - E. Substance X could be potassium.
27. You are told that 40% of Substance Y is bound to plasma proteins. Calculate the rate of filtration (filtered load) of Substance Y.
 - A. 0.10 mmol/min
 - B. 0.15 mmol/min
 - C. 0.25 mmol/min
 - D. 1.5 mmol/min
 - E. 2.5 mmol/min

28. The fractional excretion of Substance Y is:
- A. 1%
 - B. 2%
 - C. 3%
 - D. 4%
 - E. 5%
29. Select the **FALSE** statement regarding potassium transport in the cortical collecting tubule.
- A. Potassium is actively transported across the basolateral membrane.
 - B. Potassium entry into the tubule lumen is increased by a rise in tubular fluid flow rate.
 - C. Potassium channels are located in the luminal membrane.
 - D. Potassium reabsorption is stimulated by increased dietary potassium.
 - E. Potassium secretion is stimulated by an increase in blood pH.
30. In a 70 kg individual with normal acid/base balance, the **amount** of bicarbonate (HCO_3^-) in the extracellular fluid is approximately
- A. 240 mEq
 - B. 330 mEq
 - C. 670 mEq
 - D. 1 Eq
 - E. 2.4 Eq
31. Select the **FALSE** statement regarding NH_4^+ secretion.
- A. Glutamine is the major source of NH_3 production.
 - B. NH_4^+ can be transported into the tubular lumen via the Na^+-H^+ exchanger.
 - C. NH_4^+ can be transported out of the tubular lumen together with Na and 2Cl^- .
 - D. NH_3 is freely diffusible into and out of the tubule.
 - E. NH_4^+ is freely diffusible into and out of the tubule.
32. Production of NH_3 by the kidney
- A. provides the body with 2 molecules of HCO_3^- for every 2 molecules of NH_3 formed.
 - B. provides the body with 2 molecules of HCO_3^- for every 2 NH_4^+ ions excreted.
 - C. occurs mainly in the collecting tubules.
 - D. is increased during metabolic alkalosis.
 - E. is limited by the amount of filtered phosphate.

33. Which factor will enhance proximal tubular reabsorption of HCO_3^- ?
- A. an expanded extracellular volume
 - B. dopamine
 - C. parathyroid hormone
 - D. angiotensin II
 - E. an arterial pCO_2 of 30 mmHg
34. The 24 hour urinary excretion of phosphate is 25 mmol. The ratio of $\text{HPO}_4^{2-}/\text{H}_2\text{PO}_4^-$ in plasma at pH 7.4 is 4:1. At a urinary pH of 6.8 (the pK^1 of $\text{HPO}_4^{2-}/\text{H}_2\text{PO}_4^-$) how much H^+ in the form of H_2PO_4^- was secreted by the kidney?
- A. 5 mmol
 - B. 7.5 mmol
 - C. 12.5 mmol
 - D. 20 mmol
 - E. 25 mmol
35. Which of the following does NOT contribute to titratable acid when found in the urine?
- A. H_2PO_4^-
 - B. lactic acid
 - C. beta-hydroxybutyric acid
 - D. acetoacetic acid
 - E. NH_4^+
36. Which of the following would NOT contribute to an increased anion gap in the serum of a patient with metabolic acidosis?
- A. phosphate
 - B. sulfate
 - C. lactate
 - D. chloride
 - E. acetoacetate
37. The immediate compensation for acute respiratory acidosis is
- A. buffering by HCO_3^- .
 - B. H^+ excretion by the kidney.
 - C. increased HCO_3^- excretion by the kidney.
 - D. intracellular shift of H^+ in exchange for Na^+ and K^+ .
 - E. decreased HCO_3^- excretion by the kidney.

38. The following blood values were obtained from a patient:

PCO ₂	70 mmHg
HCO ₃ ⁻	36 mEq/L
pH	7.33

These would most likely indicate

- A. acute respiratory acidosis.
 - B. chronic respiratory acidosis.
 - C. acute metabolic acidosis.
 - D. chronic metabolic acidosis.
 - E. renal tubular acidosis.
39. Quantitatively, the major consequence of hydrogen ion secretion by the kidney is
- A. formation of titratable acid.
 - B. reabsorption of filtered HCO₃⁻.
 - C. generation of new HCO₃⁻.
 - D. excretion of NH₄⁺.
 - E. secretion of HCO₃⁻.
40. A 40 year old woman complains of weakness for 1 year. Serum electrolytes (in mEq/L) are:

Na	137	pH	7.48
K	3.1	BP	160/100 mmHg
Cl	90		
HCO ₃	32		

She is found to have an adrenal tumor. Select the **FALSE** statement.

- A. She has a metabolic alkalosis produced by glucocorticoids and/or mineralcorticoids.
- B. The acid/base disorder can be improved by restriction of dietary sodium.
- C. The acid/base disorder is associated with extracellular volume contraction.
- D. The acid/base disorder is associated with increased urinary potassium excretion.
- E. The acid/base disorder is associated with generation of excess HCO₃⁻ in the collecting tubules.

41. The release of LH by the pituitary gland is **NOT** influenced by
- A. dopaminergic neurons.
 - B. endorphin containing neurons.
 - C. adrenergic neurons.
 - D. GnRH neurons.
 - E. prolactin-producing neurons.
42. In the control of anterior pituitary hormone secretion, oxytocin is to dopamine as
- A. vasopressin is to CRF.
 - B. GHRH is to somatostatin.
 - C. TRH is to VIP.
 - D. LHRH is to inhibin.
 - E. somatostatin is to growth hormone.
43. Stimulation of the medial preoptic nucleus of the hypothalamus results in the
- A. secretion of growth hormone.
 - B. release of prolactin.
 - C. inhibition of prolactin secretion.
 - D. secretion of LH.
 - E. secretion of ACTH.
44. Growth hormone acts to
- A. lower blood glucose levels.
 - B. increase circulating levels of amino acids.
 - C. stimulate somatostatin secretion.
 - D. inhibit lipolysis.
 - E. decrease somatomedin production.
45. The above action of growth hormone (question #44) is an example of
- A. the catabolic effect of GH.
 - B. the anabolic effect of GH.
 - C. the hypoglycemic effect of GH.
 - D. short-loop feedback.
 - E. ultrashort-loop feedback.

46. A patient with Sheehan's syndrome will **NOT** likely suffer from diabetes insipidus because
- A. the anterior pituitary is spared from damage.
 - B. the superior hypophyseal artery maintains blood pressure.
 - C. of low perfusion pressure in the long portal veins.
 - D. the inferior hypophyseal artery blood flow remains intact.
 - E. the short portal vessels are unaffected.
47. Dwarfism does **NOT** result from
- A. hypothyroidism.
 - B. prepubertal activation of the hypothalamic LHRH pulse generator.
 - C. low IGF-1 levels.
 - D. low prepubertal levels of testosterone.
 - E. high prepubertal levels of estrogen.

FOR QUESTIONS 48-50. A previously sexually active 30 year old male patient presents to his physician with gynecomastia and galactorrhea (milky discharge from the breast). He complains of decreased libido and difficulty maintaining an erection since the development of the gynecomastia.

48. The primary disorder in the patient likely results from
- A. decreased parasympathetic nervous function.
 - B. a pituitary tumor.
 - C. Klinefelter's syndrome.
 - D. Kallmann's syndrome.
 - E. androgen resistance syndrome.
49. The agent responsible for the patient's condition is demonstrating
- A. a lack of long-loop negative feedback.
 - B. a receptor defect.
 - C. short-loop feedback.
 - D. decreased nerve conduction velocity.
 - E. a chromosomal abnormality.
50. Which of the following drugs could be used to treat the cause of the condition in the patient?
- A. bromocriptine
 - B. an opiate antagonist
 - C. LHRH
 - D. testosterone
 - E. acetylcholine

51. Administration of a cyclic AMP inhibitor will **NOT** block the action of:
- A. LHRH
 - B. LH
 - C. FSH
 - D. TSH
 - E. PTH
52. Administration of FSH would be beneficial for a patient with
- A. Klinefelter's syndrome.
 - B. an LHRH-secreting tumor.
 - C. with undescended testes.
 - D. polycystic ovarian disease.
 - E. an aromatase enzyme deficiency.
53. Administration of a progesterone antagonist could
- A. stimulate the secretory activity of the uterine glands.
 - B. induce an abortion.
 - C. increase the viscosity of cervical mucus.
 - D. inhibit the development of the ducts of the breast.
 - E. increase basal body temperature.
54. Which of the following would **NOT** be found on nuclear chromatin?
- A. 17β -estradiol
 - B. dihydrotestosterone
 - C. thyroxine
 - D. 5α -reductase
 - E. Vitamin D
55. Destruction of the paraventricular nucleus of the hypothalamus would result in
- A. a decrease in LHRH secretion.
 - B. a decrease in dopamine secretion.
 - C. elevation of plasma prolactin levels.
 - D. a decrease in GH secretion.
 - E. a decrease in ACTH levels.

FOR QUESTIONS 56-63. A 5-year-old boy was referred to Georgetown's Endocrine Clinic at the insistence of a preschool nurse who had noted the boy's large size (height = 131cm, 6 standard deviations [SD] above mean, weight = 70 lbs, 6 SD above mean), deep voice, acne, purple striae, pubic hair, enlarged penis, and hair growth on upper lip. Although the penis was enlarged, the testes were normal in size for his age. His LH and FSH levels were unmeasurable, but his ACTH levels were elevated. His serum sodium was 155 mEq/L and potassium was 3.0 mEq/L. The patient was obese, hypertensive, and slow to reestablish a normal blood glucose level after receiving an oral glucose challenge (tolerance test). Although he was seen during the winter, this Caucasian patient had an unusually good tan.

56. The most likely *all-inclusive* diagnosis for this patient is
- A. Addison's disease.
 - B. Cushing's syndrome.
 - C. Cushing's disease.
 - D. precocious puberty.
 - E. adrenogenital syndrome.
57. The above patient's ACTH levels were elevated due to
- A. altered aldosterone secretion.
 - B. adrenal enzyme deficiency.
 - C. a pituitary tumor.
 - D. low cortisol levels.
 - E. increased testosterone secretion.
58. The patient's electrolyte levels are best explained by
- A. diminished cortisol secretion.
 - B. diminished aldosterone secretion.
 - C. diminished aldosterone and diminished cortisol secretion.
 - D. increased aldosterone and decreased cortisol secretion.
 - E. elevated cortisol secretion.
59. The patient's glucose level is slow to recover from an oral glucose challenge primarily because
- A. growth hormone secretion is decreased.
 - B. insulin secretion is increased.
 - C. glucagon secretion is diminished.
 - D. somatostatin secretion is low.
 - E. cortisol secretion is increased.

60. The original cause of this patient's excessive virilization is
- A. precocious puberty due to a hypothalamic tumor.
 - B. a steroid enzyme deficiency.
 - C. excessive androgen secretion by the testis.
 - D. inadequate cortisol secretion.
 - E. a pituitary tumor.
61. Which of the following has nothing to do with the boy's tan?
- A. CRF
 - B. proopiomelanocortin
 - C. ACTH
 - D. MSH
 - E. a pituitary tumor
62. The patient's unmeasurable gonadotropin levels are due to the fact that
- A. he is prepubertal.
 - B. the gonadotropes have been destroyed.
 - C. he has Kallmann's syndrome.
 - D. he has excessive estrogen secretion.
 - E. he has excessive testicular androgen secretion.
63. The best treatment for this patient's condition would be to
- A. administer cortisol.
 - B. remove the adrenal glands.
 - C. irradiate the pituitary gland.
 - D. administer bromocriptine.
 - E. give metyrapone.
64. Vitamin D synthesis is NOT regulated by
- A. serum phosphate.
 - B. PTH.
 - C. 1,25-(OH)₂-vitamin D.
 - D. calcitonin.
 - E. the liver.
65. Which of the following is NOT associated with primary hyperparathyroidism?
- A. hypercalcemia
 - B. increased osteoclastic activity
 - C. kidney stones
 - D. muscle weakness
 - E. hyperphosphatemia

66. In the condition of undescended testes (cryptorchidism), the only cellular failure is one to produce viable spermatozoa; consequently you would expect that
- A. testosterone production is low.
 - B. LHRH levels are low.
 - C. LH levels are low.
 - D. inhibin levels are high.
 - E. FSH levels are high.
67. Which of the following does NOT stimulate insulin secretion?
- A. increased β -cell levels of cAMP
 - B. increased β -cell levels of calcium
 - C. increased blood amino acid levels
 - D. α -adrenergic activation
 - E. glucagon
68. A dietary deficiency of iodine will
- A. result in the formation of triiodothyronine.
 - B. increase the secretion of TSH.
 - C. cause exophthalmos.
 - D. increase the basal metabolic rate.
 - E. increase cardiac contractility.
69. Which of the following is NOT a characteristic of a myxedematous patient?
- A. high or low levels of TSH
 - B. dry skin
 - C. infiltration of the skin with mucopolysaccharides
 - D. fatigue
 - E. heat intolerance
70. Which of the following does NOT favor breast milk secretion?
- A. prolactin
 - B. oxytocin
 - C. VIP
 - D. low levels of estrogen, progesterone, and cortisol
 - E. high levels of estrogen and progesterone

71. Type I diabetes may be caused by
- A. ketoacidosis.
 - B. excess α cells of the pancreas.
 - C. autoimmune processes.
 - D. down-regulation of insulin receptors.
 - E. obesity.
72. Which of the following would **NOT** be included in an evaluation of a man with a macroadenoma of the pituitary?
- A. a cortrosyn (ACTH) stimulation test
 - B. a visual field test
 - C. T_4, T_3 uptake
 - D. testosterone
 - E. TSH
73. A cortrosyn stimulation test shows cortisol levels to be 3.0ug/dL at time 0, 8.0ug/dL at 30 minutes, and 7.5ug/dL at 60 minutes. This is consistent with:
- A. Cushing's syndrome
 - B. hyperaldosteronism
 - C. adrenal insufficiency
 - D. pheochromocytoma
 - E. adrenal adenoma
74. Which of the following is **NOT** associated with prolactinomas?
- A. amenorrhea, infertility
 - B. gynecomastia in men
 - C. response to dopamine agonists
 - D. compromised vision
 - E. breast cancer
75. Concerning bone, which does **NOT** typically occur in advanced age?
- A. relative widening of the bone marrow cavity
 - B. a decrease in cortical bone
 - C. fusion of epiphyseal plates
 - D. widening of the Haversian canals
 - E. a reduction in water content

76. Osteoblastic participation in bone resorption involves
- A. direct dependance on calcitonin.
 - B. transforming growth factor-beta.
 - C. secretion of plasmin by osteoclasts.
 - D. each osteoblast developing a ruffled border.
 - E. the presence of fluoride ion in bone crystals.
77. Regarding bone formation or destruction, which group has the correct temporal sequence?
- A. fusion of epiphyseal plates, adult androgen level, skeletal maturation
 - B. bone-derived growth factor II, osteogenin, somatomedin C
 - C. osteocyte, osteoblast, monocyte
 - D. monocyte, osteoclast, secretion of alkaline phosphatase
 - E. change in cell shape, secretion of protons, secretion of proteases
78. Which would slow gastric emptying after a large dinner?
- A. the ileogastric reflex
 - B. if the dinner were rich in carbohydrates
 - C. transection of the vagus nerve
 - D. an alkaline duodenal pH
 - E. antral systole
79. Which occurs during the pharyngeal stage of swallowing?
- A. occlusion of the teeth
 - B. respiration
 - C. the soft palate assumes a vertical position
 - D. descent of the epiglottis
 - E. closure of the eustachian tube
80. The gallbladder is least likely to concentrate
- A. bile salts.
 - B. lecithin.
 - C. cholesterol.
 - D. calcium.
 - E. bile pigments.

81. Which would **NOT** delay or diminish the absorption of glucose after a meal rich in dairy products and starch?
- A. the presence of alpha-dextrinase
 - B. a high galactose content of the meal
 - C. absence of an intestinal sodium-linked carrier
 - D. a deficiency of lactase
 - E. secretion of cholecystokinin
82. Select the **FALSE** statement concerning the colon.
- A. Body potassium is conserved in diarrhea.
 - B. Tactile stimulation by the luminal contents increases mucus secretion.
 - C. Its enterocytes secrete bicarbonate.
 - D. Enteric reflexes stimulate its goblet cells to secrete mucus.
 - E. Its bacteria acidify the interior of the feces.
83. Secretin
- A. greatly enhances pancreatic enzyme secretion by CCK.
 - B. greatly inhibits HCO_3^- secretion.
 - C. speeds gastric emptying.
 - D. greatly increases bile acid secretion.
 - E. and CCK use the same second messenger system.
84. Which is the correct sequence that fatty acids and monoglycerides go through before being absorbed?
- A. micelle formation/penetration of the unstirred layer/emulsion formation
 - B. emulsion formation/micelle formation/penetration of the unstirred layer
 - C. micelle formation/emulsion formation/penetration of the unstirred layer
 - D. emulsion formation/penetration of the unstirred layer/micelle formation
 - E. penetration of the unstirred layer/micelle formation/emulsion formation
85. Select the **FALSE** statement. The migrating myoelectric complex (MMC) is
- A. propagated in part by the enteric nervous system.
 - B. dependent on the vagi.
 - C. a means of removing intestinal bacteria.
 - D. present from the stomach through the ileum.
 - E. similar to a mass movement in that both extend for a considerable distance.

86. Which of the following is/are generally absorbed through sodium-dependent transport?
- A. short-chain fatty acids
 - B. amino acids
 - C. vitamin B₁₂
 - D. fructose
 - E. vitamin A
87. Which is the most important factor(s) affecting water movement through the gastrointestinal epithelium?
- A. oligosaccharide movement
 - B. an amino-acid transporter
 - C. basolateral Na/K ATPase
 - D. an apical chloride channel
 - E. carbonic anhydrase
88. After many hours of intense exercise, while you are very thirsty, which is **LEAST** likely to have occurred?
- A. a change in hematocrit
 - B. cellular dehydration
 - C. gastric histamine release
 - D. dryness of the mouth
 - E. anti-diuretic hormone (ADH) secretion
89. The primary factor determining the rate of bile acid and bile salt formation by hepatocytes is
- A. the amount of fat entering the duodenum.
 - B. the plasma secretin level.
 - C. the activity of bacterial metabolism in the colon.
 - D. the adequacy of the lymphatic circulation in the gastrointestinal tract.
 - E. the amount of bile salts absorbed from the ileum.
90. Protein digestion
- A. is begun in the stomach by both HCl and trypsin.
 - B. would be severely impaired by removal of the colon.
 - C. increases when the gastrocolic reflex is stimulated.
 - D. occurs primarily in the ileum.
 - E. involves pancreatic enzymes such as carboxypeptidase B and elastase.

91. Which is most effective in propelling chyme through the small intestine?
- A. peristalsis
 - B. segmentation
 - C. slow waves, the basic electrical rhythm (BER)
 - D. the pressure exerted by chyme leaving the stomach
 - E. smoothing out of the haustrae
92. The defecation reflex is triggered by
- A. rectal distention.
 - B. increased pressure on the external anal sphincter.
 - C. release of norepinephrine from pelvic sympathetic neurons.
 - D. the migrating myoelectric complex (MMC).
 - E. relaxation of the internal anal sphincter.
93. Following absorption into an enterocyte, which binds rapidly to a non-enzymatic cell protein?
- A. bicarbonate
 - B. sodium
 - C. iron
 - D. fructose
 - E. chloride
94. Parietal cell secretion of acid is **NOT** stimulated by
- A. carbonic anhydrase activity.
 - B. the "short pathway".
 - C. the parasympathetic nervous system.
 - D. intestinal "D" cells.
 - E. antral "G" cells.
95. The composition of saliva most closely resembles that of plasma when
- A. the parasympathetic nervous system is stimulated.
 - B. the sympathetic nervous system is stimulated.
 - C. the flow rate of the secretion is low.
 - D. meat is eaten.
 - E. there is increased secretion of dimeric IgA.

96. Carbohydrate digestion
- A. in the colon converts starch to small oligosaccharides.
 - B. in the small intestine occurs by a single enzyme.
 - C. in the stomach ends when HCl inactivates alpha-amylase.
 - D. is rarely so abnormal as to be clinically important.
 - E. provides appreciable substrate for colonic bacteria.
97. Fats are transported from the enterocyte to the blood primarily in the form of
- A. micelles.
 - B. chylomicrons.
 - C. monoglycerides.
 - D. free fatty acids.
 - E. triglycerides.
98. In the stomach, receptive relaxation is caused by
- A. chyme in the intestine.
 - B. relaxin.
 - C. a decrease in motilin.
 - D. entry of food.
 - F. gastric inhibitory peptide.
99. Which does/do NOT favor skin pigmentation?
- A. sex hormones
 - B. melatonin
 - C. melanocyte-stimulating hormone
 - D. the ability of basal cells to synthesize a specific protein
 - E. light of 300 nm wavelength
100. Keratin or keratinization is NOT involved in
- A. resistance of skin to the passage of weak electric currents.
 - B. the protective function of the skin.
 - C. the ring in the bathtub.
 - D. transepidermal water loss.
 - E. skin pigmentation.
101. Thermal insulation of the body is largely accomplished by constituents of the
- A. stratum corneum.
 - B. deeper layers of the epidermis.
 - C. basement membrane.
 - D. dermis.
 - E. subcutaneous tissue.

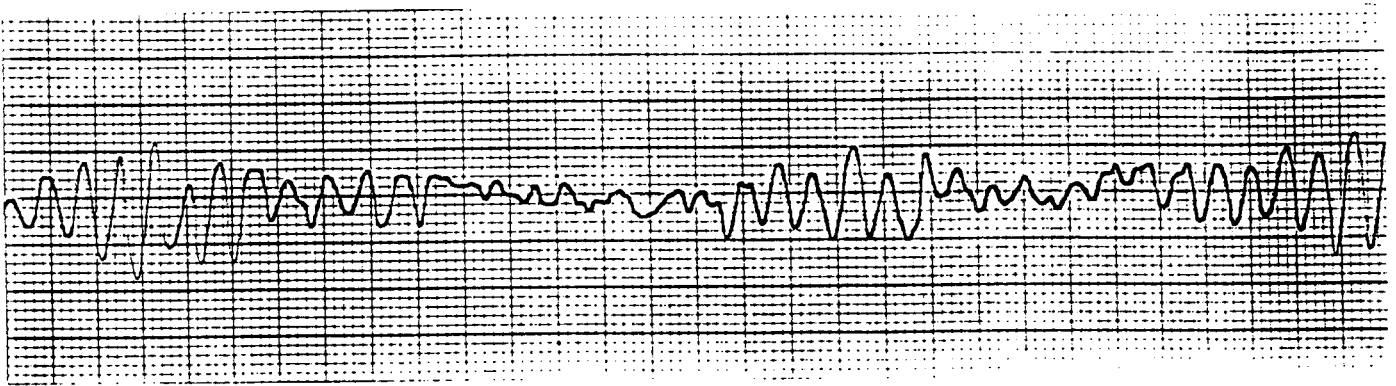
102. Select the **FALSE** statement concerning sweat secretion.
- A. The precursor secretion is produced by the epithelial cells lining the coiled portion of the sweat gland.
 - B. Cholinergic sympathetic nerve fiber activity elicits the precursor secretion.
 - C. The composition of the precursor secretion is similar to plasma except for a protein concentration one-half that of plasma.
 - D. The precursor secretion is modified in the ductal portion of the sweat gland.
 - E. When sweat production is low, most of the sodium and chloride ions are reabsorbed in the ductal portion of the sweat gland.
103. Elevation of the thermoregulatory "set point" from 37°C to 39°C would
- A. result in vasodilation of the cutaneous vessels.
 - B. result in inhibition of sympathetic nerve activity to the cutaneous arteriovenous anastomoses.
 - C. result from local release of prostaglandins in the temperature regulating center of the brain.
 - D. result in increased sympathetic cholinergic nerve activity to the sweat glands.
 - E. be associated with inhibition of shivering.
104. Select the **FALSE** statement. Arteriovenous anastomoses of the cutaneous circulation
- A. shunt blood from the arterioles to the venules.
 - B. have thick muscular walls richly supplied with nerve fibers.
 - C. are highly sensitive to circulating catecholamines.
 - D. are primarily regulated by metabolic factors.
 - E. do not exhibit basal tone.
105. Which of the following would **NOT** occur during severe exercise?
- A. Increased arteriovenous O₂ difference.
 - B. Increased sympathetically-mediated systemic venoconstriction.
 - C. A decrease in total peripheral resistance.
 - D. A shift of the left ventricular function curve downward and to the right.
 - E. A decrease in splanchnic blood flow.
106. Which of the following does **NOT** occur as the result of an endurance training program?
- A. A reduction in resting heart rate.
 - B. An increase in resting stroke volume.
 - C. An increase in maximal heart rate.
 - D. An increase in aortic pulse pressure at rest.
 - E. An increase in maximal O₂ consumption.

107. The limiting factor in exercise performance is
- A. O₂ usage by the skeletal muscles.
 - B. inadequate oxygenation of blood in the lungs.
 - C. a decrease in arterial O₂ content.
 - D. the pumping capacity of the heart.
 - E. the inability to increase pulmonary minute ventilation to sufficient levels.
108. Secretions of the bulbourethral glands constitute a substantial proportion of the
- A. semen.
 - B. epididymal fluid.
 - C. pre-ejaculatory fluid.
 - D. prostatic fluid.
 - E. seminal vesicle secretion.
109. In a normal healthy male, the final propulsion of semen from the internal urethra to the outside is most directly a result of
- A. a spinal reflex.
 - B. parasympathetic nervous system activity.
 - C. sympathetic nervous system activity.
 - D. voluntary motor activity.
 - E. neurohumoral secretion.
110. Which aspect of the human sexual response is **NOT** primarily a result of an alteration of regional blood flow and the consequent vasocongestion?
- A. clitoral enlargement
 - B. emission
 - C. penile erection
 - D. vaginal lubrication
 - E. sexual flush

111. Select the **TRUE** statement concerning fluid balance in a systemic capillary.

- A. Filtration exceeds reabsorption when interstitial fluid hydrostatic pressure exceeds capillary hydrostatic pressure.
- B. Edema often occurs when albumin synthesis by the liver is reduced.
- C. Reabsorption exceeds filtration when hydrostatic pressure in the capillary is greater than the oncotic pressure.
- D. In protein malnutrition, interstitial oncotic pressure exceeds capillary oncotic pressure.
- E. Fluid movement out of the capillary is inversely proportional to the surface area of the capillary.

For Question 112 refer to the following electrocardiogram:



112. This patient is in:

- A. sinus rhythm with a heart rate of 10 beats/min.
- B. sinus rhythm with a heart rate of 94 beats/min.
- C. atrial fibrillation
- D. ventricular fibrillation
- E. A-V block

113. The resting membrane potential (V_m) of a normal cell is -75 mV. Assuming a normal distribution of ions across this membrane, which of the following statements is most likely:

- A. $V_m = E_K$
- B. $I_K = 0$
- C. $I_K + I_{Na} = 0$
- D. $V_m = E_{Na}$
- E. $G_{Na} = G_K$

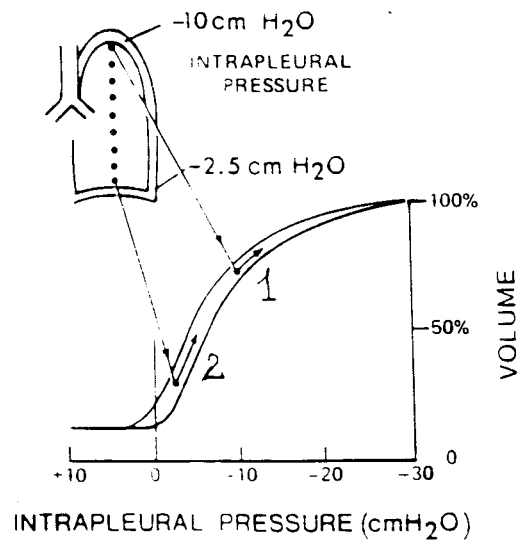
114. In the cardiac cycle, which of the following occur simultaneously?
- A. rapid active filling of the ventricles, the third heart sound, the QRS complex of the ECG
 - B. atrial a wave, closure of the mitral valve, isometric relaxation of the ventricles
 - C. first heart sound, atrial c wave, isometric contraction of the ventricles
 - D. second heart sound, T wave of the ECG, atrial a wave
 - E. fourth heart sound, dicotic notch, atrial c wave
115. Blood flow in a small segment of artery is 4 ml/sec. If the diameter is decreased by one-half without a change in the pressure gradient, the flow becomes:
- A. 0.25 ml/sec
 - B. 0.50 ml/sec
 - C. 1.0 ml/sec
 - D. 2.0 ml/sec
 - E. 16.0 ml/sec
116. Select the **FALSE** statement. Markedly decreased oxygen tension in systemic arterial blood.
- A. activates carotid and aortic chemoreceptors.
 - B. causes a reflex systemic vasoconstriction.
 - C. increases afferent vagal activity.
 - D. causes vasodilation in the pulmonary bed.
 - E. increases sympathetic nerve activity.
117. A premature newborn weighing 900 grams is brought by MEDIVAC helicopter to the neonatal intensive care unit. The child is cyanotic. During administration of 100% oxygen with a respirator, the arterial blood gases are:

$\text{PaO}_2 = 120 \text{ mmHg}$
 $\text{PaCO}_2 = 65 \text{ mmHg}$
 $\text{pH} = 7.26$
 $\text{HCO}_3 = 28 \text{ mEq/L}$

Select the **FALSE** statement.

- A. The probable cause of the condition is lack of surfactant.
- B. The infant has no tissue hypoxia.
- C. Measurements will reveal an increased FRC.
- D. The very large (A-a) O_2 gradient is due to shunt.
- E. The infant has acute respiratory acidosis.

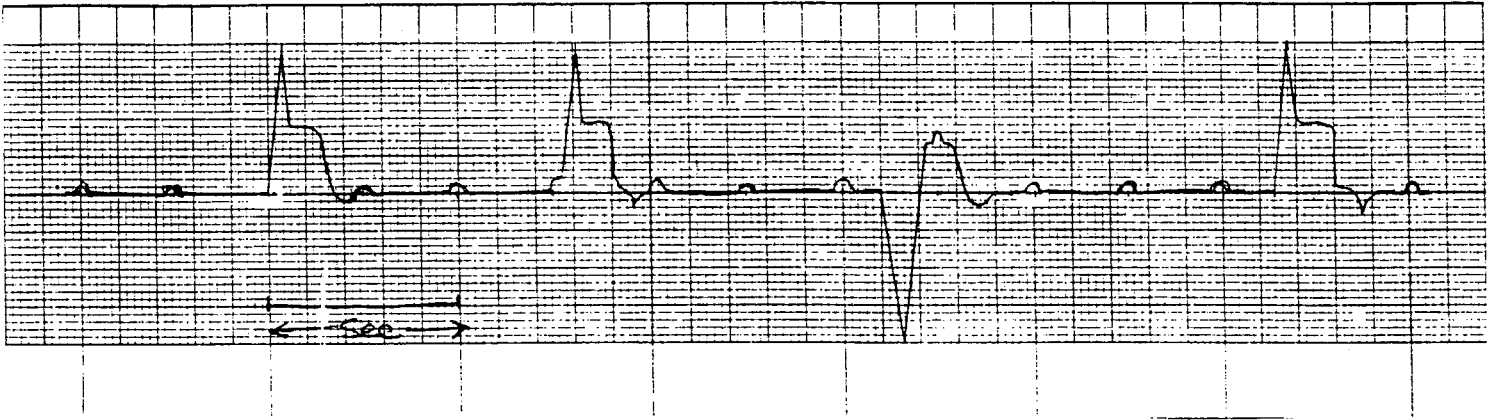
118. Using the following diagram, select the **FALSE** statement.



- A. Ventilation is less at 1 than at 2.
- B. Compliance is less at 2 than at 1.
- C. Elastic recoil pressure is higher at 1.
- D. The difference would be abolished in total water immersion.
- E. The arrows in 1 and 2 represent the PV changes in an area of the lung.

Questions 119-123 are based on the case given below.

A 67 year old male is admitted to the emergency room with severe chest pains. He has a long history of hypertension. He had two previous heart attacks and since the second one six months ago he is short of breath after moderate exertion. On admission he is cold and clammy to the touch, BP is 110/75 and the pulse is 45 and irregular.



119. The ECG shows evidence of myocardial injury (elevated S-T segment) and all of the following, **EXCEPT**:
- A. an inverted T wave
 - B. third degree heart block
 - C. a sinus rate of 120
 - D. a premature ventricular contraction (PVC)
 - E. evidence of increased vagal tone to the SA node
120. Based on the ECG, history and physical exam, a diagnosis is made of acute myocardial infarction with left ventricular heart failure. Select the **FALSE** statement.
- A. The shortness of breath is due to congestion of the lung.
 - B. Left atrial pressure will be elevated.
 - C. Left ventricular end-diastolic pressure will be elevated.
 - D. The cardiac index will be increased.
 - E. The lung will be less compliant.

121. After a few minutes a Swann-Ganz catheter (double lumen) is threaded into the pulmonary artery and wedged. The pressure is 20 mmHg. Select the **FALSE** statement:
- A. The pressure measured is indicative of left atrial pressure.
 - B. Slight withdrawal of the (unwedging) catheter will enable us to measure pulmonary arterial pressure.
 - C. Sampling of the pulmonary arterial blood will enable us to determine mixed venous blood gases.
 - D. The wedge pressure is consistent with reduced left ventricular contractility.
 - E. Pulmonary blood volume is reduced.
122. The patient has great difficulty breathing and is very short of breath. The findings of the chest X-ray are consistent with pulmonary edema. Select the **FALSE** statement:
- A. The patient would benefit from being in the sitting position.
 - B. The patient would benefit from a reduction in left ventricular preload.
 - C. The patient most likely would have hypoxemia.
 - D. The patient should have a large alveolar-arterial oxygen gradient because of fluid in the lung.
 - E. Because of diffusion barrier, the PaCO_2 should be markedly elevated.
123. The patient's condition improves within two hours after vigorous and appropriate treatment. Arterial blood gases show:

PaO_2 = 130 mmHg
 PaCO_2 = 32 mmHg
pH = 7.46
 HCO_3 = 23 mEq/L

Select the **FALSE** statement:

- A. The patient is hyperventilating.
- B. The patient is receiving oxygen therapy.
- C. There will be some cerebral vasoconstriction.
- D. The patient has metabolic alkalosis.
- E. The bicarbonate levels are compatible with an acute disorder.

CONGRATULATIONS, IT'S OVER

MESSAGE BOARD

- I. Did you remember to:
 - A. Write in and grid in your 5-digit (**ONLY 5 DIGITS!!!**) student identification number on the answer sheet (upper left).
 - B. Print you name on the answer sheet (upper right).
 - C. Indicate whether you are a medical, graduate, or GEM student.
- II. Please raise your hand when you have completed the exam. A **COURSE EVALUATION QUESTIONNAIRE** and the **INSTRUCTOR QUESTIONNAIRES** will be brought to you to fill out. Please take time to fill them out as your perception of the teachers and the course content is important to us in our ongoing efforts to improve the course.

**HAPPY HOLIDAYS AND HAVE A RELAXING SPRING BREAK,
YOU EARNED IT!!!**

REVISED

HUMAN PHYSIOLOGY
ANSWER KEY
FINAL EXAM
MARCH 31, 1994

REVISED

1. D
2. D
3. B
4. E
5. C
6. B
7. E
8. E
9. A
10. C
11. A
12. D
13. E
14. B
15. B
16. C
17. E
18. D
19. E
20. A
21. C
22. C
23. D
24. C
25. D
26. D
27. B
28. B
29. D
30. B
31. E
32. B
33. D
34. B
35. E
36. D
37. D
38. B
39. B
40. C
41. E
42. B

43. D
44. C
45. D
46. D
47. D
48. B
49. C
50. A
51. A
52. D
53. B
54. D
55. E
56. C
57. C
58. E
59. E
60. E
61. A
62. B
63. C
64. D
65. E
66. E
67. D
68. B
69. E
70. E
71. C
72. E
73. C
74. E
75. C
76. C
77. E
78. A
79. D
80. D
81. A
82. A
83. A
84. B

85. B
86. B
87. C
88. C
89. E
90. E
91. B
92. A
93. C
94. D
95. A
96. C
97. B
98. D
99. B
100. E
101. E
102. C
103. C
104. D
105. D
106. C
107. D
108. C
109. A
110. B
111. B
112. D
113. C
114. C
115. A
116. D
117. C
118. B
119. E
120. D
121. E
122. E
123. D

Mean 70 ± 10