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

HUMAN PHYSIOLOGY

FINAL EXAMINATION

THURSDAY, APRIL 18, 1996

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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**) on the line provided on the answer sheet.

5. Write **MED, GRAD, GEM or ANESTH** next to your name.

6. In the box marked "Student I.D. Number" write your **5-digit identifying number. DO NOT WRITE IN YOUR SOCIAL SECURITY NUMBER! Darken** the corresponding number box.

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 kidney?

A. secretion of renin
B. secretion of erythropoietin
C. regulation of potassium homeostasis
D. regulation of creatinine production
E. activation of vitamin D

2. The loops of Henle of outer cortical nephrons

A. are longer than those of juxtamedullary nephrons.
B. do not contribute to the inner medullary osmotic gradient.
C. do not contribute to the renal conservation of sodium.
D. do not participate in the urinary diluting mechanism.
E. do not reabsorb urea.

3. If the clearance of a substance divided by the clearance of inulin (C_X/C_{IN}) is <u>greater</u> than 1.0, then this means the substance

A. is not secreted nor reabsorbed.
B. is filtered and completely reabsorbed.
C. is filtered and completely secreted.
D. underwent net reabsorption.
E. underwent net secretion.

4. A person's GFR is determined to be 150 L/day and his plasma creatinine concentration was 1 mg%. Over the next 12 month period his plasma creatinine concentration rose to 3 mg%. Assuming his daily rate of creatinine production did not change during that year, what would you estimate his GFR to be at the end of the year?

A. 5 L/day
B. 15 L/day
C. 30 L/day
D. 50 L/day
E. 150 L/day

5. The plasma threshold for glucose

A. is the minimal plasma concentration at which glucose reabsorption begins.
B. is the minimal plasma concentration at which glucose reabsorption ceases.
C. is the minimal plasma concentration at which glucose excretion begins.
D. is the minimal plasma concentration at which glucose excretion ceases.
E. is the maximal plasma concentration at which the renal transport maximum is reached.

Use the values below for questions 6-8.

HP_{GC} = 56 mmHg π_{GC} = 21 mmHg K_f = 4 ml/min/mmHg
HP_{BS} = 12 mmHg π_{BS} = 0 mmHg RBF = 800 ml/min
HCT = 40%

HP_{GC} = hydrostatic pressure
π = oncotic pressure
GC = glomerular capillary
BS = Bowman's space
K_f = coefficient of filtration
RBF = renal blood flow
HCT = hematocrit

6. Calculate the net filtration pressure from the following data:

A. 5 mmHg
B. 12 mmHg
C. 23 mmHg
D. 28 mmHg
E. 65 mmHg

7. Using the data given above, calculate the glomerular filtration rate.

A. 88 ml/min
B. 92 ml/min
C. 100 ml/min
D. 125 ml/min
E. 180 ml/min

8. Using the data given above, calculate the filtration fraction (to the nearest percent).

A. 19%
B. 20%
C. 23%
D. 25%
E. 29%

9. Using the data given above, which of the following might occur immediately following removal of one kidney?

A. RPF = 400 ml/min
B. HP_{GC} = 54 mmHg
C. π_{BS} = 2 mmHg
D. K_f = 2 ml/min/mmHg
E. filtration fraction = 33%

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

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

11. Select the **FALSE** statement regarding urea.

A. It is the end-product of protein metabolism.
B. Its clearance is less than inulin clearance.
C. Its concentration in plasma can vary with dietary protein.
D. Its concentration in plasma will rise with an increase in GFR.
E. It undergoes recycling in the inner medulla.

12. Compared to plasma, tubular fluid in the late proximal tubule normally has a

A. sodium concentration that is approximately 20% lower.
B. chloride concentration that is approximately 30% higher.
C. lower concentration of creatinine.
D. lower concentration of urea and a higher concentration of potassium.
E. pH that is more alkaline.

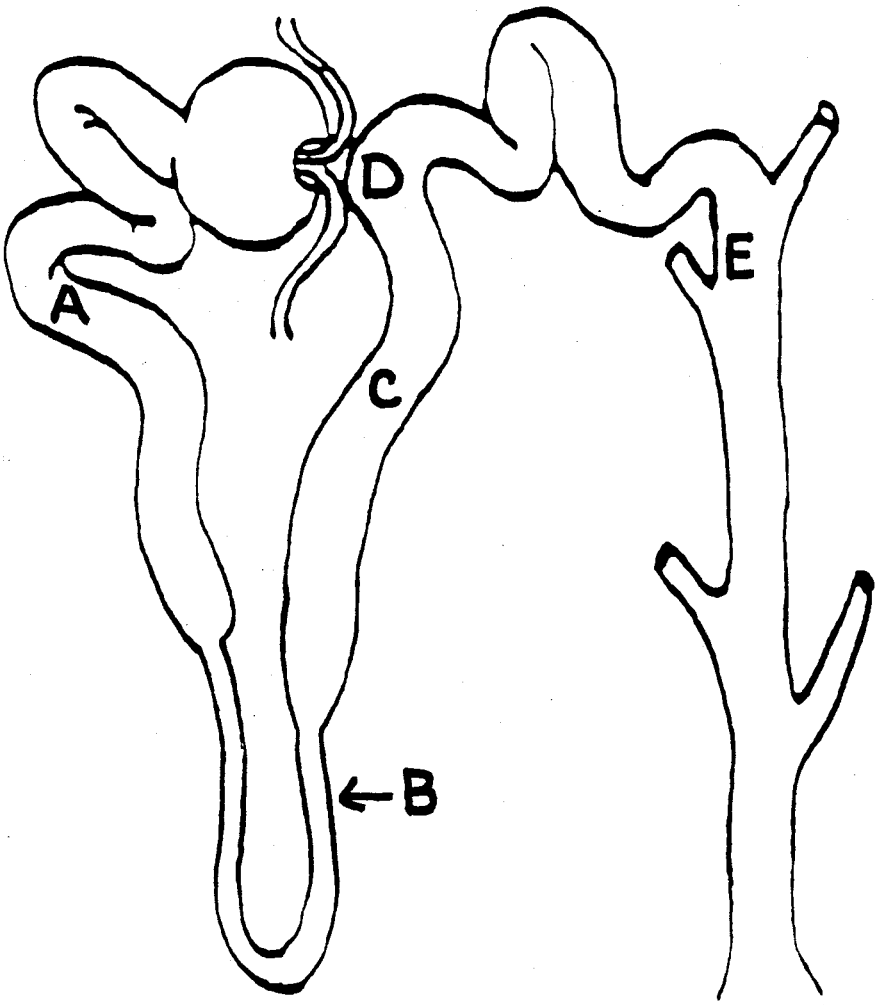
13. Which of the following will **NOT** occur following administration of a loop diuretic such as furosemide?

A. There will be an increase in both sodium and potassium excretion.
B. Urine flow will increase.
C. The ability to generate a positive free water clearance will be reduced.
D. Water reabsorption in the descending limb of Henle's loop will be reduced.
E. The osmolarity of tubular fluid entering the distal convoluted tubule will be reduced.

14. For the following question consider the normal range of tubular function and neglect the possible effects of drugs. Compared to plasma, tubular fluid entering the distal tubule is

A. isoosmotic at all times.
B. hyperosmotic at all times.
C. hypoosmotic at all times.
D. can be isoosmotic, hyperosmotic, or hypoosmotic.
E. hyperosmotic or isoosmotic, but never hypoosmotic.

FOR QUESTIONS 15-19 SELECT THE MOST APPROPRIATE NEPHRON SITE (A-E) SHOWN BELOW. EACH SEGMENT MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.



15. At which site would secretion of bicarbonate occur during alkalosis?

16. At which site would the tubule fluid sodium concentration be higher than in the interstitial space?

17. At which site would penicillin be secreted?

18. Which segment is a major tubular site of action of angiotensin II?

19. Which site is involved in tubulo-glomerular feedback control of GFR?

20. Which of the following combinations of values would lead you to suspect that a patient had the "syndrome of inappropriate ADH secretion" (SIADH)?

	Plasma Osmolarity mOsm/Kg H_2O	**Plasma [Na^+]** mEq/L	**Urine Osmolarity** mOsm/Kg H_2O
A.	293	142	647
B.	265	126	52
C.	323	152	180
D.	265	126	595
E.	300	145	152

21. Licorice contains a steroid, glycyrrhetinic acid, that has mineralocorticoid activity. Which of the following would **NOT** occur in individuals chronically ingesting large amounts of licorice?

A. metabolic acidosis
B. decreased sodium excretion
C. increased extracellular fluid volume
D. hypokalemia
E. hypertension

22. In the absence of ADH, which of the following would **NOT** occur?

A. diuresis
B. washout of the medullary interstitial osmotic gradient
C. dilution of fluid leaving the thick ascending limb of Henle's loop by the active sodium transport in the cortical collecting tubule
D. the inner medullary collecting duct becomes impermeable to urea
E. a decrease in urea excretion

23. Expansion of the extracellular fluid volume results in an increase in urinary sodium excretion. Which of the following would **NOT** explain the resulting natriuresis?

A. An increase in peritubular capillary oncotic pressure.
B. An increase in renal interstitial hydrostatic pressure.
C. An increase in peritubular capillary hydrostatic pressure.
D. An increase in the glomerular filtration rate.
E. An increase in medullary blood flow.

24. Person A has an osmolar (total solutes) excretion rate of 1500 mOsm/day in 3 liters of urine and has a plasma osmolarity of 300 mOsm/Kg H_2O. Person B has an osmolar excretion rate of 1200 mOsm/day in 2 liters of urine and has a plasma osmolarity of 300 mOsm/Kg H_2O. Select the **TRUE** statement.

A. Person A is excreting a more concentrated urine.
B. Person B is reabsorbing more "solute-free" water than person A. 3
C. Both individuals have the same free water clearance.
D. Both individuals have the same osmolar clearance (Cosm).
E. Plasma ADH is higher in person A than in person B

USE THE INFORMATION BELOW FOR QUESTIONS 25-29.
The following laboratory results are obtained from a patient over a 24 hour period:
Urine volume = 720 ml HCT = 50%

	Urine Concentration	Plasma Concentration
Inulin	2,500 mg/ml	25 mg/ml
PAH	1,200 mg/ml	2 mg/ml
Sodium	75 mM	150 mM
Calcium	7.5 mM	2.5 mM

25. The effective renal plasma flow is

A. 150 ml/min
B. 300 ml/min
C. 400 ml/min
D. 500 ml/min
E. 600 ml/min

26. The rate of sodium filtered is

A. 0.3 mmol/min
B. 3.0 mmol/min
C. 7.5 mmol/min
D. 15 mmol/min
E. 75 mmol/min

27. The fractional excretion of sodium is

A. 0.5%
B. 1.0%
C. 1.5%
D. 2.0%
E. 3.0%

28. The total amount of calcium excreted (over 24 hours) is

A. 3.2 mmol
B. 4.5 mmol
C. 5.4 mmol
D. 7.5 mmol
E. 15 mmol

29. The fractional excretion of calcium is

A. 1%
B. 2%
C. 3%
D. 4%
E. 5%

30. After eating a diet high in sodium for a period of 5 days, which of the following will **NOT** occur?

A. Urinary sodium excretion on day 5 will be greater than day 1.
B. Renal sympathetic nerve activity will be reduced on day 5.
C. Levels of atrial natriuretic factor in plasma will be elevated on day 5.
D. The plasma sodium concentration will be elevated on day 5.
E. The extracellular fluid volume will be increased on day 5.

31. Select the **FALSE** statement.

A. An increase in dietary potassium will increase renal potassium secretion.
B. High distal tubular flow will increase potassium excretion.
C. Potassium reabsorption in the proximal tubule is an example of secondary active transport.
D. The tubular maximum (Tm) for phosphate reabsorption is reduced by parathyroid hormone.
E. More phosphate is reabsorbed in the S_1 than S_3 segment of the proximal tubule.

32. Select the **FALSE** statement regarding the renal handling of calcium.

A. The kidneys normally reabsorb >98% of the filtered calcium load.
B. The concentration of calcium in Bowman's space is less than in plasma.
C. Most of the filtered calcium is passively reabsorbed.
D. Parathyroid hormone increases calcium reabsorption in the proximal tubule.
E. Extracellular volume contraction will reduce urinary calcium excretion.

33. Which one of the following is **NOT** commonly associated with the clinical syndrome of uremia?

A. metabolic acidosis
B. weakness
C. anemia
D. anorexia and taste disturbance
E. hypotension

34. What would be the body's first response to ingestion of an acid (such as acetic acid)?

A. extracellular buffering
B. hyperventilation
C. intracellular buffering with phosphates
D. intracellular buffering with bicarbonate
E. increased renal ammonium production

35. Which of the following will **NOT** increase the tubular secretion of hydrogen ions?

A. an increase in arterial PCO_2
B. extracellular volume contraction
C. an increase in aldosterone secretion
D. increased circulating levels of angiotensin II
E. hyperkalemia

36. The urinary excretion of phosphate in a patient is found to be 50 mmol in a 24 hour period. If the patient's urine pH was 6.8, how much H^+ was secreted by the kidney and buffered by $HPO_4^=$? (At pH 7.4, the ratio of $HPO_4^=/H_2PO_4^-$ is 4:1)

A. 7.5 mmol
B. 12.5 mmol
C. 15 mmol
D. 20 mmol
E. 25 mmol

For questions 37-38 use the information given below.

As part of the requirement for joining a particular fraternity, a young college student is forced to consume an unknown liquid. A few hours later this otherwise normal individual begins to hyperventilate. He feels nauseous and weak and is taken to the emergency room. Analysis of his blood reveals a pH of 7.22 and a plasma bicarbonate concentration of 12 mEq/L.

37. This person's condition is most likely

A. metabolic acidosis.
B. metabolic alkalosis.
C. respiratory acidosis.
D. respiratory alkalosis.
E. combined respiratory and metabolic acidosis.

38. In reference to the individual above (#37), it is also determined that this person's anion gap (in plasma) is within the normal range. Which of the following substances was most likely ingested?

A. aspirin (acetyl salicylic acid)
B. bicarbonate of soda ($NaHCO_3$)
C. sodium chloride
D. ammonium chloride
E. phosphoric acid

For questions 39-41 select the most likely diagnosis (choices A-E) for each of the following serum chemistries (39-41).

A. chronic renal failure
B. diarrhea
C. diabetic ketoacidosis
D. lactic acidosis
E. respiratory acidosis

39.

Na^+	138	mEq/L
K^+	5.4	mEq/L
Cl^-	102	mEq/L
HCO_3^-	15	mEq/L
PCO_2	30	mmHg
pH	7.32	
Creatinine	7.5	mg/dl
Glucose	130	mg/dl

40.

Na^+	138	mEq/L
K^+	4.0	mEq/L
Cl^-	114	mEq/L
HCO_3^-	15	mEq/L
PCO_2	30	mmHg
pH	7.32	
Creatinine	1.5	mg/dl
Glucose	130	mg/dl

41.

Na^+	138	mEq/L
K^+	5.6	mEq/L
Cl^-	102	mEq/L
HCO_3^-	15	mEq/L
PCO_2	30	mmHg
H^+	50	nEq/L
Creatinine	1.5	mg/dl
Glucose	130	mg/dl

42. As a result of a rise in ammonium production by the renal tubular cells and its excretion in the urine, more

A. titratable acid is excreted.
B. hydrogen ions are reabsorbed.
C. phosphate is excreted.
D. sodium is excreted.
E. bicarbonate is generated.

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43. The concentration of oxytocin is highest in the

A. anterior pituitary gland.
B. systemic circulation.
C. posterior pituitary.
D. the portal veins of the pituitary.
E. inferior hypophysial artery.

44. A temporary blockade of the blood flow through the portal blood vessels of the pituitary will

A. increase growth hormone secretion.
B. increase ACTH release.
C. dilute hypothalamic hormone concentrations.
D. increase prolactin secretion.
E. suppress vasopressin secretion.

45. Destruction of the paraventricular nuclei of the hypothalamus will reduce the secretion of

A. ACTH and vasopressin.
B. prolactin and LH.
C. growth hormone and prolactin.
D. TSH and FSH.
E. oxytocin and estrogen.

46. Chronic stress causes a suppression of

A. ACTH.
B. epinephrine.
C. interleukin-1.
D. testosterone.
E. glucagon.

47. A patient with Sheehan's syndrome would **NOT** have a deficit in the secretion of

A. FSH.
B. prolactin.
C. ACTH.
D. vasopressin.
E. growth hormone.

48. An acromegalic and a LARON dwarf may share the trait of having

A. elevated growth hormone levels in blood.
B. suppressed IGF-1 levels in blood.
C. a pituitary tumor.
D. elevated IGF-1 levels in blood.
E. excessive somatostatin secretion.

49. One mode of hormone synthesis and release involves the modification of hormone X from cell X by adjacent cell Y to produce hormone Y. This mode is typical of

A. testosterone synthesis.
B. vitamin D synthesis.
C. angiotensin synthesis.
D. estrogen synthesis.
E. inhibin synthesis.

50. Steroid hormones have the following in common with peptide hormones.

A. They typically bind to nuclear receptors.
B. They typically bind to plasma membrane receptors.
C. They are lipid-soluble.
D. They have long half-lives in plasma.
E. They may exert negative feedback effects.

51. Insulin is to glucagon as

A. vasopressin is to CRF.
B. GHRH is to growth hormone.
C. ACTH is to MSH.
D. somatostatin is to GHRH.
E. oxytocin is to VIP.

52. Growth hormone is to somatostatin as

A. IGF-1 is to growth hormone.
B. prolactin is to dopamine.
C. LH is to LHRH.
D. ACTH is to CRF.
E. FSH is to inhibin.

53. Anterior pituitary hormone secretion

A. is independent of central nervous system control above the level of the hypothalamus.
B. of only one pituitary hormone is signaled by each hypothalamic-releasing factor.
C. depends on a direct neural connection between the hypothalamus and the anterior pituitary.
D. depends on the release of hypothalamic-releasing factors into the primary capillary plexus in the median eminence.
E. is dependent on the blood supply from the inferior hypophysial artery.

54. Subcutaneous administration of high doses of an LHRH superagonist may be used to prevent the short stature often occurring in girls with precocious puberty. The reason for the effectiveness of such a treatment is that the superagonist

A. upregulates LHRH receptors.
B. causes an increase in testosterone.
C. causes downregulation of LHRH receptors.
D. stimulates LH secretion.
E. stimulates estrogen secretion that in turn stimulates growth hormone release.

55. Ultrashort-loop feedback involves

A. steroid hormones.
B. steroid hormone receptors.
C. the portal blood vessels.
D. axon collaterals.
E. pituitary hormones.

56. Which of the following conditions is **NOT** associated with low FSH levels?

A. Kallmann's syndrome
B. cryptorchidism
C. panhypopituitarism
D. polycystic ovarian disease
E. chronic stress

57. Cortisol is to interleukin-1 as

A. testosterone is to LH.
B. epinephrine is to glucagon.
C. testosterone is to RBCs.
D. estrogen is to the LH surge.
E. vitamin D is to PTH.

58. TSH does **NOT**

A. promote iodine trapping.
B. decrease thyroglobulin iodination.
C. increase the movement of thyroglobulin into follicle cells.
D. increase body temperature.
E. increase the activity of the sympathetic nervous system.

Use the following information for questions 59-62.

A 31 year-old woman started her menstrual periods at age 13. After 15 years of normal menses, her menstrual periods became irregular and finally ceased entirely at age 30. The only other available observation that we have about the patient is that she appears rather virilized with excess body hair. The patient had no other major complaints about her health. Her blood pressure was normal.

59. Given the above information, you would conclude that the patient most likely was suffering from

A. Kallmann's syndrome
B. polycystic ovarian disease.
C. a pituitary tumor.
D. Sheehan's syndrome.
E. adrenogenital syndrome.

60. If blood levels of pituitary hormones had been measured in the above patient, the results would have revealed

A. high FSH and low LH levels.
B. high prolactin levels.
C. high ACTH levels.
D. low ACTH levels.
E. high LH and low FSH levels.

61. The type of cells in the above patient which lacked sufficient stimulation were the

A. granulosa cells.
B. zona reticularis cells.
C. thecal cells.
D. LH secreting cells.
E. luteal cells.

62. The above patient might be successfully treated with

A. bromocriptine.
B. RU 486.
C. clomid.
D. birth control pills.
E. an androgen antagonist.

63. An increase in plasma PTH levels would lead to an increase in

A. the number of active osteoblasts.
B. renal distal tubular reabsorption of Ca^{++}.
C. plasma inorganic phosphate concentration.
D. the reabsorption of phosphate by the kidney.
E. collagen synthesis.

64. Progesterone secretion during the second and third trimesters of pregnancy is a measure of the functional status of the

A. corpus luteum.
B. fetal adrenal gland.
C. fetal pituitary gland.
D. maternal pituitary gland.
E. placenta.

65. The primary site of 1,25-dihydroxycholecalciferol formation from its immediate precursor is the

A. bone.
B. liver.
C. skin.
D. kidney
E. bloodstream.

66. Testosterone does **NOT** have the following property.

A. It is produced by the fetal testis.
B. It becomes inactivated by 5α-reductase.
C. It is an estrogen precursor.
D. It stimulates testicular descent into the scrotum.
E. It stimulates pulses of GH secretion.

67. Which of the following does **NOT** fit with the others?

A. POMC
B. ACTH
C. α-MSH
D. β-endorphin
E. CRF

68. Which one of the following characteristics is NOT shared between an uncontrolled Type I and an uncontrolled Type II diabetic?

A. hyperglycemia
B. increased glucagon secretion
C. decreased number of insulin receptors
D. increased circulating fatty acids
E. the ability of exercising muscle to stimulate glucose uptake

69. Inhibin secretion by the ovary is greatest during

A. the midcycle surge of gonadotropins.
B. the early follicular phase.
C. during pregnancy.
D. during lactation.
E. the mid-luteal phase.

Use the following information for questions 70-72.

A 25 year-old woman with an infant came into the emergency room stating that since giving birth ten months ago, she was lactating frequently, but was unable to become pregnant again, and had mysteriously broken a leg bone while simply climbing an ordinary flight of stairs.

70. You might suspect the overall reason for these problems to be due to

A. excessive PTH secretion.
B. a state of hyperprolactinemia.
C. decreased calcitonin secretion.
D. polycystic ovarian disease.
E. Sheehan's syndrome.

71. The basis for the above patient's infertility is

A. a longloop feedback effect.
B. a drop in blood pressure.
C. a high LH to FSH ratio.
D. dopaminergic inhibition of LHRH.
E. a pituitary tumor.

72. The patient's broken leg is specifically attributable to

A. too much weight gained during pregnancy.
B. the lack of estrogen positive feedback.
C. a state of hyperparathyroidism.
D. increased osteoblastic activity.
E. excess calcium in blood.

73. Abnormally high glucocorticoid levels are **NOT** associated with

A. decreased protein synthesis.
B. gluconeogenesis.
C. inhibition of growth hormone secretion.
D. increased white blood cell activity.
E. hyperglycemia.

74. Which of the following has the **LEAST** influence over water metabolism?

A. aldosterone
B. vasopressin
C. atrial natriuretic factor
D. oxytocin
E. hyperglycemia

75. Which of the following enhances TSH secretion?

A. Grave's disease
B. availability of iodine in the diet
C. increased activity of 5'-monodeiodinase in the pituitary
D. administration of somatostatin
E. increased presence of thyroxine-binding globulin

76. Which of the following is **NOT** regulated by somatostatin directly?

A. insulin
B. glucagon
C. growth hormone
D. IGF-1
E. TSH

77. An 11- beta hydroxylase deficiency in the adrenal gland may result in

A. the adrenogenital syndrome.
B. Cushing's disease.
C. Cushing's syndrome.
D. suppressed ACTH secretion.
E. testicular feminization.

78. Which is **LEAST** likely to favor the healing of a fracture of the left leg in a 28 year-old woman?

A. demineralization of her right leg since her accident
B. a pH of 7.6 at the fracture site
C. the flow of ions across the endosteum at the fracture site
D. her having run five miles a day, five days a week for two years
E. osteoblastic deposition of type I collagen

79. Which does **NOT** promote osteoclastic formation or function?

A. monoblasts or monocytes
B. carbonic anhydrase
C. transforming growth factor-beta
D. IL-1
E. osteoblasts

80. Select the FALSE statement. Bone mass

A. has its peak deposition in infancy.
B. would be expected to increase when stress increases the flow of interstitial fluid past osteoblasts.
C. of the mother tends to diminish during pregnancy.
D. decreases in old age.
E. decreases when some bone cells develop a ruffled border.

81. In the small intestine, peristaltic waves of contraction

A. involve contraction stimulated by tachykinin proximal to the bolus.
B. cannot occur in the absence of parasympathetic innervation.
C. involve receptive relaxation immediately proximal to the bolus of food.
D. occur primarily in response to chemical stimuli from digested chyme.
E. proceed in both directions from their site of origin.

82. A wrestler trying to "make weight" finds that he is a few grams over. In an attempt to lose the extra grams of weight, he sucks on a hard candy to induce copious salivation. The saliva he spits out

A. contains IgD.
B. contains a peptidase that initiates protein digestion.
C. is regulated primarily by sympathetic stimulation.
D. is relatively rich in sodium and poor in potassium.
E. is only under intrinsic regulation.

83. Gastric secretion of H^+

A. decreases in concentration with increasing gastric juice flow rate.
B. comes from chief cells.
C. is enhanced by carbonic anhydrase inhibitors.
D. is exchanged for lumenal sodium.
E. is regulated in part by the number of H^+/K^+ pumps.

84. For patients who do not respond to medical interventions for peptic ulcer disease, a complete removal of the gastric antrum may be considered. This would decrease gastric acid production by

A. reducing pepsinogen production by one-half.
B. reducing the number of parietal cells by approximately one-half.
C. eliminating the source of ACh.
D. eliminating a source of gastrin.
E. eliminating the source of histamine.

85. Gastric emptying is decreased by

A. increased discharge of nitric oxide.
B. decreased gastrin production.
C. increased CCK production.
D. neural discharge via the parasympathetics.
E. decreased secretin production.

86. Secondary bile acids

A. are derivatives of bilirubin.
B. are formed by conjugation of a bile acid with glycine or taurine.
C. are formed by bacterial deconjugation and dehydroxylation of bile acids in the intestines.
D. are incorporated into mixed micelles in the gallbladder.
E. do not enter the enterohepatic circulation.

87. The concentration of sodium remains constant regardless of the flow rate in

A. salivary secretions.
B. gastric secretions.
C. pancreatic secretions.
D. hepatic secretions.
E. intestinal secretions.

88. Which of the following is essential for the absorption of glucose?

A. salivary amylase
B. enterokinase
C. Na^+-K^+ ATPase
D. secretin
E. sucrase

89. Select the **TRUE** statement regarding protein digestion and absorption.

A. Protein digestion begins in the intestines by pancreatic proteases.
B. Each amino acid has a specific carrier.
C. Amino acid absorption into the enterocyte occurs through facilitated diffusion.
D. Brush border proteases degrade oligopeptides down to di- and tri-peptides and amino acids.
E. The majority of protein absorption occurs in the distal jejunum.

90. Select the **FALSE** statement.

Omitted

A. Removal of the gastric antrum will raise gastric pH.
B. Duodenal pH will be low in a person with chronic pancreatitis.
C. The osmolality of saliva increases as flow increases.
D. Salivary α-amylase is inactive in low pH.
E. Pancreatic proteases are inactive in low pH.

91. A medical student swallowed a very dry piece of meat, which momentarily became wedged in her esophagus. Select the **TRUE** statement.

A. The dry meat would not have stimulated salivary secretion.
B. During the oral stage of deglutition, her upper esophageal sphincter would have been relaxed.
C. Primary esophageal peristalsis was controlled by the swallowing center in the hypothalamus.
D. Secondary esophageal peristalsis to clear the bolus was controlled by the swallowing center in the hypothalamus.
E. During the esophageal stage of deglutition, her upper esophageal sphincter would have been relaxed.

92. Select the **FALSE** statement regarding the basal electrical rhythm (slow waves).

A. Slow waves are hyperpolarized by stretch, ACh, gastrin, and substance P.
B. The rate of the slow waves varies through the G.I. tract.
C. Action potentials are generated on top of the slow waves, and cause the contractions.
D. The BER controls the rate of propulsion of chyme through the intestines.
E. Slow waves are undulations in resting membrane potential caused by variations in Na^+-K^+ ATPase activity.

93. Select the **TRUE** statement regarding gastrointestinal motility.

A. The migrating myoelectric complex is stimulated by ingestion of food.
B. Segmental propulsion through the colon is very slow.
C. During the rectosphincteric reflex, the internal anal sphincter is constricted.
D. Peristalsis pushes chyme over long sections of the intestines.
E. Colonic mass movements are stimulated by secretin.

94. After eating a large meal at the Tombs, a medical student was walking home, and noticed someone following him. He ran all the way home with the stranger trailing him. What is **LEAST** likely to have occurred during this time?

A. An increase in norepinephrine binding in the G.I. tract.
B. A reduction in salivary acinar cell secretion.
C. An increase in gastric acid secretion.
D. A massive intestinal vasodilation.
E. An increase in pyloric sphincter tone.

95. Select the **FALSE** statement. The unstirred water layer lining the gastrointestinal tract

A. protects the mucosa from damage.
B. normally maintains a pH of ~7 next to the epithelial cells.
C. can be penetrated by Helicobacter pylori.
D. can be disrupted during episodes of diarrhea.
E. is readily permeable to amino acids, glucose and lipids.

96. Select the **TRUE** statement

A. Gastrin stimulates pancreatic electrolyte secretions and increases antral motility.
B. Secretin can potentiate the effects of ACh to increase pancreatic enzyme secretion, because they work through the same second messenger system.
C. GIP is secreted in response to fats and glucose and acts to increase HCl secretion and decrease gastric emptying.
D. CCK decreases HCl secretion , and stimulates mass movements in the colon.
E. ACh acts through a cAMP pathway to stimulate pepsinogen secretion in the stomach.

97. Select the **TRUE** statement regarding ion handling by the gastrointestinal tract.

A. Aldosterone administration would have corrected Aminata's hypokalemia.
B. Bicarbonate is secreted into the lumen of both the ileum and the colon as a product of carbonic acid metabolism.
C. Absorption of divalent cations favors a high pH.
D. Calcium enters the enterocytes through passive diffusion.
E. Excess calcium in the intestinal lumen facilitates phosphate absorption.

98. Select the **FALSE** statement. During protein digestion

A. in the enterocyte, cytoplasmic proteases break down di- and tri-peptides into amino acids.
B. pepsinogens are secreted by the chief cells in response to stimulation by gastrin and ACh.
C. trypsin inhibitor is secreted into the hepatic ducts to prevent autodigestion.
D. trypsin activates chymotrypsinogen, trypsinogen, and procarboxypeptidase.
E. peptides in the duodenum stimulate CCK release, which increases gastric HCl.

99. Select the **TRUE** statement.

A. The majority of lipid digestion occurs by salivary and gastric lipases and HCl.
B. Cirrhosis of the liver would have little effect on lipid digestion.
C. Pancreatic lipase alone cannot access emulsions of fat and bile salts.
D. Lipids are digested to triglycerides for absorption.
E. Vitamin D facilitates lipid absorption.

100. The absorption of vitamin B12 (cobalamin) is **NOT** dependent on

A. the salivary secretion of "R-protein".
B. the integrity of the terminal ileum.
C. the enterocyte vitamin B12 concentration.
D. vitamin B12/intrinsic factor binding sites on the enterocyte.
E. secretion of intrinsic factor from gastric parietal cells.

101. Regarding pancreatic endocrine secretions

A. glucagon can increase gastric motility.
B. GIP acts to decrease insulin secretion.
C. GIP acts to increase glucagon secretion.
D. somatostatin has no actions on HCl secretion.
E. insulin can increase gastric motility and gastric secretions.

102. Select the **FALSE** statement regarding gastric secretions.

A. Antral gastrin release is increased by distension of the stomach and vagal stimulation.
B. Pepsinogens are cleaved to pepsins in the acid environment, and begin carbohydrate digestion.
C. Gastric lipase is inactivated in an alkaline environment.
D. Mucus secreted by the surface mucous cells acts to protect the gastric mucosa from the low pH.
E. Somatostatin acts in a paracrine fashion to inhibit HCl secretion, while histamine stimulates HCl secretion.

103. During infection with *Vibrio cholerae*

A. there is a massive parasympathetic discharge.
B. the enterotoxin enters the enterocytes and stimulates cAMP, which increases chloride secretion into the lumen.
C. the enterotoxin enters the enterocytes and poisons the Na/K ATPase pump.
D. plasma sodium concentration is very low.
E. the best treatment is an oral electrolyte solution of sodium chloride.

104. Pancreatic gastrinomas (Zollinger-Ellison syndrome)

A. are associated with hypoacidity of the duodenum.
B. would decrease nutrient absorption because the pancreatic enzymes are destroyed.
C. would decrease secretin secretion.
D. would decrease gastric somatostatin release.
E. would be associated with decreased secretion of gastrin from gastric G-cells.

105. Select the **FALSE** statement regarding carbohydrate digestion.

A. Starch digestion begins in the mouth with salivary α-amylase.
B. Glucoamylase digests maltose to glucose.
C. Isomaltase digests isomaltose to glucose and maltose.
D. Enteropeptidase activates pancreatic α-amylase.
E. Carbohydrate-metabolizing enzymes function best near pH 7.4.

106. An alcoholic man with untreated, chronic pancreatitis would

A. have diarrhea with "rice-water" consistency.
B. have low levels of secretin.
C. secrete normal levels of pancreatic α-amylase.
D. have to depend primarily on salivary and gastric enzymes and HCl for digestion.
E. probably have normal levels of pancreatic ductal trypsin inhibitor.

107. Select the statement which best defines stress. Stress is

A. a nonspecific response of the body to any demand upon it.
B. a series of psychological reactions to any change in homeostasis.
C. a series of neuroendocrine responses elicited by secretion of cortisol.
D. a real or perceived inability of the body to cope with a disturbance in homeostasis.
E. a general activation of the sympatho-adrenomedullary system.

108. Which of the following conditions would **NOT** be expected to enhance the blood pressure response to cold stress?

A. genetic predisposition particularly in African-Americans
B. aging
C. high levels of androgens
D. repeated exposure to the cold stress
E. family history of hypertension

109. Select the **FALSE** statement. Cardiovascular hyperreactivity associated with psychological stress tests (e.g. mental arithmetics) is

A. defined by large increases in total peripheral resistance and/or cardiac output.
B. indicative of future development of coronary heart disease.
C. used to detect existing coronary heart disease.
D. predictive of future development of hypertension in men.
E. dependent on ethnic and sex differences.

110. Select the **FALSE** statement concerning the human female sexual response.

A. The clitoris contains erectile tissue which becomes engorged with blood during sexual excitation.
B. The Bartholin's glands produce a viscous secretion during coitus.
C. The breasts are often enlarged during sexual excitation.
D. During orgasm, rhythmic contraction of vaginal and uterine muscles occurs.
E. The normal pH of the vagina is optimal for motility of sperm.

111. Select the correct temporal sequence of neural activity associated with the following events: ERECTION-EMISSION-EJACULATION.
(SNS = Sympathetic nervous system and PNS = Parasympathetic nervous system)

A. SNS; spinal reflex; PNS
B. SNS; PNS; spinal reflex
C. PNS; spinal reflex; SNS
D. PNS; SNS; spinal reflex
E. spinal reflex; SNS, PNS

112. A post-menopausal woman complains of poor vaginal lubrication and mild discomfort during coitus. Which hormonal deficiency might account for these symptoms?

A. adrenal androgens
B. testicular androgens
C. progesterone
D. estradiol
E. corticosterone

For questions 113-116 refer to the diagram below depicting a hypothetical distribution of ions across a typical nerve cell.

OUTSIDE	INSIDE
100 mM Na^+	10 mM Na^+
5 mM K^+	150 mM K^+
10 mM Ca^{++}	0.001 mM Ca^{++}
140 mM Cl^-	50 mM Cl^-

Match the following parameters (113-116) with their appropriate membrane potential values(A-E).

A. +60 mV
B. +69 mV
C. -89 mV
D. -15 mV
E. -27 mV

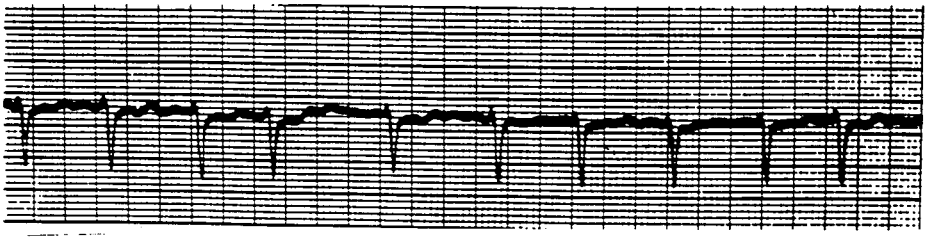
113. The resting membrane potential.

114. The maximal amplitude of an excitatory postsynaptic potential (assume $G_K = G_{Na} = 1$).

115. The maximum amplitude of the action potential.

116. The maximal amplitude of the action potential undershoot.

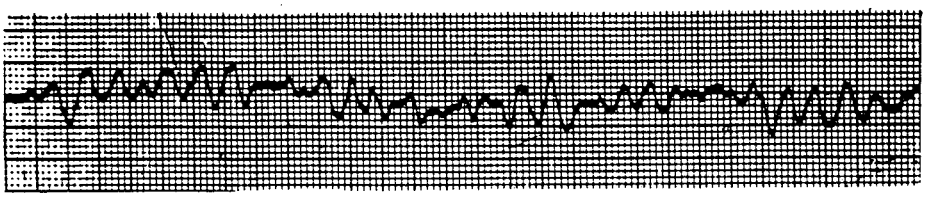
A 35 year-old woman with mitral stenosis (of cardiovascular tutorial fame), suddenly becomes very short of breath. She is taken to the emergency room where the following electrocardiogram is recorded.



117. Select the **FALSE** statement.

A. Her ventricular rate is rapid and irregular.
B. The pacemaker site for the ventricles is located in the Purkinje system.
C. During this rhythm , not all ventricular excitations are accompanied by a radial pulse.
D. Her left atrial pressure is higher than her left ventricular end diastolic pressure.
E. Her arrhythmia can probably be corrected by a single strong electric shock.

A year after the woman above is treated and released from the hospital, she is having an argument with her son when she clutches her chest as if in pain and collapses. When the ambulance arrives, her electrocardiogram is as follows.



118. Select the **FALSE** statement regarding her electrocardiogram.

A. Her venous pressure equals her arterial pressure equals her mean circulatory pressure.
B. Her current arrhythmia may have been caused by local conduction blocks in the ventricle.
C. Her circulating catecholamine level is likely to be higher than normal.
D. Her rhythm was probably initiated by complete AV-block.
E. Her arrhythmia may have been caused by extrasystolies during ventricular repolarization.

119. During administration of an unknown agent, the systolic arterial pressure was found to rise, the ventricular end-diastolic volume was unchanged, and the ventricular end-systolic volume was decreased. The drug was

A. a pure arteriolar constrictor.
B. a systemic venoconstrictor.
C. a positive inotropic agent.
D. a vasoconstrictor with negative inotropic properties.
E. an α-adrenergic agonist.

120. An individual sustains an acute severe hemorrhage. From the possibilities listed below, select the changes in hemodynamic parameters one would expect to occur in this individual.

	Stroke volume	Heart rate	Left ventricular end-diastolic pressure	Systemic systolic pressure	Systemic diastolic pressure	Mean right atrial pressure
(A)	↓	↑	↓	↓	↑	↓
(B)	↑	↑	=	↑	↑	=
(C)	↓	↑	↓	↓	↓	↓
(D)	↑	↓	↑	↑	↑	↑
(E)	↓	↑	↓	↓	↓	↑

121. Select the **FALSE** statement. In the individual above (#120) one would expect

A. capillary hydrostatic pressure to be increased.
B. ventricular end-systolic volume to be decreased.
C. baroreceptor firing rate to be diminished.
D. increased β-adrenergic receptor activation.
E. increased α-adrenergic receptor activation.

122. A patient has a history of 3-4 minutes of chest pain (angina pectoris) occurring spontaneously at rest. Measurements during such an episode show no change in aortic blood pressure or heart rate with a decrease in the O_2 content of the coronary sinus (venous) blood from 6 vol. % to 3 vol. %. From the above information it can be surmised that

A. coronary vascular resistance fell.
B. myocardial O_2 consumption must have risen.
C. coronary vascular resistance remained constant.
D. coronary blood flow decreased.
E. myocardial work decreased.

123. Which is **NOT** related to the stratum corneum?

A. interstitial fluid retention
B. callus formation
C. Langerhans cells
D. abundant keratin
E. a high electrical impedance

A 56 year-old male patient is admitted to the emergency room with shaking chills and a severe cough. The patient states that he has a history of "heart trouble." On physical examination, the patient has a fever (104°F) and looks very ill. The chest X-ray shows extensive pneumonia.

The arterial blood gases are: pH = 7.42
PO_2 = 63 mmHg
PCO_2 = 35 mmHg
HCO_3 = 25 mEq/L

124. Select the **FALSE** statement.

A. The patient has a shunt.
B. The reduction in PO_2 is not primarily due to hypoventilation.
C. The CO_2 production is expected to be increased.
D. The O_2-Hemoglobin dissociation curve is expected to be shifted to the right.
E. The A-a gradient for O_2 is increased.

The patient develops severe shortness of breath and a subsequent determination of arterial blood gases shows:

pH = 7.25
PO_2 = 120 mmHg
PCO_2 = 55 mmHg
HCO_3 = 26 mEq/L

125. Select the **FALSE** statement:

A. The patient has acute respiratory acidosis.
B. The patient is hypoventilating.
C. The patient is receiving O_2.
D. The bicarbonate is not sufficiently high to indicate chronic compensation.
E. The O_2 content will be decreased.

****

IT'S OVER!

FILL OUT YOUR EVALUATION SHEETS AND YOU ARE READY FOR A WELL DESERVED LONG WEEKEND!

HUMAN PHYSIOLOGY

FINAL EXAM ANSWERS

April 18, 1996

1. D
2. B
3. E
4. D
5. C
6. C
7. B
8. A
9. D
10. E
11. D
12. B
13. E
14. C
15. E
16. B
17. A
18. A
19. D
20. D
21. A
22. E
23. A
24. C
25. B
26. C
27. A
28. C
29. E
30. D
31. C
32. D
33. E
34. A
35. E
36. C
37. A
38. D
39. A
40. B
41. D
42. E
43. C
44. D
45. A
46. D
47. D
48. A
49. D
50. E
51. D
52. B
53. D
54. C
55. D
56. B
57. A
58. B
59. B
60. E
61. A
62. C
63. B
64. E
65. D
66. B
67. E
68. C
69. E
70. B
71. D
72. C
73. D
74. D
75. E
76. D
77. A
78. D
79. C
80. A
81. A
82. D
83. E
84. D
85. C
86. C
87. C
88. C
89. D
90. OMITTED
91. C
92. A
93. B
94. D
95. E
96. D
97. B
98. E
99. C
100. C
101. E
102. B
103. B
104. E
105. D
106. D
107. D
108. D
109. C
110. E
111. D
112. D
113. C
114. D
115. A
116. C
117. B
118. D
119. C
120. C
121. A
122. D
123. C
124. ~~B~~ D
125. E