

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

HUMAN PHYSIOLOGY

FINAL EXAMINATION

THURSDAY, APRIL 13, 1995

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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) 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 7-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 kidneys?
  - A. regulation of urea production
  - B. regulation of hydrogen ion balance
  - C. regulation of extracellular osmolality
  - D. regulation of extracellular volume
  - E. excretion of organic acids
  
2. Which of the following substances is NOT released or activated by the kidneys?
  - A. renin
  - B. erythropoietin
  - C.  $1,25(\text{OH})_2$  vitamin D
  - D. vasopressin
  - E. prostaglandin  $\text{E}_2$
  
3. The superficial cortical nephron differs from the juxtamedullary nephron in that
  - A. the glomerulus of the juxtamedullary nephron is located in the outer medulla.
  - B. the superficial nephron lacks a loop of Henle.
  - C. the superficial nephron lacks a juxtaglomerular apparatus.
  - D. the superficial nephron lacks peritubular capillaries.
  - E. the superficial nephron lacks vasa recta.
  
4. Creatinine can be used to measure the glomerular filtration rate because
  - A. essentially all of the creatinine delivered to the kidney (in one pass) is filtered.
  - B. essentially all of the creatinine delivered to the kidney (in one pass) is excreted.
  - C. creatinine is completely secreted by the kidney (in one pass).
  - D. the amount of creatinine excreted is essentially equal to the amount filtered.
  - E. creatinine is neither filtered nor reabsorbed by the kidney.
  
5. A 50 year-old woman with chronic pyelonephritis is unable to concentrate her urine above an osmolality of  $300 \text{ mOsm/kg H}_2\text{O}$ . Through diet and metabolism, she accumulates  $600 \text{ mOsm/day}$  of solute, which must be excreted by the kidneys. Assuming that she takes in about  $500 \text{ ml}$  of water in her food, her daily insensible water loss is  $900 \text{ ml}$  and that her water losses in sweat and feces total  $100 \text{ ml}$  (and neglecting any water produced metabolically), what is the minimum volume of water that she must drink daily to prevent a rise in plasma osmolality?
  - A.  $0.5 \text{ liter}$
  - B.  $1.0 \text{ liter}$
  - C.  $2.0 \text{ liter}$
  - D.  $2.5 \text{ liter}$
  - E.  $3.0 \text{ liter}$
  
6. If the GFR remains constant, a decrease in the urine-to-plasma (U/P) ratio of inulin indicates that
  - A. inulin clearance has decreased.
  - B. free water clearance has increased.
  - C. urine flow has increased.
  - D. osmolar clearance has decreased.
  - E. plasma inulin concentration has increased.

7. Of the following changes in afferent or efferent arteriolar resistances, which would result in an increase in glomerular filtration rate and an increase in filtration fraction?

Afferent Arteriolar Resistance	Efferent Arteriolar Resistance
A. $\leftrightarrow$	$\downarrow$
B. $\downarrow$	$\leftrightarrow$
C. $\uparrow$	$\leftrightarrow$
D. $\downarrow$	$\uparrow$
E. $\uparrow$	$\downarrow$

8. When the plasma concentration of paraaminohippuric acid (PAH) slightly exceeds threshold
- PAH first appears in the urine.
  - the clearance of PAH is less than the inulin clearance.
  - the amount of PAH filtered exceeds the amount secreted.
  - the secretion of PAH ceases because the  $T_m$  for PAH secretion is reached.
  - PAH appears in the renal vein.

USE THE VALUES BELOW FOR QUESTIONS 9-11.

9. Calculate the glomerular filtration rate from the following data:

HPGC = 50 mm Hg	$\pi_{GC} = 22$ mm Hg	$K_f = 5$ ml/min/mm Hg
HPBS = 12 mm Hg	$\pi_{BS} = 0$ mm Hg	RBF = 800 ml/min
		HCT = 50%

HPGC = hydrostatic pressure	$K_f$ = coefficient of filtration	$\pi$ = oncotic pressure
RBF = renal blood flow	GC = glomerular capillary	HCT = hematocrit
BS = Bowman's space		

- 80 ml/min
  - 90 ml/min
  - 100 ml/min
  - 115 ml/min
  - 125 ml/min
10. Using the data given above, calculate the filtration fraction.
- 10%
  - 15%
  - 20%
  - 25%
  - 33%
11. Using the data given above, which of the following might occur during intrarenal infusion of a drug that causes glomerular mesangial cells (but not vascular smooth muscle cells) to contract?
- RBF = 1 L/min
  - HPBS = 15 mm Hg
  - $\pi_{GC} = 25$  mm Hg
  - $K_f = 4$  ml/min/mm Hg
  - filtration fraction = 20%

12. In an isolated kidney, if renal perfusion pressure is reduced from 120 mmHg to 90 mmHg
- renal blood flow will be maintained near control values due primarily to afferent arteriolar vasoconstriction.
  - renin secretion from the kidney would decrease.
  - the clearance of inulin would be maintained near control values.
  - the clearance of PAH would decrease by approximately 30%.
  - urinary sodium excretion would increase.
13. The osmolarity in which of the following nephron segments is always equal to that in the surrounding interstitial fluid?
- thin descending limb of Henle's loop
  - thin ascending limb of Henle's loop
  - thick ascending limb of Henle's loop
  - cortical collecting tubule
  - papillary collecting tubule

FOR QUESTIONS 14 AND 15 USE THE INFORMATION GIVEN BELOW.

14. A patient is admitted to your unit with the following laboratory data:

urine flow =	1 ml/min		
P <sub>Na</sub> =	110 mEq/L	Posm =	250 mOsm/Kg H <sub>2</sub> O
U <sub>Na</sub> =	100 mEq/L	Uosm =	750 mOsm/Kg H <sub>2</sub> O

Calculate the free water clearance.

- 2.0 ml/min
  - 1.0 ml/min
  - + 0.3 ml/min
  - + 3.0 ml/min
  - 30%
15. This patient most likely has
- insufficient intake of sodium.
  - just participated in a prolonged and vigorous exercise
  - a lack of ADH receptors in the collecting tubules
  - chronic excess of antidiuretic hormone
  - chronic deficit of antidiuretic hormone

- 
16. During dehydration
- volume flow out of the vasa recta would normally exceed vasa recta inflow.
  - the inner medullary collecting ducts are impermeable to water.
  - the permeability of the ascending limb of Henle's loop to water is relatively high due to the presence of ADH.
  - recycling of urea in the medulla would be less than during water diuresis.
  - free water clearance would be positive.

FOR QUESTIONS 17-20 REFER TO THE INFORMATION BELOW:

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

	Tubular Fluid	Plasma
Inulin	500 mg%	50 mg %
Sodium	75 mM	150 mM
Potassium	48 mM	4 mM

17. What percent of the filtered sodium load was reabsorbed up to the point of puncture?
- A. 0%
  - B. 5%
  - C. 10%
  - D. 90%
  - E. 95%
18. What percent of the GFR (filtered water) was reabsorbed up to the point of puncture?
- A. 0%
  - B. 5%
  - C. 10%
  - D. 90%
  - E. 95%
19. Using the above information, which of the following statements is TRUE?
- A. More potassium was reabsorbed than sodium.
  - B. The tubule fluid at the point of puncture contains 20% more potassium than was filtered.
  - C. The tubule fluid at the point of puncture contains 120% more potassium than was filtered.
  - D. There is no net secretion of potassium.
  - E. The rat was fed a diet containing very low amounts of potassium.
20. Using the above information, from which nephron segment was the fluid obtained?
- A. Bowman's space
  - B. Proximal convoluted tubule
  - C. Bend of the loop of Henle in the renal medulla
  - D. Thick ascending limb of the loop of Henle
  - E. Cortical collecting tubule
- 
21. Which of the following will result in increased sodium excretion?
- A. increased renal interstitial hydrostatic pressure
  - B. increased renin secretion
  - C. increased peritubular capillary oncotic pressure
  - D. increased renal sympathetic nerve activity
  - E. decreased medullary blood flow

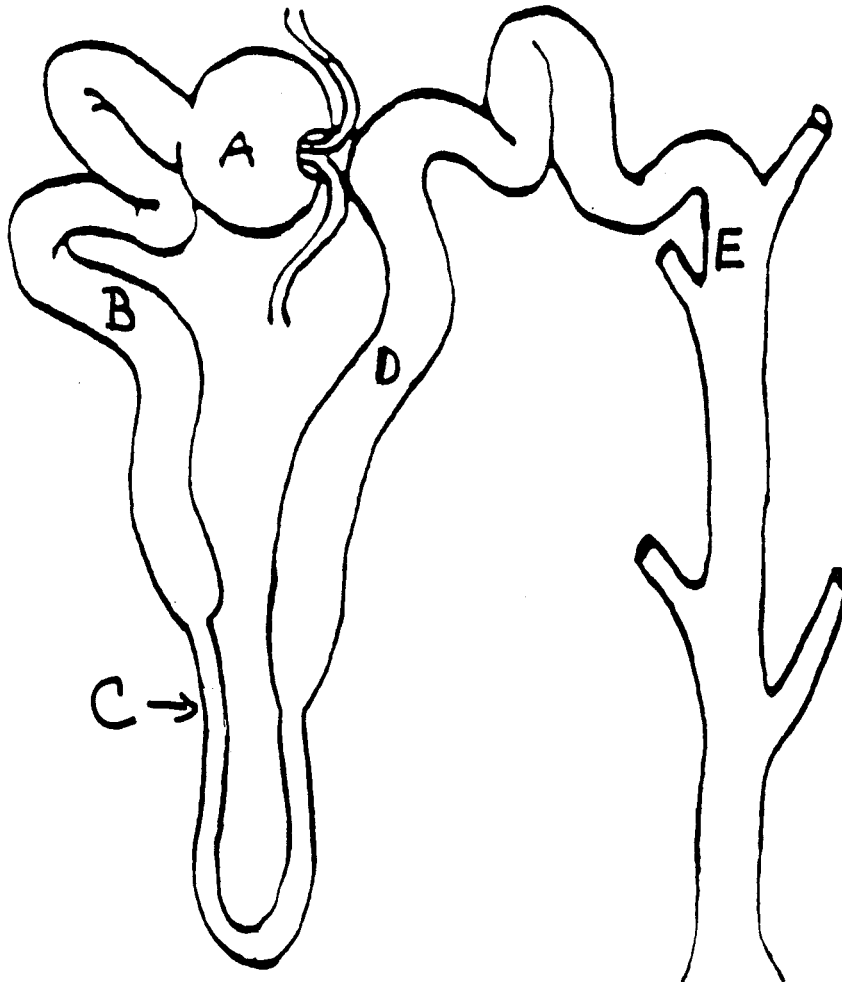
USE THE INFORMATION BELOW FOR QUESTIONS 22 AND 23

A 56 year-old man had a myocardial infarction 4 months ago, and now complains of fatigue and dyspnea. On physical examination he is found to have distended neck veins and pitting edema of the ankles. His breathing is rapid and rales are heard bilaterally at the bases of the lungs. The patient is admitted to the hospital and the following laboratory values are obtained. Blood pressure was 110/70 and heart rate was 95 beats/min. A 24 hour urine collection yielded 500 ml., and the concentrations of creatinine and sodium in the urine were 200 mg/dL and 13 mEq/L, respectively. Concentrations of creatinine and sodium in plasma were 2.0 mg/dL and 130 mEq/L, respectively.

22. Select the FALSE statement regarding this patient.
- A. Both left and right ventricular end-diastolic pressures are elevated.
  - B. His fractional excretion of sodium is 0.1%.
  - C. His glomerular filtration rate is 50 L/D.
  - D. He excreted 65 mEq of sodium in the past 24 hours.
  - E. He has an increase in extracellular fluid volume.
23. Which of the following would NOT be elevated in this patient (compared to a healthy individual)?
- A. plasma angiotensin II levels
  - B. plasma antidiuretic hormone levels
  - C. renal prostaglandin E<sub>2</sub> production
  - D. plasma levels of atrial natriuretic factor
  - E. renal blood flow

- 
24. A patient is found to have an aldosterone-producing of the adrenal gland. Which of the following would NOT occur in this patient?
- A. low plasma levels of renin
  - B. high plasma levels of atrial natriuretic factor
  - C. high rate of urinary potassium excretion
  - D. metabolic alkalosis
  - E. reduced extracellular volume
25. Select the FALSE statement regarding renal potassium secretion.
- A. It is stimulated by high dietary potassium intake.
  - B. It is increased during metabolic acidosis.
  - C. It is stimulated by aldosterone.
  - D. It is increased by a rise in flow of tubular fluid.
  - E. It occurs in the cortical collecting tubule.

FOR QUESTIONS 26-32 SELECT THE MOST APPROPRIATE NEPHRON SITE (A-E) SHOWN BELOW. EACH SEGMENT MAY BE USED ONCE, MORE THAN ONCE, OR NOT AT ALL.



26. Which segment is the primary site of organic acid secretion?
27. Which segment is permeable to water but impermeable to solute?
28. In the absence of ADH, at which of the above sites would the tubule fluid sodium concentration be LOWEST?
29. Assuming the plasma concentration of glucose is below threshold, at which site would the tubule fluid concentration be HIGHEST?
30. At which site would there be passive sodium chloride transport?
31. At which site would the transepithelial potential difference be of greatest magnitude (most lumen negative)?
32. Which segment contains a Na-K-Cl cotransporter?

33. Select the FALSE statement regarding the renal handling of phosphate.
- A. Phosphate transport across the proximal tubule brush border membrane is linked to sodium.
  - B. More phosphate is reabsorbed in the S<sub>1</sub> than S<sub>3</sub> segment of the proximal tubule.
  - C. Parathyroid hormone decreases renal phosphate reabsorption.
  - D. A decrease in dietary phosphate increases the T<sub>m</sub> for phosphate reabsorption.
  - E. Regulation of phosphate homeostasis occurs through changes in the rate of tubular secretion.
34. Select the FALSE statement regarding the renal handling of calcium.
- A. Approximately 40% of plasma calcium is protein-bound and not filtered.
  - B. The daily excretion is 1-2% of the filtered load.
  - C. Calcium reabsorption in the proximal tubule is an example of secondary active transport.
  - D. Parathyroid hormone increases tubular calcium reabsorption.
  - E. An increase in calcium intake leads to an increase in urinary calcium excretion.
35. In a 100 kg individual with normal acid/base balance, the **amount** of bicarbonate (HCO<sub>3</sub>) in the extracellular fluid is approximately
- A. 24 mEq
  - B. 240 mEq
  - C. 330 mEq
  - D. 480 mEq
  - E. 2.4 Eq
36. Most of the H<sup>+</sup> secreted by the tubules is
- A. consumed in the reabsorption of filtered bicarbonate.
  - B. excreted as ammonium ions.
  - C. excreted as titratable acid.
  - D. excreted as free hydrogen ions.
  - E. excreted in the distal nephron.
37. Increased secretion of hydrogen ion is caused by
- A. decrease in pCO<sub>2</sub>.
  - B. decrease in angiotensin II levels.
  - C. volume contraction.
  - D. decrease in aldosterone level.
  - E. carbonic anhydrase inhibitor.



FOR QUESTIONS 38 AND 39 USE THE FOLLOWING DATA.

The following urine values were obtained from a patient with metabolic acidosis.

Titrateable acid	120 mEq/day	Bicarbonate	0
Ammonium	200 mEq/day	pH	5.0

38. The amount of new bicarbonate generated by the kidneys that day was
- A. 0.
  - B. 120 mEq.
  - C. 200 mEq.
  - D. 320 mEq.
  - E. 370 mEq.
39. Which of the following is the most likely explanation for the acidosis?
- A. Proximal renal tubular acidosis
  - B. Distal renal tubular acidosis
  - C. Uremia
  - D. Diarrhea
  - E. Diabetic ketoacidosis
- 

40. A patient presents with a history of vomiting and has the following blood values:

Plasma $p\text{CO}_2$	32 mmHg
Plasma $\text{HCO}_3^-$	32 mEq/L
Blood pH	7.62

The acid base disorder is

- A. metabolic alkalosis.
  - B. respiratory alkalosis.
  - C. respiratory acidosis.
  - D. mixed respiratory and metabolic alkalosis.
  - E. mixed respiratory acidosis and metabolic alkalosis.
41. The  $p\text{CO}_2$  of a urine sample is 40 mmHg. The urine pH is 6.1. What is the  $\text{HCO}_3^-$  concentration of the urine?
- A. 0
  - B. 1.0 mEq/L
  - C. 1.2 mEq/L
  - D. 10 mEq/L
  - E. 24 mEq/L

42. A normal subject producing 60 mEq per day of fixed acid from his diet ingests 120 mEq/day of  $\text{NaHCO}_3$ . Which of the following statements is FALSE?
- A. The urine would be alkaline and contain  $\text{HCO}_3^-$ .
  - B. Volume expansion would increase the reabsorption of bicarbonate.
  - C. Urinary titratable acid would fall to zero.
  - D. Bicarbonate would be secreted by the cortical collecting tubule.
  - E. In the absence of any kidney function the net change in body fluids would be a gain of 60 mEq of  $\text{HCO}_3^-$ .

43. In response to an acute acid-base metabolic challenge, the first response of the body is
- A. extracellular buffering.
  - B. increased ammonium production.
  - C. intracellular buffering.
  - D. respiratory compensation.
  - E. renal correction.

44. An individual presents with the following blood values.

pH	=	7.30	$\text{PCO}_2$	=	25 mmHG	$\text{HCO}_3^-$	=	12 mEq/L
Na	=	135 mEq/L	$\text{K}^+$	=	4.80 mEq/L	Cl	=	103 mEq/L

These values are compatible with

- A. respiratory acidosis.
  - B. respiratory alkalosis.
  - C. metabolic acidosis secondary to diarrhea.
  - D. metabolic acidosis secondary to lactic acidosis.
  - E. metabolic alkalosis.
45. A long-acting hormone is one that
- A. is readily water-soluble.
  - B. diffuses readily through a plasma membrane.
  - C. is expensive.
  - D. can not be taken orally.
  - E. is biologically active when bound to plasma proteins.

46. LH is to FSH as
- A. prolactin is to oxytocin.
  - B. estrogen is to clomid.
  - C. inhibin is to activin.
  - D. somatostatin is to GHRH.
  - E. ACTH is to MSH.

47. Which of the following does NOT increase prolactin levels?
- A. VIP
  - B. destruction of the arcuate nucleus
  - C. oxytocin
  - D. bromocriptine
  - E. suckling

48. GH has the same effect on somatostatin that
- A. LHRH has on LH.
  - B. TSH has on TRH.
  - C. prolactin has on dopamine.
  - D. LH has on LHRH.
  - E. prolactin has on oxytocin.
49. Which of the following does NOT require blood-borne activity?
- A. testosterone regulation of LH
  - B.  $T_4$  regulation of TSH
  - C. PTH regulation of renal phosphate reabsorption
  - D. somatostatin regulation of TSH
  - E. insulin regulation of glucagon
50. Destruction of the inferior hypophyseal artery would be most detrimental to
- A. the function of the arcuate nucleus.
  - B. the function of the primary capillary plexus.
  - C. the release of oxytocin
  - D. the release of GHRH.
  - E. the secretion of ACTH.
51. Which of the following functions both as a pituitary hormone and a releasing factor?
- A. vasopressin
  - B. neurophysin
  - C. dopamine
  - D. GHRH
  - E. TRH
52. Selective destruction of the somatotrophs in an adult would be expected to
- A. increase the secretion of somatostatin from the hypothalamus.
  - B. elevate blood glucose.
  - C. cause dwarfism.
  - D. increase the secretion of GHRH from the hypothalamus.
  - E. increase IGF-1 production.
53. What hormonal condition do Sheehan's syndrome, polycystic ovarian disease, hyperprolactinemia, and cryptorchidism (undescended testes) have in common?
- A. high LH levels
  - B. high prolactin levels
  - C. low FSH levels
  - D. low LH levels
  - E. none of the above
54. The withdrawal of progesterone does NOT contribute to
- A. a quiescent myometrium.
  - B. parturition.
  - C. menstruation.
  - D. spontaneous abortion.
  - E. lactation.

FOR QUESTIONS 55-57 USE THE FOLLOWING INFORMATION.

An 18-year old female is seen by her gynecologist for the chief complaint of absence of menstrual periods for the past 12 months. History and physical examination reveal that the patient began menstruation at 8; however, menses have been irregular from puberty and ceased one year ago. The patient is noted to be 4 feet, 10 inches tall. She tells her physician that her breasts developed early and became quite large in relation to her body size. External and internal female genitalia are noted to be present and well developed. No excessive body hair (hirsutism) is noted. The first lab results reveal low LH and FSH levels. Blood pressure and temperature are normal.

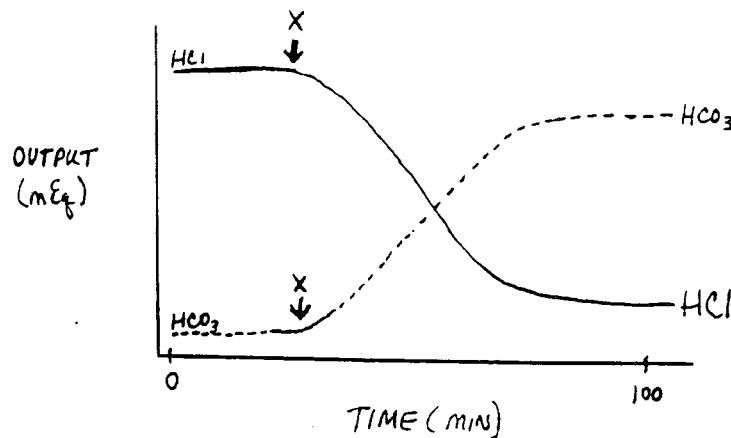
55. The information given would be MOST consistent with the primary diagnosis of
- A. hyperprolactinemia.
  - B. Sheehan's syndrome.
  - C. precocious activation of hypothalamic LHRH pulse generator.
  - D. polycystic ovarian disease.
  - E. granulosa cell tumor.
56. The patient described above would be expected to have
- ☒ A. high amplitude GH peaks.
  - ☒ B. Laron dwarfism.
  - C. suppressed IGF-1 levels.
  - D. elevated baseline levels of GH.
  - ☒ E. failure of closure of epiphyseal end-plates.
57. In such a patient, you would not be surprised to see a secondary elevation of which hormone?
- A. ACTH
  - B. prolactin
  - C. LHRH
  - D. cortisol
  - E. testosterone
- 
58. Infusion of glucose would only be necessary in a patient
- A. with a GH-secreting tumor.
  - B. with diabetes mellitus.
  - C. who took an overdose of insulin.
  - D. with a glucagon-secreting tumor.
  - E. with Cushing's disease.
59. Destruction of the preoptic area of the hypothalamus will
- A. prevent ovulation.
  - B. lower plasma cortisol.
  - C. stimulate somatic growth.
  - D. result in precocious puberty.
  - E. cause a goiter.

60. During the early follicular phase of the menstrual cycle, the only elevated hormone is
- A. estradiol.
  - B. progesterone.
  - C. LH.
  - D. FSH.
  - E. LHRH.
61. The administration of the progesterone antagonist RU486 will NOT
- A. cause an abortion.
  - B. cause menstruation.
  - C. raise basal body temperature.
  - D. inhibit formation of the alveolar-lobular formation in the breast.
  - E. decrease the viscosity of cervical mucus.
62. Cyclic AMP is NOT the major intracellular second messenger for
- A. LH.
  - B. TSH.
  - C. LHRH.
  - D. PTH.
  - E. GHRH.
63. Elevated levels of androgen are NOT found in
- A. polycystic ovarian disease.
  - B. congenital adrenal hyperplasia.
  - C. testicular feminization syndrome.
  - D. Kallmann's syndrome.
  - E. precocious male puberty.
64. Which of the following is the LEAST involved in parturition?
- A. hCG
  - B. oxytocin
  - C. prostaglandin  $F_{2\alpha}$
  - D. progesterone
  - E. estriol
65. Growth hormone and insulin have similar effects on
- A. the liver.
  - B. blood glucose concentrations.
  - C. the release of fatty acids.
  - D. protein synthesis in muscle.
  - E. ketogenesis.
66. Excess thyroxine administration would most likely
- A. decrease heart rate.
  - B. decrease body temperature.
  - C. decrease respiratory rate.
  - D. increase TSH production.
  - E. increase GI motility.

67. Life in mountainous terrain may result in the formation of a goiter because
- A. TSH levels will be elevated.
  - B. excess iodine down-regulates Na-K ATPase.
  - C. excess iodine results in excess  $T_4/T_3$  negative feedback.
  - D. Grave's disease is most common among mountain-dwelling peoples.
  - E. cretinism occurs.
68. While most circulating thyroid hormone is in the form of  $T_4$ ,
- A. most of the  $T_4$  circulates in free-form.
  - B. most of the  $T_4$  must act on plasma membrane receptors.
  - C. most of the  $T_4$  is converted to  $T_3$  in plasma.
  - D. most of the  $T_4$  is converted to  $T_3$  by tissue 5' deiodinase enzymes.
  - E. it is only  $T_3$  that can bind to nuclear receptors.
69. Many of the hormonal deficits of chronic stress are **PRIMARILY** attributable to
- A. excess epinephrine secretion by the adrenal medulla.
  - B. endorphin secretion.
  - C. increased hypothalamic CRF.
  - D. increased cortisol secretion.
  - E. increased vasopressin secretion.
70. The major regulator of aldosterone secretion is
- A. ACTH
  - B. CRF
  - C. cortisol
  - D. angiotensin II
  - E. serum osmolality
71. The most distinguishing feature between Cushing's syndrome and Cushing's disease is the
- A. hyperglycemia.
  - B. ACTH level.
  - C. cortisol level.
  - D. androgen level.
  - E. redistribution of body fat.
72. Which of the following would **NOT** tend to raise the level of blood calcium?
- A. a parathyroid gland tumor
  - B. calcitonin
  - C. PTH
  - D. 1,25-dihydroxy Vitamin D
  - E. increased osteoclastic activity
73. Which statement correctly describes Type II diabetes?
- A. It is also known as insulin-dependent diabetes mellitus.
  - B. It is characterized by insulin resistance.
  - C. It results in ketogenesis.
  - D. It results in lowered glucagon levels.
  - E. Patients with Type II diabetes are usually lean in body mass.

74. Which of the following is NOT elevated by stress?
- A. glucagon
  - B. IL-1
  - C. ACTH
  - D. insulin
  - E. aldosterone
75. A 30-year old female presents with headaches. Her work up reveals a prolactin level of 250 ug/L (Normal 2.2-19.2 ug/L) and a CT of the head shows a 3mm microadenoma. You would recommend treatment with
- A. somatostatin agonist.
  - B. dopamine agonist.
  - C. dopamine antagonist.
  - D. prolactin agonist.
  - E. estrogen.
76. In a male patient with a large 2cm growth hormone secreting adenoma, which of the following tests would NOT be appropriate?
- A. cortrosyn (ACTH) stimulation test
  - B. visual field exam
  - C. thyroid function tests
  - D. dexamethasone suppression test
  - E. testosterone level
77. A 40-year old patient recovering from transphenoidal surgery for a large pituitary tumor complains of weight gain, dry skin, cold intolerance and constipation one month after surgery. Which of the following test results would be compatible with his clinical history?
- A. high FSH, low testosterone
  - B. low cortisol, high ACTH
  - C. low thyroxine, high TSH
  - D. high cortisol, low ACTH
  - E. low thyroxine, low TSH
78. Which substance is MOST associated with closure of the epiphyseal plate?
- A. thyroid hormone
  - B. bone-derived growth factor II
  - C. vitamin D<sub>3</sub>
  - D. estrogen
  - E. bone morphogenetic protein
79. Which characteristic of osteoblasts is MOST necessary for osteoclast function?
- A. tissue plasminogen activator (tPA) secretion
  - B. a ruffled border
  - C. alkaline phosphatase secretion
  - D. incorporation into the bone matrix
  - E. a squamous shape

80. Salivary secretions
- A. are significantly increased by sympathetic stimulation.
  - B. that are released into the mouth are the "primary secretion".
  - C. are dependent on parasympathetic innervation.
  - D. are inhibited during nausea.
  - E. are modified by the secretion of sodium during passage through the salivary ducts.
81. Which of the following would delay or diminish the absorption of proteins?
- A. secretion of CCK
  - B. pH of 3 in the duodenum and early jejunum
  - C. increase in the Na/K ATPase activity in the basolateral membranes of the enterocytes
  - D. stimulation of pepsin secretion
  - E. inhibition of somatostatin release



82. The graph shows tracings of acid output from the stomach, and bicarbonate output from the pancreas of a fasting dog during continuous infusion of gastrin. At the arrow (X), a peptide is injected intravenously. This peptide is most likely
- A. ADH
  - B. cholecystokinin (CCK)
  - C. motilin
  - D. secretin
  - E. somatostatin
83. Select the TRUE statement
- A. Salivary  $\alpha$ -amylase begins protein digestion in the mouth.
  - B. The optimal pH for pepsin's enzymatic activity is ~5.
  - C. In chronic pancreatitis there is increased secretion of amylase and trypsin.
  - D. Pancreatic lipase requires a colipase to digest intestinal lipids.
  - E. Disaccharidases are secreted from the crypts of Lieberkuhn.
84. Which of the following is NOT a mechanism by which sodium ions enter the intestinal epithelial cells from the luminal membrane?
- A. a neutral NaCl cotransport system.
  - B. simple diffusion.
  - C. cotransport with amino acids.
  - D. active transport via Na/K ATPase.
  - E. cotransport with monosaccharides.



85. During digestion of a meal, secretion of acid by the stomach is  
A. stimulated by impulses carried in the celiac nerve.  
B. stimulated by somatostatin.  
C. stimulated by hormones released from the jejunal mucosa.  
D. inhibited by hormones released from the duodenal mucosa.  
E. inhibited by gastrin.
86. After acid enters the duodenum, there is  
A. decreased bile flow from the liver.  
B. increased rate of gastric acid secretion.  
C. decreased rate of gastric emptying.  
D. decreased volume of pancreatic exocrine (enzyme) secretions.  
E. decreased volume of pancreatic endocrine (electrolyte) secretions.
87. In the enterocytes, reesterification of 2-monoglycerides with fatty acids occurs in the  
A. cytoplasm  
B. mitochondria  
C. smooth endoplasmic reticulum  
D. nucleus  
E. endosomes
88. Which of the following sugars is taken into the enterocyte by facilitated diffusion?  
A. glucose  
B. fructose  
C. galactose  
D. maltose  
E. gulose
89. Dietary lipid absorbed by the small intestine is transported out of the enterocyte through the interstitium directly  
A. into lymph as free fatty acids.  
B. into blood as low-density lipoproteins.  
C. into lymph as low-density lipoproteins.  
D. into blood as chylomicrons.  
E. into lymph as chylomicrons.
90. Prior to absorption, proteins must be digested to form  
A. free amino acids.  
B. free amino acids, dipeptides, and tripeptides.  
C. polymers.  
D. pentapeptides and dipeptides.  
E. oligopeptides.
91. Which secretions are almost entirely under neural control?  
A. salivary  
B. gastric  
C. pancreatic  
D. hepatic  
E. duodenal

99. The migrating myoelectric complex:
- A. is triggered by ingestion of a meal.
  - B. is triggered by intestinal bacteria.
  - C. has the most contractile activity during phase I.
  - D. consists of strong aboral contractions during phase III.
  - E. helps keep bacteria out of the colon.
100. Gastric acid secretion is reduced:
- A. when pepsin is formed from pepsinogen.
  - B. when acidic chyme enters the duodenum.
  - C. when food stretches the corpus.
  - D. when intrinsic factor is secreted.
  - E. when the lower esophageal sphincter contracts.

Aunt Edna has a history of epigastric pain which is not periodic and not related to meals. It is relieved by antacids. She also has diarrhea and steatorrhea. Basal HCl secretion rate after an overnight fast was 25 mEq/hour, and this could be increased to 40 mEq/hour by the augmented histamine test. Radiologic examination revealed a gastric ulcer. A high level of a "gastrin-like" substance was found in her plasma. Following surgical removal of a pancreatic tumor, her epigastric pain and diarrhea disappeared and her acid secretion was reduced.

101. Select the FALSE statement:
- A. Edna's high rate of HCl secretion resulted in a low duodenal pH.
  - B. Edna's high rate of HCl secretion was due to hypersecretion of gastrin from her duodenal G-cells.
  - C. Secretin was acting at the pancreas to release a hydrelatic (electrolyte) solution.
  - D. Pancreatic enzyme activation was severely reduced in the duodenum.
  - E. Edna had osmotic diarrhea.

USE THE INFORMATION BELOW FOR QUESTIONS 102 and 103.

A 35-year old woman underwent a 55 cm ileal resection (normal ileal length is ~65 cm) because of ileal disease. After recovery from the operation the patient suffered from chronic diarrhea and mild steatorrhea (10 g fat/day). She was treated with cholestyramine, which sequesters bile acids and prevents their function. This resulted in a dramatic reduction in her diarrhea and an increase in fecal fat content to 20 g fat/day. Isotope studies revealed that her jejunal bile acid content was normal and that her daily excretion of bile acids was higher than normal values.

102. Select the FALSE statement below: Following the ileal resection
- A. the cholestyramine probably prevented the bile acids from inhibiting sodium and water absorption in the colon, and prevented micelle formation.
  - B. the post-operative diarrhea was secretory in origin.
  - C. the synthesis of bile acids probably increased.
  - D. the extraction of bile acids from the portal blood decreased.
  - E. the fecal fat resulted from some unabsorbed lipids.
103. The loss of ileal mass
- A. does not seriously affect intestinal digestion and absorption.
  - B. does not seriously affect intestinal vitamin absorption.
  - C. increases gastrin-induced jejunal motility.
  - D. reduces bile acid recycling.
  - E. reduces the secretion of bile from the liver.

104. Complete the FALSE statement. Stress
- A. is a stimulus which disturbs body homeostasis.
  - B. is a series of psychological and biological reactions to any change in homeostasis.
  - C. is defined by increased secretion of cortisol.
  - D. is perceived as body's inability to cope with a situation.
  - E. cannot be elicited without the involvement of the central nervous system.
105. Complete the FALSE statement. Repeated exposure to the same type of stress leads to
- A. increased synthesis of catecholamines.
  - B. centrally-mediated homotypic habituation.
  - C. end-organ adrenergic receptor desensitization.
  - D. sensitization to a novel stress.
  - E. development of established hypertension.
106. Complete the FALSE statement. Cardiovascular hyperreactivity to mental stress is associated with:
- A. greater than normal increase in plasma catecholamines.
  - B. type A personality, particularly hostility and anger.
  - C. greater incidence of coronary heart disease.
  - D. augmented immune responses.
  - E. greater than normal vasoconstrictor responses.
107. Select the FALSE statement.
- A. Expulsion of semen from the internal urethra is mainly caused by a spinal reflex.
  - B. Lubrication of the vagina is mainly accomplished by secretions of the Bartholin's glands.
  - C. Emission of semen into the internal urethra is caused by a sudden increase in sympathetic nerve discharge.
  - D. The major site of storage of mature spermatozoa is the vas deferens.
  - E. Regional blood flow changes are responsible for enlargement and coloration changes of the labia during sexual excitation.
108. Select the FALSE statement.
- A. A significant proportion of senior citizens are able to function sexually.
  - B. Prescription drugs taken by the elderly might reduce libido.
  - C. Physiological causes of impotence become more important than psychological causes as men age.
  - D. Natural vaginal lubrication may be diminished after menopause.
  - E. Libido normally drops precipitously after menopause.
109. The stereotypic sexual response (excitation-plateau-orgasm-resolution) observed in men is
- A. followed by a refractory period.
  - B. is less variable than in the female.
  - C. unaffected by autonomic neuropathies.
  - D. is solely dependent on tactile stimulation.
  - E. experienced only during heterosexual acts.

110. The resting potential of an axon is seen to depolarize from -70 mV to -20 mV when the medium surrounding the axon is changed. This depolarization is **MOST LIKELY** due to
- a decrease in the external chloride concentration.
  - an increase in the external calcium concentration.
  - blockade of the voltage-gated sodium channel by tetrodotoxin.
  - an increase in the external potassium concentration.
  - a decrease in the internal concentration of sodium.
111. Demyelination of an axon is associated with
- loss of the axonal membrane.
  - an increase in membrane capacitance.
  - a longer (i.e. greater) space constant.
  - an increased internal resistance of the axon.
  - an increased conduction velocity of the axonal action potential.
112. Which one of the following best distinguishes a cardiac ventricular muscle action potential from that of a skeletal muscle cell?
- Resting membrane potential
  - Height of spike
  - Duration of action potential
  - Rate of rapid repolarization
  - Role of sodium ion channels
113. The heart rate can be calculated from the normal ECG from the
- p-wave duration.
  - P-R interval.
  - QRS duration.
  - S-S interval.
  - T-wave duration.
114. Complete the FALSE statement. Sympathetic nerve stimulation to the heart results in an
- increase in heart rate.
  - increase in force of ventricular contraction.
  - increase in the slope of the SA nodal cells' membrane diastolic potential (phase 4).
  - increase in potassium permeability of SA nodal cells during phase 4.
  - increase in calcium permeability of the SA nodal cells during phase 0.
115. An aneurysm (dilation) is present in the distal portion of the abdominal aorta of a 68 year old male. The cross-sectional area of the aneurysm is estimated to be  $8.0 \text{ cm}^2$  and the blood flow is 3 L/min. Blood velocity through the aneurysm is
- 50 cm/min.
  - 6.2 cm/sec.
  - 8.4 cm/min.
  - 10.0 cm/sec.
  - 7.4 cm/sec.

**QUESTIONS 116 AND 117 REFER TO THE SECOND PBL CASE**

116. Which of the following would NOT occur during the intravenous administration of dobutamine ( $\beta_1$ -agonist) in a patient with left ventricular failure?
- A shift of the left ventricular function curve upward and to the left.
  - A decrease in pulmonary arterial wedge pressure.
  - An increase in ventricular end-systolic volume.
  - An increase in LV  $dP/dt$ .
  - An elevation of mean aortic pressure.
117. Following cardiac transplantation, Mr. Bill
- would be completely dependent on heterometric autoregulation of the heart for increasing cardiac output.
  - would have a constant heart rate during varying levels of physical activity.
  - would not respond to the baroreceptor reflex.
  - would have no significant limitations of physical activity.
  - would not respond to inotropic agents.
118. Of the total blood volume in the average human adult, that contained in the systemic capillaries is about
- 18%.
  - twice as much as that in the heart.
  - 5%.
  - about half as much as in the systemic veins.
  - the same as that in the pulmonary circulation.
119. The Frank-Starling mechanism is a type of
- extrinsic regulation of stroke volume.
  - Anrep effect.
  - heterometric autoregulation of stroke volume.
  - intrinsic regulation of heart rate.
  - extrinsic regulation of heart rate.
120. Calculate the LV ejection fraction, based on the following data:
- |   |             |
|---|-------------|
| Arterial blood pressure                 | 120/90 mmHg |
| Left ventricular end-diastolic pressure | 9 mmHg      |
| Left ventricular end-diastolic volume   | 175 ml      |
| Left ventricular end-systolic volume    | 120 ml      |
- 0.31
  - 0.40
  - 0.46
  - 0.58
  - 0.69
121. Maximal velocity of contraction of cardiac muscle occurs only at
- maximum heart rate.
  - maximum preload.
  - zero preload.
  - maximum afterload.
  - zero afterload.

122. Which of the following does NOT contribute to the maintenance of resting arterial blood pressure in a normal individual?
- A. local blood flow autoregulation
  - B. sympathetic nerve activity
  - C. baroreceptor reflex
  - D. vasopressin
  - E. renin-angiotensin-aldosterone system
123. Complete the FALSE statement. Prolonged standing may result in
- A. increased peripheral venous pressure.
  - B. decreased vagal activity.
  - C. skeletal muscle vasodilation.
  - D. increased angiotensin II levels.
  - E. syncope.
124. Which of the following would lead to greatest rise in mean arterial pressure in a normal individual?
- A. whole body dynamic exercise
  - B. isometric exercise of small-intermediate size muscle
  - C. moderate hypoglycemia
  - D. orthostasis
  - E. exposure to moderate heat

**FOR QUESTIONS 125 - 127.**

A young woman is admitted to the emergency room in respiratory distress with audible wheezing. She gives a history of severe asthmatic attacks, precipitated by exposure to cats. On physical examination the most prominent finding is wheezing (whistling sound during expiration).

125. Select the FALSE statement.
- A. The principal problem in this patient is bronchoconstriction (narrowing of the airways).
  - B. Expiration will be prolonged.
  - C. Airway resistance will be increased.
  - D. The airways will be narrowed more during inspiration.
  - E. The FEV<sub>1</sub>/FVC ratio will be reduced below 75%.

Her condition becomes worse in the emergency room in spite of treatment. She is receiving 40% O<sub>2</sub> through a nasal catheter. Analysis of arterial blood gases shows:

PaO <sub>2</sub>	=	65 mmHg
PaCO <sub>2</sub>	=	50 mmHg
pH	=	7.30
HCO <sub>3</sub>	=	25 mEq/L

126. Select the FALSE statement.
- A. The patient is hypoventilating.
  - B. The blood gases indicate mild respiratory acidosis
  - C. There is evidence of V<sub>A</sub>/Q imbalance and/or shunting.
  - D. The plasma bicarbonate level indicates that the acid base problem is acute.
  - E. The (A-a)O<sub>2</sub> gradient is probably less than 10 mmHg.

After further successful treatment, the wheezing stops and the next set of blood gases shows:

PaO<sub>2</sub> = 135 mmHg  
PaCO<sub>2</sub> = 35 mmHg  
pH = 7.45  
HCO<sub>3</sub> = 24 mEq/L

127. Select the FALSE statement.
- A. The patient must be still receiving oxygen.
  - B. She is hyperventilating.
  - C. If measured, her residual volume would have decreased compared to the RV during the acute attack.
  - D. Bronchial asthma is a restrictive lung disease.
  - E. Animal furs, particularly cat fur are known allergens and should be removed from the environment of asthmatics.

\*\*\*\*\*

**IT'S ALL OVER!**  
**FILL OUT YOUR EVALUATION SHEETS AND YOU ARE READY FOR A**  
**WELL DESERVED BREAK!**

ANSWERS  
HUMAN PHYSIOLOGY FINAL EXAM  
APRIL 13, 1995

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

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

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