Name_____ Student Number_____

UNIVERSITY OF TORONTO
Faculty of Arts and Science

APRIL 2012 EXAMINATIONS

PSL301H1 S

Duration: 2 hours

No aids allowed.

Filling in and coding your answer card (St. George scantron).

1. To 'bubble in' numbers and letters, it is best to use an HB pencil, in case you make an error. Ballpoint pen cannot be erased. Do not make any stray marks on your scantron outside of boxes.

2. Fill in NAME, and STUDENT NUMBER (the blocks first, then code below).

   a) NAME: Print it clearly in block letters, last name and initials. Then code it.

   b) STUDENT NUMBER: Be very careful to code your student number correctly.

3. Complete your answer card BEFORE the end of the exam, as you go along. No extra time is given at the end to transfer answers to the scantron.

Under the heading 'FORM' on your scantron, identify the test version that you have as A or B or C or D (use one letter only). You will see the correct code when you start the test; it is indicated on top of Question 1 in your test paper.

There 58 questions in total. All are of equal value.
There are 12 pages.

Invigilators are not permitted to interpret questions to individual students. If you think that a question is ambiguous, answer it as you understand it, then make a note below (not your answer card). If you do this, print and sign your name on your question book. Spelling or typing errors do not make a statement incorrect.

FORM A

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Which of the following is NOT released into the lumen of the duodenum?
   A) bile salts
   B) sucrase
   C) bilirubin
   D) trypsinogen
   E) HCO_3^-

2) Flopsy and Mopsy are identical twins who have urine collected as part of a study of diet in teenagers. Flopsy has 50 mmol of sodium in her 24 hour urine collection and Mopsy has 150 mmol of sodium in her 24 h urine collection. Which of the following would **NOT** explain this difference?
   A) Mopsy took a diuretic medication at the beginning of the study
   B) Mopsy eats all her meals at restaurants
   C) Flopsy has had a recent viral illness with diarrhea
   D) Mopsy eats more sodium than Flopsy
   E) Mopsy has been training for a marathon in hot weather

3) Fred is a 70 year old man who is found to have a serum sodium concentration of 120 mmol/L; one year ago it was 140 mmol/l (normal). Which of the following would BEST explain his low serum sodium concentration?
   A) He has a non-osmotic stimulus for vasopressin secretion
   B) He increased his daily fluid intake from 1 L to 3 L
   C) He reduced his dietary sodium from 300 to 100 mmol/d
   D) He has an adrenal gland secreting excess aldosterone
   E) He is taking an aquaporin 2 antagonist

4) What is observed when an opening is made from the outside of the body into the pleural cavity on the right side of the body?
   A) The lung on the right side remains inflated because pleural membranes are connected to the rib cage.
   B) Pressure in the pleural cavity becomes negative in comparison to atmospheric pressure.
   C) The lung on the right side expands and airflow through the trachea initially doubles.
   D) The lung on the right side collapses and airflow through the trachea initially reduces by half.
   E) Both lungs collapse and there is no air flow through the trachea.

5) Which ONE of the following would be the appropriate response to an increase in dietary protein intake?
   A) An increase in urine glucose excretion
   B) An increase in urine ammonium excretion
   C) A decrease in urine urea excretion
   D) An increase in urine bicarbonate excretion
   E) An increase in urine creatinine excretion

6) An investigator takes a sample of fluid from the lumen of a tubule segment of an experimental animal. The investigator is unsure which nephron segment it is. The following solute concentrations are noted: Sodium 10 mmol/L, potassium 60 mmol/L, osmolality 600 mosmol/kg, glucose 0, pH 5.0

This fluid most likely comes from which nephron segment?

A) The distal convoluted tubule
B) Medullary collecting duct
C) Early proximal tubule
D) Late proximal tubule
E) End of the loop of Henle

7) The thick ascending limb of the loop of Henle contributes to the ability of the kidney to excrete a low volume, concentrated urine because of which ONE of the following characteristics?

A) It reabsorbs ammonium
B) It transports sodium chloride to the medullary interstitium
C) It has vasopressin receptors
D) It reabsorbs filtered glucose
E) It is highly permeable to water

8) What is an advantage of the Astrand fitness test?

A) Can be completed in two minutes
B) Is preformed at submaximal heart rates
C) Simply requires measuring resting heart rates
D) Provides the most accurate measure of VO_2 max
E) Only requires measurement of heart rate and respiratory rate

9) Which of the following is **NOT** a step in the activation of B cells and the release of antibodies?

A) $CD4^+$ T cell secretes cytokines.
B) Antigen binds to the B cell receptor.
C) Some B cells differentiate into plasma cells.
D) B cell receptor binds to MHC class II + antigen
E) Antigen is internalized by the B cell.

10) Which ONE of the following combinations of agents would be MOST likely to increase urine potassium excretion when given to a normal human adult?

A) Angiotensin II and an aldosterone antagonist
B) Adrenaline and amiloride (an inhibitor of the collecting duct sodium channel)
C) Glucose and an angiotensin converting enzyme inhibitor
D) A diuretic acting on the loop of Henle and aldosterone
E) Vasopressin and insulin

11) People who have severe Crohn's disease sometimes need to have a substantial part of their small intestine removed. What would be **NOT** be observed in these individuals?
   A) enhanced acid secretion
   B) inadequate protein digestion
   C) increased volume of feces
   D) poor absorption of free fatty acids
   E) tendency to become dehydrated

12) Newborns in a hospital nursery were given a 5% saline solution to drink instead of a 5% glucose solution in error. Which of the following would be the most likely consequence of this error? (Note: 5% saline is about 800 mmol/L)
   A) Hypovolemic shock
   B) Reduced interstitial fluid volume
   C) Brain edema
   D) Excretion of large volumes of dilute urine
   E) Rapid neurologic deterioration

13) Restoring lost fluid from the capillaries back to the circulatory system is one of the major functions of which system?
   A) urinary
   B) lymphatic
   C) nervous
   D) immune
   E) digestive

14) Shirley is a 25 year old woman with kidney disease. She has edema, a low serum albumin concentration and a serum sodium concentration of 125 mmol/L (normal 140 mmol/L). Blood pressure is low, and her physician determines from her clinical examination that her jugular venous pressure is low. Which of the following best describes her body fluid compartment volumes?
   A) Normal extracellular fluid volume, normal interstitial volume, low intracellular fluid volume
   B) Low blood volume, increased interstitial volume, increased intracellular fluid volume
   C) Normal blood volume, increased interstitial volume, low intracellular fluid volume
   D) Low blood volume, increased interstitial fluid volume, low intracellular fluid volume
   E) Low blood volume, low interstitial fluid volume, increased intracellular fluid volume

15) Using the data below, calculate the rate of net fluid movement across the capillary wall:

[Pressures (in mmHg)]

Mean arterial = 65

Mean venous hydrostatic = 12

Mean plasma colloid osmotic = 28

Mean capillary hydrostatic = 20

Mean interstitial hydrostatic = 4

Mean interstitial colloid osmotic = 8

Filtration coefficient = 10 ml/min/mmHg

A) 40 ml/min (Reabsorption)
B) 4 ml/min (Reabsorption)
C) 40 ml/min (Filtration)
D) 0 ml/min
E) 4 ml/min (Filtration)

16) What might happen if the pyloric sphincter was damaged and could not close properly?
A) Absorption of nutrients and water would be reduced.
B) Peristalsis in the esophagus would be increased.
C) The individual would become constipated.
D) Contents from the stomach would regurgitate into the esophagus.
E) Digestion of protein in the stomach would be enhanced.

17) Dr. C is trying to find a new agent to measure glomerular filtration rate in humans. He makes the following measurements of the drug (D) using inulin as the known gold standard for measuring true GFR.

Serum concentration of D = 0.1 mmol/ml

Urine flow rate = 4 ml/min

Urine concentration of D = 4 mmol/ml

True GFR by inulin = 100 ml/min

Dr. C concludes that:

A) D underestimates GFR
B) D is reabsorbed by the tubules
C) No conclusions regarding D can be made from this data
D) D is secreted by the tubules
E) D is an excellent marker of GFR

18) The most important sodium transport protein in the proximal tubule is which one of the following?
A) Sodium-glucose cotransporter
B) Sodium-hydrogen exchanger
C) Sodium-potassium-2 chloride cotransporter
D) Sodium channel
E) Sodium-chloride cotransporter

19) What might an individual have if he/she had been living at high altitude for several weeks?
A) Jaundice
B) Polycythemia
C) Low concentrations of 2,3 DPG in the plasma
D) Acidosis
E) Hyposecretion of erythropoietin

20) When is alveolar pressure at its highest?
A) Mid-way through inspiration
B) At the start of expiration
C) At the start of inspiration
D) Mid-way through expiration
E) None of the above

21) What does the body normally produce to breakdown fibrin?
A) Tissue factor
B) Plasmin
C) Coumadin
D) Factor VIII
E) Thrombin

22) You would expect to find fenestrated capillaries in:
A) cardiac muscle
B) skeletal muscle
C) the liver
D) skin
E) the brain

23) Which of the following would be found at a higher level in the hepatic artery in comparison to the hepatic portal vein?
A) glucose
B) oxygen
C) amino acids
D) insulin
E) hemoglobin

24) The main effect of vasopressin on the kidney is which ONE of the following?
A) Increased resistance in the efferent arteriole
B) Increased urine solute excretion
C) Reduced urine flow rate
D) Insertion of aquaporin 2 into the peritubular capillaries of the medulla
E) Increased sodium reabsorption by the thick ascending limb of the loop of Henle

25) Dr. C. studies the effect of a new drug on kidney function. Renal blood flow, glomerular filtration rate and arterial blood pressure are measured before and after administration of the drug. Dr. C. finds that the drug increased blood pressure, increased glomerular filtration rate, but did not change renal blood flow. This drug most likely belongs to which class of drug?
A) Atrial natriuretic peptide
B) Angiotensin II agonist
C) Angiotensin II receptor inhibitor
D) Aldosterone antagonist
E) Angiotensin converting enzyme inhibitor

26) Imagine that a person has climbed to high altitude. What hampers the unloading of oxygen in this individual?

A) CO_2 binding to hemoglobin blocks O_2 binding
B) Hyperventilation increases pH
C) Low PO_2 levels are found at the tissues
D) Blood flow to exercising muscles is reduced
E) An increase in 2,3 DPG in the blood

27) Which layer of the GI tract contains the cells that secrete pepsinogen?

A) Muscularis externa
B) Mucosa
C) Myenteric plexus
D) Serosa
E) Submucosa

28) A 3 year old boy has had increased thirst and urine flow since birth. On testing, his serum sodium concentration is 155 mmol/L (normal 140), urine osmolality is 50 mosmol/kg and when he is given a vasopressin analogue there is no change in his urine osmolality or flow rate. Which of the following is the BEST explanation for his problem?

A) Excessive fluid ingestion
B) Aldosterone deficiency
C) Gain-of-function mutation of the sodium channel in the collecting duct
D) Congenital disorder of thirst
E) Loss-of-function mutation of the gene for the kidney vasopressin receptor

29) Which of the following concerning congenital central hypoventilation syndrome is correct?

A) Caused by a defect in the neurons in the pre-Botzinger complex.
B) Caused by a mutation in a gene leading to total loss of a specific protein.
C) Caused by destruction of the respiratory motor neurons that innervate the diaphragm.
D) May involve an inability to integrate information from chemorecpetors.
E) All individuals with this syndrome require constant artificial ventilation.

30) What is observed in the transport of CO_2 in the blood and its exchange at the tissues?

A) Most of the bicarbonate produced at the tissues travels to the lungs inside erythrocytes
B) Most of the CO_2 that is transported is dissolved in the plasma
C) Transport of CO_2 involves the binding of H^+ to hemoglobin at the tissues
D) More CO_2 binds to hemoglobin when PCO_2 levels are high
E) At the tissues, H_2CO_3 is transported out of the erythrocyte in exchange for Cl^-

31) What is the main route from the brain to the stomach for excitatory information during the gastric phase of digestion?
A) Sympathetic chain ganglia
B) Cranial nerve IX
C) Phrenic nerves
D) Cranial nerve VII
E) The vagus nerve

32) The only blood vessels whose walls permit exchange between the blood and the surrounding interstitial fluids are the:
A) capillaries
B) arteries
C) venules
D) arterioles
E) veins

33) Excessive iron absorption is one of the main features of β-thalassemia. How might you reduce iron absorption in individuals with this condition? Develop a drug that:
A) enhances the activity of DMT-1
B) mimics the action of hepcidin
C) increases the levels of cAMP in cells that transport iron
D) enhances the expression of ferroporin
E) inhibits the activity of calmodulin

34) Which Ig class is correctly matched with its function or description?
A) IgA — secreted onto epithelial surfaces
B) IgG — first Ig class produced after initial exposure to microbes
C) IgE — most abundant Ig class in blood
D) IgD — secreted in breast milk
E) IgM — crosses the placenta

35) Which of the following hormones promotes insulin release and a feeling of satiety?
A) Glucagon-like peptide 1
B) Secretin
C) Glucagon
D) Somatostatin
E) Gastric inhibitory peptide

36) Why are H_2 antagonists sometimes given to individuals with peptic ulcers?
A) Bind to receptors on G cells to inhibit gastrin release
B) Block the release of histamine from enterochromaffin-like cells
C) Bind to and block the activity of cholinergic receptors
D) Are antibiotics that kill *H. pylori*
E) Inhibit the binding of histamine on parietal cells

37) What is a feature of the major histocompatibility complex II?
A) found on most cell types in the body
B) able to bind extracellular antigens without intracellular processing
C) interact with CD4 molecules on T cells
D) recognized by natural killer cells
E) present antigens that are synthesized within cells

38) Blood flow to a tissue will increase if the:
A) level of oxygen at the tissue increases
B) vessel constricts
C) pH rises
D) level of carbon dioxide at the tissue increases
E) all of the above

39) A loss-of-function mutation in the collecting duct H^+-ATPase (proton pump) would MOST likely lead to which of the following compared to normal?
A) Lower urine ammonium
B) Lower urine osmolality
C) Higher blood pH
D) Higher blood PCO_2
E) Lower urine pH

40) Sodium reabsorption by the kidney tubules is mainly regulated by which ONE of the following?
A) Interstitial fluid volume
B) Blood volume
C) Serum sodium concentration
D) Intracellular volume
E) Effective circulating volume

41) What triggers relaxation of the internal anal sphincter?
A) inhibition of the sympathetic nervous system
B) the enteric nervous system
C) activation of the parasympathetic system
D) the hormone motilin
E) relaxation of the external anal sphincter

42) Which of the following is a function of gastrin?
A) Decreases the release of acetylcholine.
B) Decreases motility of the stomach.
C) Increases acid secretion from G cells.
D) Stimulates the release of pepsinogen from chief cells.
E) Causes relaxation of the upper esophageal sphincter.

43) Reactive hyperemia is triggered by:
A) reflex contraction of smooth muscle following a period of dilation
B) toxins or allergens, such as bee venom or pollen
C) local accumulation of paracrines due to reduced blood flow
D) stress and the hormones released during stress
E) none of the above

44) What would you expect to observe in someone if he had taken a drug that inhibited the action of cholecystokinin and had eaten a meal 3 hours earlier in comparison to someone who had eaten the same meal but had not taken the drug?
A) enhanced plasma glucose concentration
B) difficulty emulsifying fat
C) reduced stomach motility
D) higher pH in the duodenum
E) reduced secretion of gastrin

45) All blood vessels are lined with a thin layer of:
A) cartilage
B) smooth muscle
C) astrocytes
D) endothelium
E) pericytes

46) Which vessels are the main site of variable resistance in the circulatory system and contribute more than 60% of the total resistance?
A) muscular arteries
B) veins
C) elastic arteries
D) venules
E) arterioles

47) As part of an assessment of body composition, a patient's total body water is determined to be 35% of body weight. This patient is most likely:
A) A 25 year old African-American basketball player
B) A 30 year old female long distance runner
C) An obese 85 year old woman with chronic arthritis
D) A 60 year old male of average height and weight
E) A 2 year old in good health

48) Malnutrition can cause edema because:
A) interstitial protein levels are lower than plasma protein levels
B) red blood cell lysis
C) the resulting anemia increases blood pressure
D) there are not enough nutrients for plasma protein synthesis
E) lack of fluid intake lowers blood pressure

49) Which ONE of the following would be most likely to cause an increase in serum potassium concentration if given to a normal human?
A) An aldosterone antagonist
B) Adrenaline
C) A diuretic acting on the ascending limb of the loop of Henle
D) Vasopressin
E) Angiotensin II

50) Which of the following is needed for the release of acid from the parietal cell into the stomach?
A) H^+ and intrinsic factor are transported into the lumen of the stomach via a symporter
B) Cl^- moves from the lumen of the stomach into the parietal cell
C) Cl^- enters the parietal cell via the CFTR channel
D) H^+ is transported into the lumen of the stomach in exchange for Na^+
E) HCO_3^- is transported out of the parietal cell in exchange for Cl^-

51) It is a common observation that when patients are given an angiotensin converting enzyme inhibitor (ACEi), serum creatinine increases. This observation is BEST explained by which of the following?
A) ACEi causes creatinine secretion by kidney tubules
B) ACEi increases muscle mass
C) ACEi reduces glomerular capillary hydrostatic pressure
D) ACEi increases afferent arteriolar resistance
E) ACEi reduces aldosterone secretion by the adrenal gland

52) What would happen to breathing in an animal in which a lesion was made to the respiratory pathway between the pons and the medulla? (Note information flow from the cerebral cortex to the medulla was left intact.)
A) All breathing movement would stop
B) Breathing rhythm would become irregular
C) Voluntary control of breathing would be impaired
D) The ability to gasp and sigh would be blocked
E) Information from central chemoreceptors to respiratory rhythmic centres would be blocked

53) Kidney failure (low glomerular filtration rate) is associated with low serum calcium because of which ONE of the following?

A) Impaired secretion of parathyroid hormone
B) Impaired 1-hydroxylation of vitamin D by the kidney
C) Resistance to the action of 1,25-dihydroxyvitamin D (calcitriol)
D) Increased urinary excretion of calcium
E) Increased bone uptake of calcium

54) Hypokalemia impairs skeletal muscle function by which ONE of the following mechanisms?

A) Hypokalemia lowers blood pressure
B) Hypokalemia makes muscle cell resting membrane potential more negative
C) Hypokalemia inhibits vasopressin secretion
D) Hypokalemia dilates arterioles in muscle tissue
E) Hypokalemia increases serum creatinine concentration

55) Which hormone is elevated in the fasted state?

A) Gastrin
B) Secretin
C) Gastric inhibitory peptide
D) Motilin
E) Cholecystokinin

56) Henry is taking a drug for a viral infection. The drug is known to cause damage to the reabsorptive functions of the proximal tubule. Which of the following changes would **NOT** be expected in Henry's urine if he developed this type of drug toxicity?

A) Increased urine glucose
B) Increased urine phosphate
C) Increased urine glutamine
D) Increased urine creatinine
E) Increased urine bicarbonate

57) Which of the following is a step in the digestion and absorption of protein?

A) Protein digestion begins in the duodenum through the action of pancreatic proteases.
B) Trypsin is a brush border enzyme that is needed for the activation of other proteases.
C) Upon absorption, amino acids are transported to the bloodstream via the lymphatics.
D) The main source of enzymes that digest protein is the liver.
E) Pepsinogen is coverted to active pepsin via the action of acid or pepsin itself.

58) Which cells have Toll receptors and what is the purpose of these receptors?

A) Natural killer cells, activate natural killer cells
B) B cells, bind to antigens and stimulate antibody production
C) Cytotoxic T cells, bind MHC class I + antigen
D) Macrophages, bind to the Fc portion of antibodies
E) Phagocytes, bind to pathogens