Fill in your scantron form as follows:

- Write and bubble in your name in the upper left (last name first).
- Sign your form on the upper right. By so doing you verify that you are abiding by Creighton’s policy on academic honesty.

Multiple choice: As always, choose the best answer for each multiple-choice question. Answer on your scantron form. Each question is worth 3 points.

1. When a physiologist talks about osmoregulation, the fluid that is being regulated is the
   a. intracellular fluid.
   b. extracellular fluid.
   c. interstitial fluid but not the blood.
   d. sweat.
   e. urine.

2. Two different solutions are put on either side of a membrane, and over time some of the volume shifts from one side to the other. If that is all the information you are given, which of the following could you say with certainty?
   a. The osmotic pressure differs on the two sides.
   b. The hydrostatic pressure differs on the two sides.
   c. The two solutions could not have been isosmotic at the start of the experiment.
   d. The solutes must be uncharged.
   e. None of the above is certain.

3. Which of the following is never (as far as we know) moved across a lipid bilayer by a carrier protein?
   a. Ca^{2+}
   b. Glucose
   c. H_{2}O
   d. K^{+}
   e. Na^{+}

4. The portion of the nervous system that controls the skeletal muscle system is the
   a. afferent nervous system.
   b. enteric nervous system.
   c. parasympathetic nervous system.
   d. somatic nervous system.
   e. sympathetic nervous system.
5. Which of the following statements about myelinated axons is true?
   a. Myelin improves the cable properties of the axon and allows action potentials to occur at all points along the axon.
   b. Myelin improves the cable properties of the axon, but action potentials can only occur at gaps in the myelin.
   c. Myelin worsens the cable properties of the axon, but action potentials can occur at all points along the axon.
   d. Myelin worsens the cable properties of the axon, and action potentials can only occur at gaps in the myelin.
   e. Myelin is only found in squids.

6. Ionotropic and metabotropic receptors found in post-synaptic neurons differ in that
   a. ionotropic receptors cause a more rapid change in membrane potential, and the change in potential tends to persist for a longer period.
   b. metabotropic receptors cause a more rapid change in membrane potential, and the change in potential tends to persist for a longer period.
   c. ionotropic receptors cause a more rapid change in membrane potential, but the change in potential tends to be shorter-lived.
   d. metabotropic receptors cause a more rapid change in membrane potential, but the change in potential tends to be shorter-lived.
   e. Potato, potahto

7. The process of neuronal integration (including both spatial and temporal summation)
   a. can involve only excitatory post-synaptic potentials.
   b. can involve only inhibitory post-synaptic potentials.
   c. can involve both excitatory and inhibitory post-synaptic potentials.
   d. always results in the generation of an action potential in the post-synaptic neuron.
   e. always prevents generation of an action potential in the post-synaptic neuron.

8. Sensory neurons encode information about stimulus intensity through
   a. changing the amplitude of individual action potentials.
   b. changing the duration of individual action potentials.
   c. changing the polarity of action potentials.
   d. changing the frequency with which action potentials occur.
   e. changing the type of neurotransmitter released by the neuron.

9. A cutaneous mechanoreceptor would probably exhibit the smallest receptive field size in the
   a. back.
   b. fingertip.
   c. foot.
   d. neck.
   e. upper arm.
10. Which of the following statements about olfactory receptors is true?
   a. They respond to only four different types of odorants.
   b. They are hyperpolarized when activated.
   c. They shrink in response to an appropriate odorant.
   d. They are a type of mechanoreceptor.
   e. Their responses to an odor are integrated by the olfactory bulb.

11. If the hair cells in the portion of the cochlea near the oval window were destroyed, but the
    remaining hair cells were left intact, the cochlea would
   a. lose the ability to perceive quieter sounds.
   b. lose the ability to perceive high-pitched sounds.
   c. lose the ability to sense acceleration in the vertical axis.
   d. lose the ability to detect rotation in the horizontal plane.
   e. no longer look like a snail.

12. Retinal isomerase is the enzyme that converts trans-retinal back to cis-retinal. If a chemical
    were introduced into the eye that inhibited this enzyme, which of the following would most
    likely be true?
   a. The rod photoreceptors would remain depolarized indefinitely.
   b. The bipolar cells would become inactivated.
   c. The retina would turn black.
   d. The eye would react as though viewing a bright light.
   e. The pupil would fully dilate.

13. Which of the following is a correct hormonal pathway?
   a. Thyrotropin releasing hormone → thyroid stimulation hormone → thyroid hormones
   b. Thyroid stimulating hormone → thyrotropin releasing hormone → thyroid hormones
   c. Corticotropin releasing hormone → cortisol → adrenocorticotropic hormone
   d. Cortisol → corticotropin releasing hormone → adrenocorticotropic hormone
   e. Adrenocorticotropic hormone → corticotropin releasing hormone → cortisol

14. Cross-bridge cycling in a muscle myofibril could still occur even if one of the following
    molecules were absent. Which is it?
   a. Actin
   b. ATP
   c. Myosin
   d. Tropomyosin
   e. All of the following are required for cross-bridge cycling to occur.
15. Which of the following would likely generate the greatest amount of force?
   a. A fast-glycolytic myofiber generating a twitch contraction
   b. A fast-glycolytic myofiber generating a tetanic contraction
   c. A slow-oxidative myofiber generating a twitch contraction
   d. A slow-oxidative myofiber generating a tetanic contraction
   e. All of these would produce about the same amount of force.

16. A person at rest has four liters per minute of blood flowing through her aorta. Based on this, which of the following statements must be true (at least on average)?
   a. She also has four liters per minute flowing through her renal arteries.
   b. She also has four liters per minute flowing through her pulmonary artery.
   c. She has the same blood pressure in her pulmonary and systemic circuits.
   d. She has the same resistance to flow in both her pulmonary and systemic circuits.
   e. She must be a superhuman.

17. Normally the heartbeat is initiated by
   a. an action potential in the atrioventricular node.
   b. an action potential in the bundle of His.
   c. an action potential in the Purkinje fibers.
   d. an action potential in the sinoatrial node.
   e. an action potential in the contractile myocardium.

18. During a normal heartbeat, which of the following is the cause of the closing of the atrioventricular valves?
   a. Pressure increase in the atria due to blood returning from the venous system
   b. Pressure increase in the atria due to atrial contraction
   c. Pressure increase in the ventricles due to the injection of blood by atrial contraction
   d. Pressure increase in the ventricles due to contraction of the ventricles
   e. Pressure decrease in the ventricles due to ventricular relaxation.

19. Which of the following does not influence the diameter of most arterioles in the body?
   a. Active hyperemia
   b. Epinephrine release from the adrenal medulla
   c. The parasympathetic nervous system
   d. The sympathetic nervous system
   e. All of the above influence most arterioles

20. The lymphatic system empties into the
   a. gastrointestinal tract.
   b. liver.
   c. renal nephrons.
   d. arterial side of the circulatory system.
   e. venous side of the circulatory system.
21. During a complete resting ventilatory cycle, intrapleural pressure is normally lowest
   a. at the end of an exhalation.
   b. midway through inhalation.
   c. at the end of inhalation.
   d. midway through exhalation.
   e. Intrapleural pressure is constant throughout the ventilatory cycle.

22. When using a snorkel, a swimmer normally has to increase her tidal volume (even if her O$_2$ demand and CO$_2$ production do not increase) because of the
   a. increased pressure in the surrounding water.
   b. greatly increased resistance to flow.
   c. increase in the effective anatomical dead space of the ventilatory pathway.
   d. decreased intrapleural pressure.
   e. fear of sharks.

23. Using the oxygen affinity curve below, determine the amount of oxygen that would be delivered to cells at P$_{O_2}$ = 20 torr if the P$_{O_2}$ of the lungs were 60 torr.

   ![Oxygen Affinity Curve](image)

   a. 17% of the maximum HbO$_2$ would be delivered.
   b. 22% of the maximum HbO$_2$ would be delivered.
   c. 65% of the maximum HbO$_2$ would be delivered.
   d. 70% of the maximum HbO$_2$ would be delivered.
   e. 82% of the maximum HbO$_2$ would be delivered.
24. Which of the following does not represent a significant (>2%) form of transport for carbon dioxide in the blood?
   a. CO₂ dissolved in the water of the blood
   b. CO₂ bound to the lipid bilayer of the red blood cells’ plasma membranes
   c. Carbamino compounds formed with blood proteins (including hemoglobin)
   d. Bicarbonate ions
   e. All of the above are significant modes of transport for CO₂.

25. In the kidney, water is filtered into the nephron at Bowman’s capsule. Most of the water (in terms of total volume) is reabsorbed in the
   a. proximal tubule.
   b. descending loop of Henle.
   c. ascending loop of Henle.
   d. distal tubule.
   e. collecting duct.

26. If a solute in the urine of a normally functioning kidney has the same concentration in the fluid leaving the collecting duct as it did in the fluid that entered Bowman’s capsule, we can say that
   a. it must be a substance that shows net secretion.
   b. it must be a substance that shows net absorption.
   c. it shows neither net secretion nor reabsorption.
   d. It is impossible to determine what the net movement was.
   e. Die, kidney questions, die!

27. The most important function of the loop of Henle is
   a. to adjust the salt content of the urine.
   b. to reabsorb urea.
   c. to secrete hydrogen ions.
   d. to create a concentration gradient in the renal medulla.
   e. to make urine hyposmotic.

28. Consider an individual who has recently consumed a large volume of water. Relative to his previous state, he should now be secreting
   a. more anti-diuretic hormone and more atrial natriuretic hormone.
   b. more anti-diuretic hormone and less atrial natriuretic hormone.
   c. less anti-diuretic hormone and less atrial natriuretic hormone.
   d. less anti-diuretic hormone and more atrial natriuretic hormone.
   e. a lot of sweat.
29. In a person suffering an acute respiratory acidosis (so ignore any renal responses), what blood chemistry would we expect relative to normal values?
   a. Elevated CO₂ and elevated H⁺.
   b. Elevated CO₂ and decreased H⁺.
   c. Decreased CO₂ and elevated H⁺.
   d. Decreased CO₂ and decreased H⁺.
   e. No change in either variable

30. Which of the following does not occur in the stomach?
   a. Breakdown of food through effects of hydrochloric acid and motility
   b. Sterilization of food through the action of hydrochloric acid
   c. Digestion of proteins by pepsin
   d. Digestion of starches by gastric amylase
   e. All of the above occur in the stomach.

31. The release of digestive enzymes from the pancreas is controlled mainly by the hormone
   a. cholecystokinin.
   b. enterokinase.
   c. gastrin.
   d. procarboxyypeptidase.
   e. secretin.

32. What is one of the primary effects of the hormone glucagon?
   a. It promotes stomach motility.
   b. It promotes mass movements in the large intestine.
   c. It promotes increased ventilation.
   d. It promotes increased glucose reabsorption in the kidneys.
   e. It promotes glycogen breakdown and release by the liver.

33. In human males, the first physiological event in the erection of the penis is
   a. vasoconstriction of penile arterioles.
   b. vasodilation of penile arterioles.
   c. vasoconstriction of penile venules.
   d. vasodilation of penile venules.
   e. Insert joke of your choice here

34. Which of the following does not provide any contribution to the formation of semen?
   a. The epididymis
   b. The seminal vesicles
   c. The prostate gland
   d. The bulbourethral gland
   e. The glans penis
35. In women, the number of follicles that normally begin development during each menstrual cycle is about
   a. one.
   b. 3-4.
   c. 10-20.
   d. 80-100.
   e. 360-400.

36. Ovulation is associated with which of the following events?
   a. Rupture of the ovary wall.
   b. A spike in levels of luteinizing hormone.
   c. Peak levels of progesterone.
   d. Two of the above are seen at the time of ovulation.
   e. All of the above are seen at the time of ovulation.

37. Menstruation results directly from which of the following?
   a. Decreasing levels of luteinizing and follicle-stimulating hormones
   b. Increasing levels of luteinizing and follicle-stimulating hormones
   c. Decreasing levels of progesterone and estrogen
   d. Increasing levels of progesterone and estrogen
   e. Ovulation

38. An embryo that was unable to produce chorionic gonadotropin would probably
   a. not form a blastocyst.
   b. be unable to initially implant in the uterus.
   c. implant but be lost when a normal menstrual cycle occurred.
   d. implant and develop normally for about three months before the pregnancy failed.
   e. have to be delivered by caesarian section since labor would not begin.

39. Which of the following statements about lactation in humans is correct?
   a. Prolactin promotes milk production while oxytocin promotes milk ejection (or let-down).
   b. Oxytocin promotes milk production while prolactin promotes milk ejection.
   c. Estrogen promotes milk production while progesterone promotes milk ejection.
   d. Progesterone promotes milk production while estrogen promotes milk ejection.
   e. Humans don’t produce milk – that would be gross!

40. Why do women generally have a different distribution of body hair than men?
   a. They don’t produce any of the androgens necessary to promote body hair growth.
   b. They produce less androgens than men.
   c. Estrogen promotes a different pattern of hair growth in women.
   d. High levels of luteinizing hormone inhibits hair growth.
   e. Their body hair falls out during each menstrual cycle.
**Extra-credit:** Get some free stuff for simply filling out a survey – it’s just like the internet! (1 point each)

41. How often did you access lecture materials on BlueCast?
   a. Never
   b. A few times
   c. A middling number of times
   d. For many or all lectures

42. Did you find the lecture recordings on BlueCast to be
   a. of little or no help.
   b. somewhat helpful.
   c. very helpful.
   d. I already told you I didn’t look at them! Idiot.

43. Having figures drawn on the podium tablet meant they would show up in BlueCast, but they were generally lower resolution and kept me (Dr. Cullum) tied to the podium. Overall did you find
   a. having the figures drawn on the tablet more useful.
   b. having the figures drawn on the whiteboard more useful.
   c. Too close to call.

**Short answer:** Write a concise answer to each of the questions that begin on the next page. Your answers should fit in the spaces provided. Diagrams are welcome 
but must be accompanied by written explanations. Each question is worth 8 points.
44. Consider the control of oxygen levels in the body. Although this is not a tightly regulated variable, it is still normally defended if it drops below a certain partial pressure. Describe or diagram how the body’s $P_{O_2}$ is regulated in the context of a standard negative feedback loop. In your control loop, identify the sensor, afferent pathway, integrating center, efferent pathway and effector(s) as specifically as you can.

45. Graph an action potential. You need to indicate the approximate values for each axis, but there is some range for error. Next, on the graph or in a written description, indicate when the voltage-gated $Na^+$ and $K^+$ channels are opening and closing, and briefly explain how these events relate to the patterns seen in the action potential.
46. Diagram or describe the main hormonal pathway initiated in the hypothalamus that controls growth and tissue repair. Also briefly indicate how the release of these hormones varies throughout the day and throughout one’s lifetime.

47. Explain how a single action potential in a motor neuron triggers a twitch contraction in a myofiber (muscle cell). Describe the process from the arrival of acetylcholine at the sarcolemma (muscle membrane) to the end of the contraction. You do not need to describe anything that occurs in the sarcomeres.
48. Describe changes that occur in the cardiovascular system as a person moves from a resting state to a physically active one. In particular, indicate the changes that are seen in muscle, heart and the GI tract, and explain why the changes described are occurring.

49. Diagram or describe the hormonal pathways influenced by the release of renin. You need to indicate the factors that control the release of renin, but not the details of how this control is mediated by the juxtaglomerular apparatus.
50. Explain how fats are digested and absorbed in the small intestine. You do not need to describe the mechanisms controlling the release of digestive secretions into the intestine.

51. Describe the effects of increased release of insulin on metabolism (both anabolic and catabolic pathways) in the liver and in other body tissues.
52. Describe the process of spermatogenesis in men, including the cells and hormones involved. You do not need to describe any events that occur past the epididymis.

53. Diagram or describe the hormonal pathway controlling the events of the menstrual cycle as it is operating mid-way through the follicular phase (about day 7 of the cycle).
Extra-credit:  Wow – more chances for extra points! You have to think about this one, though.  (4 points)

54. Modern birth control pills are generally just a dose of progesterone that results in blood levels similar to those seen in the mid luteal phase. The result is that ovulation does not normally occur. What causes this result?