This key is for HALF of the final exam in Spring 2008. The other half was written in the short-answer, problem-solving style.

Due to constraints on grading, your final exam will be written entirely in the style that you see here. Please be sure that you understand the logic of it!
PLEASE be absolutely sure you read this page before you begin to answer questions on this part of the final exam. Failure to follow the instructions can destroy your score or make your exam impossible to machine-score, which gives you a grade of zero.

PLEASE NOTE: If we notice you have improperly marked answers or forgotten to bubble in your name, etc., we will attempt to fix your error, but we will charge you 10 points per minute for our work. Do it right, and avoid losing points unnecessarily! If you make errors and we do not catch them, the machine will score your exam as you wrote it.

Use the Scantron form provided. Answer the questions on the Scantron form as directed below AND put your Scantron into the box at the front of the room SEPARATE from the rest of the exam.

1. You MUST use a #2 pencil to fill in the circles on the answer sheet. Completely and darkly fill in the circles. Don’t make any extra pencil marks. As you fill in your answers, be certain you are on the correct response number. Fill in only one circle for any single line—the computer will count more than one filled circle as an incorrect response.

2. Begin by writing BOTH YOUR NAME AND YOUR STUDENT ID number on the back of the Scantron sheet AND COMPLETELY FILLING IN the corresponding circles below the letters and numbers. Remember: if we have to bubble these in for you it will cost you 10 points per minute of our time. Ignore the rest of the information requested.

3. I strongly suggest that you DON’T WRITE ON THE QUESTION SHEET! Mark your answers on the Scantron page. You CANNOT be given extra time to transfer answers to the Scantron. Leave the questions attached to your exam.

4. READ each question CAREFULLY. The questions are not intended to be tricky, but to answer them correctly you MUST understand exactly what each one says.

5. Notice there are 4 possible responses for each question and the responses are numbered sequentially. If a response correctly completes the initial phrase, completely fill in the circle under “A” on the Scantron sheet. If a response does not correctly complete the initial phrase, fill in the circle under “B” on the Scantron sheet. YOU WILL NEVER fill in circles C, D, OR E.

NOTE: If any part of a statement is false, the whole thing is false.

6. Any number of responses can be correct, from 0 to 4; any number of responses can be incorrect, from 0 to 4. We will not subtract points if you answer wrong, so guessing is OK!

Here is a sample question:

1. Blood plasma is:
   (1) Basically a saline fluid. A
   (2) Three times more viscous than water. B
   (3) Always a saturated solution of glucose. C
   (4) Able to cross most capillary walls. D

   Scantron answer: A 0 0 0 0
1. In ALL action potentials:

(1) Voltage-gated Na\(^+\) channels are necessary, but not sufficient.
(2) Na\(^+\)/K\(^+\) ATPase molecules contribute to repolarization.
(3) The rising phase depends either on the influx of cations or on the efflux of anions.
(4) \(V_m\) must become sufficiently inside-positive to open voltage-gated channels.

2. Myelination of axons:

(5) Increases conduction velocity by increasing the amplitude of action potentials.
(6) In the periphery consists of Schwann cells that wrap around an axon, with gaps between the cells.
(7) Is an evolutionary adaptation that allows axons to have smaller diameter.
(8) Eliminates the necessity for active propagation of signals along axons.

3. In synaptic transmission:

(9) Abnormally low [Ca\(^{2+}\)] in the interstitial fluid will inhibit exocytosis of fast, direct neurotransmitters, but will leave slow, indirect transmission relatively unchanged.
(10) Temporal summation depends on a burst of high-frequency action potentials along a pre-synaptic axon.
(11) An action potential will be elicited if post-synaptic receptors are brought to threshold.
(12) The signal ends when transmitter molecules are hydrolyzed in the synaptic cleft.

4. Post-synaptic potentials:

(13) May be caused by the flow of ions through channels that are opened by a change in the transmembrane potential.
(14) May be caused by the flow of ions through channels that are opened when a transmitter molecule binds to the channel protein.
(15) May be caused by the flow of ions through channels that are opened when intracellular second-messengers phosphorylate channel proteins.
(16) Follow Ohm’s law: \(\Delta V = \Delta I \times R\)

5. \(E_{ion}\) at an inhibitory synapse:

(17) May be more inside-negative than rest.
(18) May be more inside-positive than rest.
(19) May be more inside-positive than \(E_{Na}\).
(20) May be more inside-positive than threshold.

6. Graded potentials:

(21) In sensory neurons have an amplitude that is proportional to the intensity of stimulation.
(22) May be depolarizing.
(23) May be hyperpolarizing.
(24) Can sum at the neuromuscular junction to produce muscle action potentials.
7. Muscle-stretch reflexes:

(25) Are monosynaptic.
(26) Are characteristic of leg muscles, but are not found elsewhere in the body.
(27) Will remain functional following a devastating injury to the cervical spinal cord.
(28) Play a critical role in protecting the body from painful or damaging stimuli.

8. Pain and temperature sensory information:

(29) Is sensed by primary sensory neurons that synapse onto second-order neurons in the spinal cord.
(30) Is carried in the spinal cord ipsilateral to the site of stimulation.
(31) Like all somatosensory information is carried along axons in the dorsal spinal cord.
(32) Travels through the hypothalamus on its way to the cortex.

9. In motor pathways:

(33) Pyramidal tract axons control motor neurons innervating the arms and legs, whereas extrapyramidal tract axons control motor neurons innervating trunk muscles.
(34) All motor information is carried in the ventral spinal cord.
(35) Spinal motor neurons have cell bodies in the ventral horn ipsilateral to the muscle they control.
(36) Signals that originate in the primary motor cortex typically pass through the basal ganglia and cerebellum on the way to the spinal cord.

10. At least some unconscious visceral functions:

(37) Are controlled by some neurons in the basal ganglia.
(38) Are controlled by some neurons in the medulla.
(39) Are controlled by some neurons in the hypothalamus.
(40) Are controlled by some neurons in the cerebral cortex.

11. Gonadotropin-releasing hormone (GnRH):

(41) Is likely to be secreted in very large quantities, so it should be detectable in blood drawn from the elbow vein.
(42) Is synthesized by some neurons in the hypothalamus and is released into the hypothalamic-hypophyseal portal system.
(43) Would be released in smaller quantities in response to the exogenous estrogen in oral contraceptive pills.
(44) Stimulates cells in the adenohypophysis to release follicle-stimulating hormone and luteinizing hormone in both males and females.
12. Thyroid hormone:

(45) Like all amino acid-based hormones, is hydrophobic and binds to protein receptors in the plasma membrane of its target cells.
(46) Produces a change in transcription within its target cells, so its effects are long-lasting.
(47) Is released under the control of a pituitary hormone, thyroid-stimulating hormone (TSH).
(48) Generally increases the metabolic rate in most cells.

13. Skeletal muscle fibers:

(49) Each contain a single nucleus.
(50) Contain fragments of the organelle called sarcoplasmic reticulum.
(51) Contract when [Ca\textsuperscript{2+}]\textsubscript{cytoplasm} increases.
(52) Produce force only when they can shorten.

14. Human skeletal muscles:

(53) Normally include both glycolytic fibers and oxidative fibers.
(54) In a sprinter’s legs would probably be changed into glycolytic fibers following many months of training.
(55) Produce more force per cross-sectional area if they contain a large proportion of fast-twitch fibers.
(56) Get bigger during weight-training because more fibers are added to the muscle.

15. In rigor mortis muscles stiffen, which demonstrates that:

(57) Oxidative metabolism is not required in order for muscles to contract.
(58) ATP is required to break the bonds between actin and myosin.
(59) ATP is required to keep [Ca\textsuperscript{2+}]\textsubscript{cytoplasm} low.
(60) Different parts of the body cease functioning at different times after “death.”

16. Cardiac contractile fibers:

(61) Are coupled by way of gap junction proteins, which keep the fibers from being torn apart during the large forces produced during contraction.
(62) Cannot enter a state of tetanus because the production of force lasts only a little longer than does depolarization.
(63) Contract simultaneously in the entire heart, increasing cardiac effectiveness.
(64) Produce the electrical fields that are recorded by electrocardiography.

17. Cardiac pacemaker fibers:

(65) Produce Ca\textsuperscript{2+}-based action potentials.
(66) Contain thick filaments and thin filaments, but these structures are not organized into sarcomeres.
(67) Are electrically coupled to other pacemaker/conducting fibers and to contractile fibers.
(68) Are evenly distributed throughout the heart.
18. Which of the following statements is/are true in contraction of cardiac muscle?

- Dihydropyridine receptors are activated by an action potential and allow Ca\textsuperscript{2+} ions to cross the plasma membrane.
- Calcium-mediated Ca\textsuperscript{2+} release through ryanodine receptors in the membrane of sarcoplasmic reticulum adds Ca\textsuperscript{2+} to the cytoplasm.
- Tropomyosin moves to reveal myosin-binding sites on thin filaments.
- ATP binds to a vacant nucleotide-binding site on the myosin head, causing it to dissociate from actin.

19. Cardiac output would decrease if:

- Stroke volume decreased, with no other change.
- Heat rate dropped, with no other change.
- Parasympathetic activity onto the contractile fibers increased.
- The level of circulating epinephrine increased.

20. In a lead II EKG:

- The downward phase of the P wave indicates repolarization of atrial fibers.
- The upward segment of the QRS complex indicates that depolarization is moving through the ventricles from rostral to caudal.
- The downward segment of the QRS complex is associated with contraction of the ventricles.
- The T wave is associated with relaxation of the ventricles, which proceeds from caudal to rostral.

21. Consider the left side of the heart during a single cardiac cycle:

- Pressure in the atrium is greater than pressure in the ventricle during isovolumetric filling.
- Pressure in the ventricle is greater than pressure in the atrium when the bicuspid valve closes.
- The volume of the ventricle drops during ejection because pressure in the ventricle exceeds pressure in the aorta and the aortic valve is pushed open.
- During isovolumetric relaxation, ventricular fibers remain depolarized, but intraventricular pressure has dropped because blood has entered the aorta.

22. When you exercise, the preload in your left ventricle increases somewhat.

- This increase would cause an increase in stroke volume.
- This increase would cause an increase in contractility.
- This increase would cause an increase in heart rate.
- This increase would cause a decrease in the ejection fraction.
23. Venous return to the heart increases:

(89) If cardiac output increases.
(90) When large skeletal muscles contract rhythmically producing the “muscle pump” effect.
(91) If total peripheral resistance increases in a person who is lying flat on his back.
(92) During each exhalation, caused by changes in intrathoracic pressure.

24. A decrease in:

(93) Activity in most parasympathetic post-ganglionic neurons would have no effect on vasodilation.
(94) Circulating epinephrine released from the adrenal medulla would cause an increase in peripheral resistance.
(95) Stroke volume would increase pulse pressure.
(96) Blood volume, caused by hemorrhage, would lead to reflex vasoconstriction.

25. Osmolarity:

(97) Indicates the total number of solute particles in a solution; one liter of a 1 Osmolar solution contains Avagadro’s number of solute particles.
(98) Indirectly indicates the partial molar fraction of water in the solution: a high osmolarity indicates a low partial molar fraction of water.
(99) Of 10 mM CaCl$_2$ is 20 mOsm.
(100) Of 300 mM fructose is 300 mOsm.

26. The kidneys:

(101) Indirectly regulate blood pressure.
(102) Regulate the osmolarity of all body fluid compartments.
(103) Trap urea in the renal medulla via a countercurrent multiplier system.
(104) Are characterized by high expression of the Na$^+$/K$^+$ ATPase protein.

27. During normal nephron function:

(105) Blood enters the nephron by absorption from the glomerular capillary into Bowman’s capsule.
(106) Glucose is freely filtered into the nephrons, and about 65% of the filtered glucose is reabsorbed along the proximal tubule.
(107) Na$^+$/K$^+$ ATPase molecules are selectively inserted into the serosal membrane of nephron epithelial cells.
(108) Some solutes cross the wall of the nephron through the paracellular pathway, and others cross through the transcellular pathway.
28. In a nephron:

(109) Water is actively reabsorbed as tubular fluid moves along the proximal convoluted tubule.
(110) $\text{Na}^+$ leaves the tubular fluid as the fluid moves along the ascending thin limb of the loop of Henle.
(111) Water is reabsorbed secondary to solute transport as tubular fluid moves along the thick ascending limb of the loop of Henle.
(112) Aquaporins are expressed in all epithelial cells, but some of the aquaporins are open all of the time, whereas others are gated.

29. Somewhere along each nephron:

(113) Water is reabsorbed.
(114) $\text{Na}^+$ is secreted.
(115) Creatinine is reabsorbed.
(116) Penecillin is secreted.

30. In a patient with psychogenic polydipsia (drinking excessive volumes of water, caused by psychological problems) you would expect to see:

(117) Production of an unusually large volume of urine.
(118) Dilute plasma compartment, but normal concentration of interstitial fluid and intracellular compartments.
(119) Increase in the circulating levels of antidiuretic hormone.
(120) Increase in the circulating levels of atrial natriuretic hormone.