Name: _____

Physiology: Cardiovascular System Worksheet: The Heart

Directions: Write in and circle best answer on this sheet.

The Cardiovascular System Consists of the Heart and Blood Vessels

1. The cardiovascular system is a _____ system, this means that the blood is always contained within the heart and blood vessels. The total blood volume for an average sized man is about _____.

2. The heart is a central _____ and the vessels are the structures that circulate _____ to and from the heart, lungs, and the body.

3. An artery is:

4. A vein is:

5. There are ___ chambers in the heart, the top ___ chambers are called _____ and they _____ blood. The bottom ___ chambers are called _____ and they _____blood.

6. The pulmonary circuit can be described as going from the _____ ventricle to the _____ atrium.

7. The systemic circuit can be described as going from the _____ ventricle to the _____ atrium.

8. The volumes of blood in each of the two circuits is _____. This means that in a healthy person, the volume of blood in the systemic circuit is always (*half/the same as/double/triple?*) the volume of blood in the pulmonary circuit. *(Circle one!)*

9. The pressure of blood in each of the two circuits is _____. In a healthy person, the pressure of blood in the systemic circuit is always (*half/the same as/double/triple?*) that of the pressure of blood in the pulmonary circuit.

10. The anatomy of the heart indicates purpose in that the walls of the **left ventricle** are about ____ times the thickness of the walls of the right ventricle. This is because the pressure generated by the left ventricle is about ____ times that of the right ventricle.

11. The reason for the differences in the pressures between the two circuits is because the systemic circuit pumps blood _____, covering a greater _____ than the pulmonary circuit.

12. There is a band of fibrous connective tissue in the heart that physically separates the atria (the top chambers) form the ventricles (the bottom chambers). It has 3 very important functions. Name 3 functions of the **fibroskeleton** surrounding the openings to major arteries and chambers (on page 375 of OER text).

1)

2)

3)

13. There are ___ heart valves; ___ atrioventricular (AV) valves and ___ semilunar valves. The right AV valve is called the _____ AV valve and the left AV valve is called the _____ AV valve, or the _____ valve.

There are two types of Cardiac Muscle Cells (Myocardiocytes)

14. About **1%** of the cardiac muscle cells are called _____ myocardiocytes. This is because they generate their own spontaneous, rhythmic _____. This also means that these cells send signals without stimulation from the _____ system. The heart therefore controls itself, a term for this is: _____ _____ _____. [Hint: it's a term that says 'within the muscle itself, control is generated'].

15. The remaining **99%** of cardiac muscle cells are called _____ myocardiocytes. This is because they _____ and generate _____. They require a _____ in order to have an action potential. The purpose of an action potential in a muscle cell is to create a signal for the muscle cell to _____, shorten, and generate tension or force.

16. A distinct structure of cardiac muscle are the _____ _____. These contain two structures: **1)** the _____ _____ for cell to cell communication, and **2)** they have also _____ that function to hold the tissue together during continuous mechanical distention.

Excitation-Contraction Coupling in Cardiac Muscle is Similar to and Skeletal Muscle

17. In cardiac muscle, an action potential (AP) initiates excitation-contraction coupling (meaning that the AP is a signal that triggers muscle to contract). These AP's originate spontaneously in the hearts pacemaker (autorhythmic) cells and spreads into the contractile cells through the _____ _____.

18. As the AP travels along the sarcolemma of the contractile myocardiocyte, it triggers _____ sensitive _____ channels in the T-tubules to open. The result is an _____ of _____ ions travelling (*into/out of*) the cell (*to/from*) the extracellular fluid (ECF).

19. On the **sarcoplasmic reticulum** (SR) within cardiac muscle cells are _____ receptors and the incoming _____ binds to these receptors and triggers the opening of gates on the SR, which then allows for the release of the internally stored _____. (See page 381 of OER text)

20. There are 2 sources of Ca^{2+} in contractile myocardiocytes: **1)** From the _____ ; and **2)** from the _____.

21. The Ca^{2+} released from the SR provides about _____ of the Ca^{2+} needed for muscle contraction.

22. In cardiac muscle, when cytoplasmic Ca^{2+} concentrations decrease, muscle tension _____.

23. What are the two ways that Ca^{2+} is **removed** from the cytoplasm of cardiac muscle cells?
1)

2)

24. For the Na^{+}/Ca^{2+} antiport protein, _____ Ca^{2+} moves _____ cell for every _____ Na^{+} moving _____.

25. When Ca^{2+} is re-sequestered into the SR, it requires _____ ATP to move _____ Ca^{2+} _____ the SR. In relation to cardiac physiology and for review purposes, the Na^{+}/K^{+} antiport protein, moves _____ K^{+} _____ cell for every _____ Na^{+} moving _____ cell.

Cardiac Muscle Contraction can be Graded (Varied) in terms of Force

26. The force generated by cardiac muscle is proportional to the number of crossbridges that are active. The number of active crossbridges is determined by _____.

27. Which of the following is true about what happens to resting cardiac muscle when it is <u>stretched</u>?

a) The length of the sarcomere stretches toward the optimal length and generates more force.
b) Gap junctions are opened by this stretching and allow ions in that increase force.
c) Stretch sensitive channels are opened allowing more Ca^{2+} to enter and generate greater force.
d) This causes Na^{+} influx that reduces the force of contraction.
e) Both a and c are correct.

Action Potentials in Autorhythmic Myocardiocytes

28. In the autorhythmic cells the membrane potential is not stable, but fluctuates or 'drifts' from _____mV to _____ mV. The threshold for these cells is _____ mV. At threshold, this triggers the opening of _____ ion channels, and the rapid _____ of this creates the depolarization phase.

29. The depolarization phase is caused by: _____.

30. The repolarization phase is caused by: _____.

31. Is there a hyperpolarization phase to this autorhythmic AP? Briefly explain: [Hint: Influenced by ANS]

Action Potentials in Contractile Myocardiocytes

32. In the contractile myocardiocytes the resting membrane potential is _____ mV. The threshold for these cells is _____ mV.

33. The depolarization phase is caused by: _____.

34. The plateau phase is caused by: _____.

35. The repolarization phase is caused by: _____.

36. Is there a hyperpolarization phase to this AP? _____. Is there a refractory period? _____.

The Heart as an Elegantly Coordinated Conductor

37. List the 5 main component of the electrical conduction system of the heart in firing sequence.

38. Which of the areas listed above is the normal *Pacemaker* of the heart? _____.
39. The Location of the SA node is: _____.
40. The Location of the L and R Bundle branches is: _____.

The Cardiac Cycle is a way of Describing the Details One Heart Beat

41. List the main attributes of the two key words **Diastole** and **Systole** for cardiac activity in table below.

Diastole	Systole

There are 5 Phases in the Cardiac Cycle: Each is presented below

1) Atrial and Ventricular Diastole: The Heart at 'Rest'!

42. Is the heart in atrial and ventricular diastole at the same time during this phase? _____.

43. When both the atria and ventricles are relaxing, which valves are open? _____.

44. Is blood flowing into the heart? _____. Which chambers? _____.

2) Atrial Systole: Completion of Ventricular Filling.

45. In a person at rest, how much of ventricular filling depends on atrial contraction? _____.

46. What wave/segment on the ECG immediately precedes this phase? _____.

47. Does EDV occurs at the end of this phase? _____ What is that normal volume at rest? _____.

3) Ventricular Systole Part 1 (and the first heart sound):

48. What electrical event precedes ventricular systole? _____. As the ventricles contract, why do the AV valves close? _____.

49. What creates the heart sounds? _____.

50. What is happening to the volume during isovolumetric ventricular contraction? _____.

51. What happens to pressure in the ventricles during isovolumetric ventricular contraction? _____.

4) Ventricular Systole Part 2: Ventricular Ejection

52. Why do the semilunar valves open, allowing blood to be ejected into the arteries?

53. If blood flows out of ventricles then ventricular pressure must be (*lower/higher?*) than arterial pressure.

5) Ventricular Diastole (and the second heart sound):

54. As the ventricles relax, the ventricular pressure (*increases/decreases?*).

55. Why do the semilunar valves close? _____.

56. When do the AV valves open? _____.

57. What is mitral valve stenosis? _____.

58. What can it result in? _____.

59. What is AV valve prolapse? _____.

60. What can it result in? _____.

Stroke Volume is the Volume of Blood Pumped by one Ventricle in one Contraction

61. Define stroke volume. (Give units!)_____.

62. How do you calculate stroke volume? _____.

63. If the EDV increases and the ESV decreases, has the heart pumped more or less blood? _____.

Cardiac Output is a Measure of Cardiac Performance

64. Define cardiac output (CO). (Give units!) _____.

65. For the average values for stroke volume and heart rate for a 70 kg man, calculate CO at rest:

66. How would CO change during exercise? It would _____. Why? _____.

Heart Rate is Modulated by Autonomic Neurons and Catecholamines

67. Explain the antagonistic control of heart rate by parasympathetic and sympathetic neurons that innervate the heart. Name the main nerves that convey parasympathetic and sympathetic innervation, the neurotransmitters they release, and their receptors at the SA node.

Para:

Sym:

Multiple Factors Influence Stroke Volume

68. Stroke volume is directly related to the _____ generated by cardiac muscle during contraction.

69. Venous return is simply defined as: _____.

70. a) End diastolic volume (EDV) is the _____of the ventricles. 'Preload' is another way of expressing EDV. Therefore, the greater the preload/venous return/EDV, the _____ the stroke volume. Conversely, the lower the preload/venous return/EDV, the _____ the stroke volume.

b) In the heart, the term afterload is described as the force that the ventricles must generate to pump blood _____. An increase in resistance requires a/an _____ in afterload to force open the semilunar valves and pump the blood into the arteries. If there is an increased afterload, this causes a/an _____ in stroke volume (SV). Conversely, a decreased afterload causes a/an _____ SV.