1 **Electrocardiography for Healthcare Professionals**

Chapter 2:
The Cardiovascular System

2 **Learning Outcomes**

2.1 Describe circulation as it relates to the ECG.

2.2 Recall the structures of the heart.

2.3 Differentiate between the pulmonary, systemic and coronary circulation.

2.4 Explain the cardiac cycle, and relate the difference between systole and diastole.

3 **Learning Outcomes (Cont'd)**

2.5a Describe the parts and function of the conduction system.

2.5b Recall the unique qualities of the heart and their relationship to the cardiac conduction system.

2.5c Explain the conduction system as it relates to the ECG.

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4 **Learning Outcomes (Cont'd)**

2.6a Identify each part of the ECG waveform.

2.6b Describe the heart activity that produces the ECG waveform.

5 **2.1 Circulation and the ECG**

- Transports blood
- Muscular pump
- Electrical activity
- ■

6 **2.1 Apply Your Knowledge**

What is the function of the heart?

7 **2.1 Apply Your Knowledge**

What is the function of the heart?

8 **2.2 Anatomy of the Heart**

- Lies in center of chest
- Under sternum
- Between the lungs
- The size of your fist
- Weighs 10.6 oz or 300 grams

9 **2.2 Heart Statistics**

- Average beats per minute = 72
- Total output = 5 liters per minute

10 **2.2 Heart Anatomy**

- Pericardium
- Pericardial space
- Epicardium
- Myocardium
- Endocardium
-

11 **2.2 Heart Layers**

12 **2.2 Heart Chambers**

13 **2.2 Heart Valves**

- ☐Tricuspid valve
- ☐Mitral (bicuspid) valve
- ☐Semilunar valves

14 **2.2 Heart Vessels**

- Vena cava
- Pulmonary artery
- Pulmonary veins
- Aorta
- Coronary arteries

15 **2.2 Heart Valves and Vessels**

16 **2.2 Apply Your Knowledge**

Which valve of the heart lies between the left atrium and the left ventricle?

17 **2.2 Apply Your Knowledge**

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18 **2.2 Apply Your Knowledge**

Name the three layers of the heart.

19 **2.2 Apply Your Knowledge**

Name the three layers of the heart.

20 **2.3 Principles of Circulation**

- Pulmonary
- Systemic
- Coronary

21 **2.3 Pulmonary Circulation**

- Enters right atrium
- Blood passes through the tricuspid valve to the right ventricle
- Right ventricle pumps to the lungs
- Blood returns into the left atrium

22 **2.3 Systemic Circulation**

- Enters the left atrium and passes through into the left ventricle
- The left ventricle pumps to the aorta
- From the aorta, blood circulates throughout the body
- Deoxygenated blood returns to the heart

23 **2.3 Coronary Circulation A**

24 **2.3 Coronary Circulation B**

25 **2.3 Coronary Circulation**

- Oxygenated blood travels from left ventricle to the coronary arteries
- Coronary arteries supply entire heart
- Deoxygenated blood returns to the right atrium

26 **2.3 Apply Your Knowledge**

Which vessels transport blood from the lungs to the left atrium?

27 **2.3 Apply Your Knowledge**

Which vessels transport blood from the lungs to the left atrium?

28 **2.4 The Cardiac Cycle**

29

2.4 The Cardiac Cycle (Cont'd)

30 **2.4 Diastole – Relaxation Phase**

- Blood returns to the heart via the superior and inferior vena cava
- Blood flows from the right atrium into the right ventricle
- Blood from the pulmonary veins flows from the left atrium into the left ventricle

31 **2.4 Systole – Contraction Phase**

- Contraction creates pressure, opening the pulmonary and aortic valves
- Blood from the right ventricle flows to the lungs
- Blood from the left ventricle flows through the aorta to the body

32 **2.4 Apply Your Knowledge**

The relaxation phase of the cardiac cycle is known as:

33 **2.4 Apply Your Knowledge**

The relaxation phase of the cardiac cycle is known as:

34 **2.5 Unique Qualities of the Heart**

- Automaticity
- Conductivity
- Contractivity
- Excitability

35 **2.5 Regulation of the Heart**

- Autonomic Nervous System
  - ☐Speeds up or slows down the heart rate
  - ☐Sympathetic branch can increase the heart rate
  - ☐Parasympathetic branch can decrease the heart rate

36 **2.5 Pathways for Conduction**

- SA node
- AV node
- Bundle of His
- Bundle branches

- Purkinje fibers
-

37 **2.5 Sinoatrial (SA) Node**

- Located in upper right portion of right atrium
- Initiates the heartbeat
- Pacemaker of the heart (60-100 beats per minute)
- Normal conduction begins in SA node

38 **2.5 Atrioventricular (AV) Node**

- Located on the floor of the right atrium
- Causes delay in the electrical impulse, allowing for blood to travel to ventricles
- Can act as pacemaker if SA node is not working (40-60 bpm)

39 **2.5 Bundle of His (AV bundle)**

- Located next to the AV node
- Transfers electrical impulses from the atria to the ventricles via bundle branches
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40 **2.5 Bundle Branches**

- Split the electrical impulse down the right and left side
- From interventricular septum, the impulse activates myocardial tissue, causing contraction
- Contractions occur in left-to-right pattern
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41 **2.5 Purkinje Fibers**

- Electrical pathway for each cardiac cell
- Impulse activates left and right ventricles simultaneously
- Produce an electrical wave
-

42 **2.5 Conduction System**

43 **2.5 Conduction System**

44 **2.5 Apply Your Knowledge**

What is the ability of the heart to generate an electrical impulse called?

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46 **Apply Your Knowledge**

Which part of the conduction system is known as the pacemaker of the heart?

47 **Apply Your Knowledge**

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48 **2.6 Electrical Stimulation**

- Depolarization
  - ☐State of stimulation, preceding contraction
  - ☐Electrical activation of heart cells
  - ☐Causes the heart to contract

- Most important electrical event

49 **2.6 Electrical Stimulation (Cont'd)**

- Repolarization
  - State of cellular recovery, following contraction
  - Cell returns to a resting state
  - Heart relaxes, allowing for refilling of the chambers

50 **2.6 ECG Waveform**

- Recorded activity of depolarization and repolarization
- Isoelectric line or baseline
- Labeled P,Q,R,S,T
-

51 **2.6 ECG Waveform (Cont'd)**

- P wave
  - First positive deflection
  - Occurs when the atria depolarize
  - Small compared to other ECG waves
  -

52 **2.6 ECG Waveform (Cont'd)**

- QRS complex
  - Q wave
    - Represents conduction of impulse down the interventricular septum
    - First negative deflection before the R wave
    - Not always visualized on the ECG
    - Less than 1/4 the height of the R wave

53 **2.6 ECG Waveform (Cont'd)**

- QRS complex
  - R wave
    - First positive wave of the QRS complex
    - Represents conduction of electrical impulse to the left ventricle
    - Usually easiest to find

54 **2.6 ECG Waveform (Cont'd)**

- QRS complex
  - S wave
    - First negative deflection after the R wave
    - Represents conduction of electrical impulse through both ventricles

55 **2.6 ECG Waveform (Cont'd)**

- QRS complex
  - Represents complete ventricular depolarization
  - Reflects the time required for impulses to activate the ventricular myocardium to contract

56 **2.6 ECG Waveform (Cont'd)**

- ST segment
  - Measured from end of the S wave to the beginning of T wave
  - Indicates end of ventricular depolarization and beginning of ventricular repolarization
  - Elevated ST segment indicates myocardial damage

57 **2.6 ECG Waveform (Cont'd)**

- T wave
  - ☐Represents ventricular repolarization
  - ☐Normal T wave is in same direction as R wave and P wave

58 **2.6 ECG Waveform (Cont'd)**

- U wave
  - ☐Follows the T wave
  - ☐Represents repolarization of Bundle of His and Purkinje fibers
  - ☐Not on all ECGs
  - ☐Presence can indicate an electrolyte imbalance

59 **2.6 ECG Waveform (Cont'd)**

- PR interval
  - ☐Measured from beginning of P wave to beginning of QRS complex
  - ☐Normal length of time is 0.12-0.20 second
  - ☐Interval should be consistent

60 **2.6 ECG Waveform (Cont'd)**

- QT interval
  - ☐Time required for ventricular depolarization and repolarization to occur
  - ☐Starts at beginning of QRS complex and ends at end of T wave
  - ☐Includes QRS complex, ST segment, and T wave

61 **2.6 ECG Waveform (Cont'd)**

- R to R interval
  - ☐Measurement of time from start of one QRS complex to start of next QRS complex
  - ☐Used to calculate heart rate
  - ☐Readily seen on ECG

62 **2.6 ECG Waveform (Cont'd)**

- J point
  - ☐Junction of the QRS interval and the ST interval
  - ☐Represents end of the QRS complex and ventricular depolarization
  - ☐Important when measuring the length of the QRS complex

63 **2.6 ECG Waveform (Cont'd)**

64 **2.6 Apply Your Knowledge**

Which wave on the ECG waveform represents ventricular repolarization?

65 **2.6 Apply Your Knowledge**

Which wave on the ECG waveform represents ventricular repolarization?

66 **2.6 Apply Your Knowledge**

What is the normal length of time for the PR interval?

67 **2.6 Apply Your Knowledge**

What is the normal length of time for the PR interval?

68 **Chapter Summary**

- The heart consists of four chambers and four valves
- Blood travels through the pulmonary and systemic circulation
- Coronary circulation supplies blood to the coronary arteries

69 **Chapter Summary (Cont'd)**

- The cardiac cycle consists of a contraction phase and a relaxation phase
- Diastole is known as the relaxation phase and systole is the contraction phase
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70 **Chapter Summary (Cont'd)**

- The conduction system of the heart together maintains electrical activity
- The conduction system and conducting tissue have qualities that control the heartbeat
- The conduction system creates the electrical activity and thus the ECG waveform

71 **Chapter Summary (Cont'd)**

- Depolarization causes the heart to contract, repolarization allows for cellular recovery
- The ECG waveform includes the P wave, QRS complex, T wave, U wave, PR interval, QT interval, and ST segment

72 **Chapter Summary (Cont'd)**

- The ECG waveform is created by the various activities of the conduction system
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