Conduction System of the Heart and Electrocardiography

**The Intrinsic Conduction System**

1. **List the elements of the intrinsic conduction system** in order starting from the SA node.

   SA node $\longrightarrow$ **AV node** $\longrightarrow$ **AV bundle (bundle of His)** $\longrightarrow$

   **left and right bundle branches** $\longrightarrow$ **Purkinje fibers**

   Which of those structures is replaced when an artificial pacemaker is installed? **SA node**

   At what structure in the transmission sequence is the impulse temporarily delayed? **AV node**

   Why? _Allows completion of atrial contraction before initiation of ventricular systole._

2. **Even though cardiac muscle has an inherent ability to beat, the nodal system plays a critical role in heart physiology._**

   What is that role? _Ensures that depolarization proceeds in an orderly manner from atria to ventricles; accelerates and coordinates heart activity._

3. **How does the “all-or-none” law apply to normal heart operation?**

   _The myocardium (heart as a whole) beats as a unit as long as the intrinsic conduction system is operative and the heart muscle is healthy._

**Electrocardiography**

4. **Define ECG:** _Recording of electrical changes occurring during heart activity._

5. **Draw an ECG wave form representing one heartbeat.** Label the P, QRS, and T waves; the P-R interval; the S-T segment; and the Q-T interval.

![ECG Wave Form](image)
6. **What is the normal length of the P-R interval?**

When the heart rate increases, which interval becomes shorter?

7. **What changes from baseline were noted in the ECG recorded during running?**

   *None. The rate and strength of heart contractions is increased but the electrical current pattern height remains unchanged. ↑ rate; ↓ Q-T interval.*

   Explain why these changes occurred. *Both increased body heat and muscular activity enforce a faster heart rate. During exercise, cardiac output increases in almost linear proportion to the increased oxygen needs. This is mediated through sympathetic nerves.*

   **What changes in baseline were noted during breath holding?**

   *See ↑ rate of heartbeat as above, but mechanism differs.*

   Explain these changes. *Even though O₂ exchange is still occurring, CO₂ accumulation ↓ blood pH, causing cerebral vessel vasodilation and exciting sympathetic centers, which in turn cause a reflex increase in heart rate and ↑ the respiratory drive.*

8. **Describe what happens in the cardiac cycle in the following situations:**

   1. during the P wave: **depolarization of the atria**
   2. immediately before the P wave: **the heart is in relaxation (diastole)**
   3. immediately after the P wave: **contraction of the atria**
   4. during the QRS wave: **depolarization of the ventricles**
   5. immediately after the QRS wave (S-T interval): **contraction of the ventricles**
   6. during the T wave: **repolarization of the ventricles**

9. **Define the following terms:**

   1. **tachycardia** Heart rate over 100 beats/min.
   2. **bradycardia** Heart rate below 60 beats/min.
   3. **flutter** Extremely rapid but coordinated heart activity, e.g. atrial flutter = 300 beats/min.
   4. **fibrillation** Very rapid uncoordinated myocardial activity.
   5. **myocardial infarction** Region of dead myocardium that does not depolarize.
10. **Which would be more serious, atrial or ventricular fibrillation?** Ventricular fibrillation

Why? *The ventricles bear major responsibility for ejecting blood from the heart.*

11. Abnormalities of heart valves can be detected more accurately by auscultation than by electrocardiography. Why is this so?

*Most often serious valve problems can be detected (heard) with a stethoscope. However, since valves are not part of the depolarization pathway of the heart, their inefficiency would not be recorded on an ECG.*