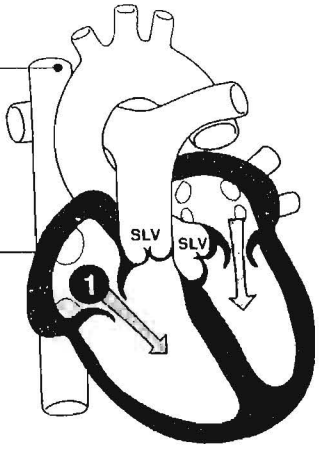
Heart Function

The **cardiac cycle** refers to the sequence of events of a heartbeat. The pumping of the heart consists of alternate contractions (**systole**) and relaxations (**diastole**). During a complete cycle, each chamber undergoes a systole and a diastole. For a heart beating at 75 beats per minute, one cardiac cycle lasts about 0.8 seconds. Pressure changes within the heart's chambers generated by the cycle of contraction and relaxation are responsible for blood movement and cause the heart valves to open and close, preventing the backflow of blood. The noise of the blood when the valves open and close produces the heartbeat sound (**lubb-dubb**).

The Cardiac Cycle

The **pulse** results from the rhythmic expansion of the arteries as the blood spurts from the left ventricle. Pulse rate therefore corresponds to heart rate.

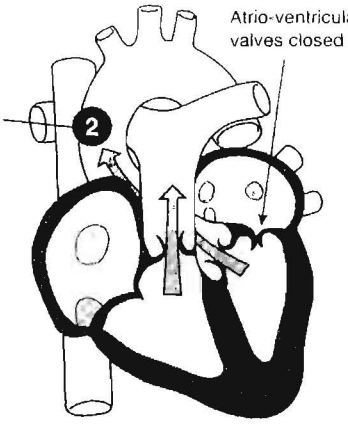
Stage 1: Atrial systole and ventricular filling The ventricles relax and blood flows into them from the atria. Note that 70% of the blood from the atria flows passively into the ventricles. It is during the last third of ventricular filling that the atria contract.



Heart during ventricular filling

Stage 2: Ventricular systole The atria relax, the ventricles contract, and blood is pumped from the ventricles into the aorta and the pulmonary artery. The start of ventricular contraction coincides with the first heart sound.

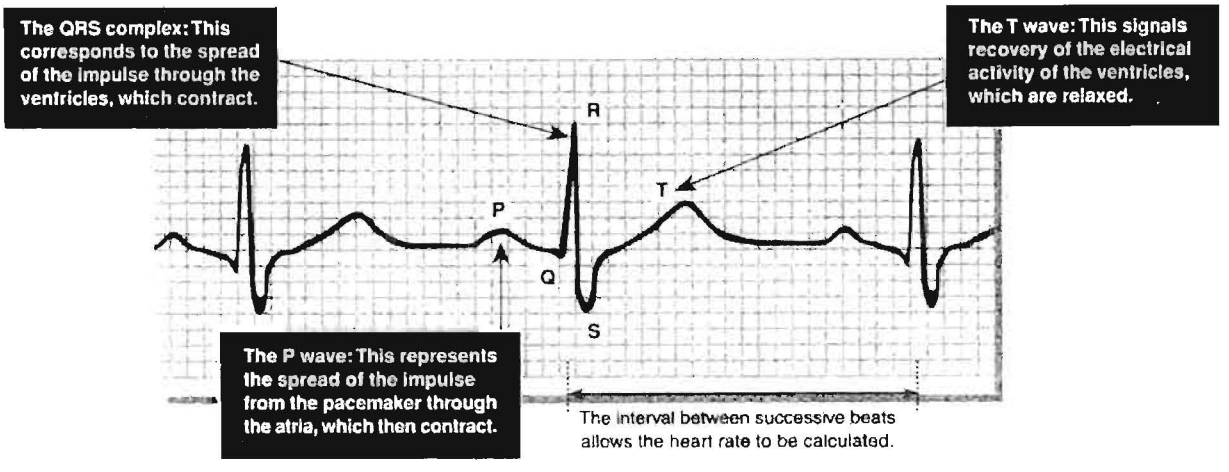
Stage 3: (not shown) There is a short period of atrial and ventricular relaxation (diastole). Semilunar valves (**SLV**) close to prevent backflow into the ventricles (see diagram, left). The cycle begins again.



Heart during ventricular contraction

The Cardiac Cycle and the ECG

The electrical impulses transmitted through the heart generate electrical currents that can be detected by placing metal electrodes on the body's surface. They can be recorded on a heart monitor as a trace, called an **electrocardiogram** or ECG. The ECG pattern is the result of the different impulses produced at each phase of the **cardiac cycle**. A normal ECG (below) shows a regular repeating pattern of electrical pulses. Each wave of electrical activity brings about a corresponding contraction in the part of the heart receiving the electrical impulse. Each part of the ECG is given a letter according to an international code (below). An ECG provides a useful method of monitoring changes in heart rate and activity and detection of heart disorders.



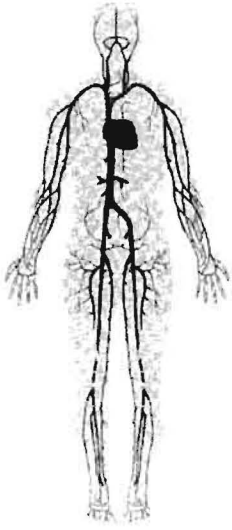
1. Identify each of the following phases of an ECG by its international code:
   (a) Excitation of the ventricles and ventricular systole: R
   (b) Electrical recovery of the ventricles and ventricular diastole: T
   (c) Excitation of the atria and atrial systole: P
2. Suggest the physiological reason for the period of electrical recovery experienced each cycle (the T wave):

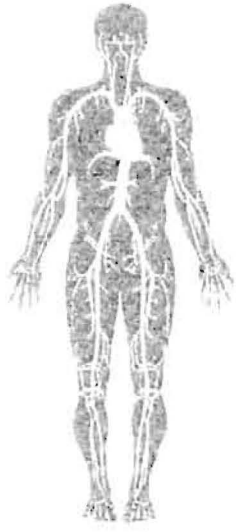
Mammalian Transport

The blood vessels of the circulatory system form a vast network of tubes that carry blood away from the heart, transport it to the tissues of the body, and then return it to the heart. The arteries, arterioles, capillaries, venules, and veins are organized into specific routes to circulate the blood throughout the body. The figure below shows a number of the basic **circulatory routes** through which the blood travels. Mammals have a **double circulatory system**: a **pulmonary system** (or circulation), which carries blood between the heart and lungs, and a **systemic system** (circulation), which carries blood between the heart and the rest of the body. The systemic circulation has many subdivisions. Two important subdivisions are the coronary (cardiac) circulation, which supplies the heart muscle, and the **hepatic portal circulation**, which runs from the gut to the liver.

Schematic Overview of the Human Circulatory System

Deoxygenated blood (colored gray below) travels to the right side of the heart via the vena cavae. The heart pumps the deoxygenated blood to the lungs where it releases carbon dioxide and receives oxygen. The oxygenated blood (colored white below) travels via the pulmonary vein back to the heart from where it is pumped to all parts of the body. The **venous system** (figure, left) returns blood from the capillaries to the heart. The **arterial system** (figure right) carries blood from the heart to the capillaries. **Portal systems** carry blood between two capillary beds.





VENOUS SYSTEM

ARTERIAL SYSTEM