What is the purpose of the circulatory system?

1. To deliver nutrients and oxygen to every cell
2. To remove wastes
3. To carry disease-fighting agents, hormones, and other chemical messengers.
4. To control body temperature in warm-blooded organisms.
Simple Transport

Amoeba

This unicellular organism lacks an organized transport system.

Simple diffusion or active transport across the cell membrane is used to carry materials in and out of the cell.
Amoeba

Materials are distributed around the cell by a process known as cytoplasmic streaming.
Hydra

This multicellular animal lacks an organized transport system. It has a central body cavity around which it’s body cells are closely arranged. Water enters the cavity bringing dissolved gases, and foods are able to dissolve into individual cells.
Hydra
Planarian

Similar to the hydra, a planarian relies on direct diffusion of materials across the cell membrane of individual cells to transport materials to and from the external environment.

The planarian also has a central body cavity that is used for transport to internal cells.
Planarian

Dugesia sp. Planaria Wholemount

Auricle
Eyespot
Pharynx
Gastrovascular cavity
Specialized Transport Systems

In more complex organisms, simple diffusion cannot supply or remove materials at a speed needed to maintain the metabolism of the organism.

A specialized transport system is needed to deliver materials to deep cells at a rapid rate.
An open transport system is one where the transport fluid does not remain within blood vessels, but instead bathes body organs directly to allow for diffusion of nutrients, gases and wastes between organs and the transport fluid.
Open Transport System

Grasshoppers and other insects have an open transport system. Grasshoppers do not have blood as their transport fluid – instead the fluid is known as **haemolymph**.

Haemolymph delivers hormones, nutrients and waste, but not gases. (since their gas exchange system does this directly)
Grasshopper
Disadvantages of an Open Transport System

1. Because the fluid sloshes around in the body cavity, it’s rate of circulation is slow. It is an adequate system in insects because their metabolism is lower, and their body cavities are small.

2. Fluid circulation is poorly controlled. If transport fluid is needed in one area of the body, it may not easily be directed there.
Closed Transport System

In a **closed transport system**, transport fluids are always contained within blood vessels. The fluid may move through large blood vessels involved in pumping, or through small blood vessels across which materials diffuse to and from individual cells.
Earthworms

The earthworm has the simplest closed circulatory system. The system consists of 2 large blood vessels (dorsal and ventral b.v.), a system of capillaries, blood and series of 5 pairs of hearts (aortic arches).

Blood in earthworms has the same pigment (hemoglobin) found in vertebrates but it is not found in red blood cells; rather it is just in the fluid. It carries gases around the worms body.
Earthworm
Fish

Fish have a true 2-chambered heart to pump blood. Blood flows in one direction in a closed loop through blood vessels.

The closed system in a fish is known as a single circulatory system. This means that the blood is pumped only once in its circulation around the body.
Figure 14.8
The major parts of the circulatory system of a primitive fish, such as a shark. The chambers of the heart are numbered: 1 = sinus venosus, 2 = atrium, 3 = ventricle, and 4 = conus arteriosus.
Fish

The single closed system is a simple one. It has a number of disadvantages:

1. Blood flows slowly, as it is pumped only once in its path around the body.
2. Blood has low pressure, as it loses momentum by being slowed down in capillary beds within the gills and organs.

These factors limit the metabolism of fish, as delivery of materials to the tissues is limited.
Amphibians such as Frogs

Circulatory system is known as an incomplete double circulation.

A frog has a three-chambered heart, consisting of 2 atria (small upper chambers) and 1 ventricle (large, lower, muscular chamber).
Amphibians such as Frogs

Within an incomplete double system, blood is pumped twice in its path around the body. It is pumped separately from the heart to the lungs, then back to the heart before being pumped out to the body tissues.
Amphibians such as Frogs

Because there is only one ventricle, oxygenated blood from the lungs mixes with deoxygenated blood that has returned from the body.

This is a disadvantage to the system, that the frog makes up for in its ability to diffuse gases across its skin; BUT they also have higher blood pressure than a fish (which is an advantage.)
Amphibians such as Frogs
Mammals

- The mammalian circulatory system is known as a **complete double circulation**.
- In this system, blood is pumped through a 4-chambered heart (possessing 2 atria and 2 ventricles) twice in its path around the body.
- Deoxygenated blood from the body tissues is kept separate from the oxygenated blood from the lungs.
Mammals

Because the blood is pumped twice, it travels with high speed and pressure around the body. This is required to maintain high energy level requirements in mammals.
Mammals
a) Fish Heart: One Atrium, One Ventricle, "Single Circulation"

b) Reptile/Amphibian Heart: Two Atria, One Ventricle (both oxygenated and deoxygenated blood are mixed), "Double Circulation"

c) Mammalian Heart: Two Atria, Two Ventricles (oxygenated and deoxygenated blood separate), "Double Circulation"