Circulatory System- Vertebrates

Course Zool. 202

Energetics and Homeostasis

Lecture 5

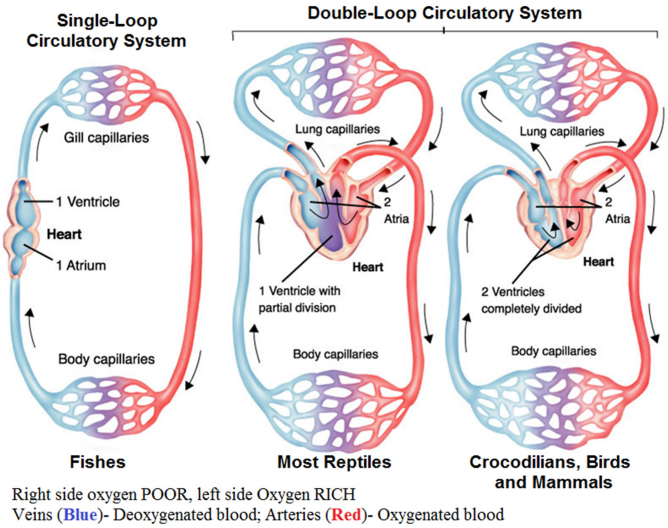
Components of Circulatory System

- Pump- this supplies the system with pressure to keep the fluid moving in the tubes.
  - The heart
- Medium- the fluid that flows in the system and carry the substances to the organs
  - The Circulatory Fluids (Blood, Lymph, Tissue Fluids, Blood plasma)
- System of tubes- this helps to carry the fluid around the body from place to place.
  - The arteries and veins
- Site of exchanges- this allow the materials deliver by the blood to enter the organs that needed it.
  - The capillaries.

Vertebrate Circulatory System

- Chordate circulatory systems:
- Single loop systems
  - found in organisms with gills
- Double loop systems
  - Double loop systems of most reptiles have three chambered hearts
  - Double loop systems of crocodiles, birds and mammals have four chambered hearts.

Looped CS- Vertebrate



Right side oxygen POOR, left side Oxygen RICH
Veins (Blue)- Deoxygenated blood; Arteries (Red)- Oxygenated blood

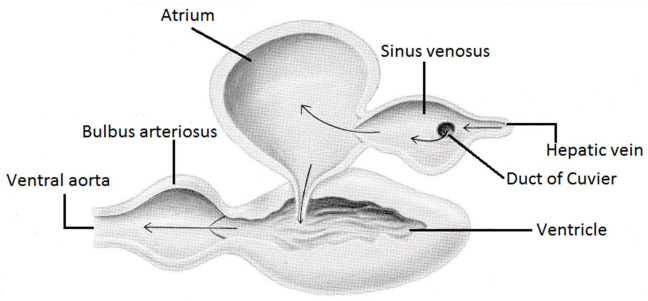
Single circulation

1. Occurrence: Found in only fishes.
2. Mode of circulation: Blood passes only once through the heart to supply once to the body.
3. Nature of blood: Only venous blood passes through the heart.
4. Efficiency: Less efficient as gill capillaries slow down the blood flow so the body receives blood at a low pressure which decreases the rate of oxygen supply to the cells.

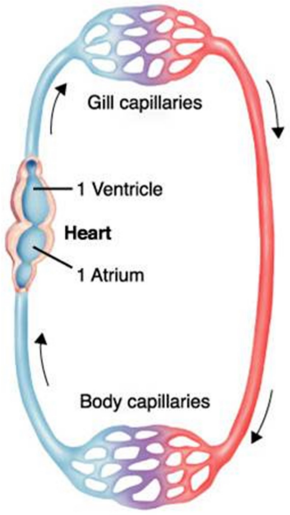
Double circulation

1. Occurrence: Found in amphibians, reptiles, birds and mammals.
2. Mode of circulation: Blood passes twice through the heart to supply once to the body.
3. Nature of blood: Mixed or oxygenated or venous blood passes through heart.
4. Efficiency: More efficient as blood flows at higher pressure, especially in birds and mammals, which increases the rate of food and oxygen supply to the cell and also rapid removal of wastes from them.

Hemodynamics of Fish



Sagital section through the heart of a Teleost



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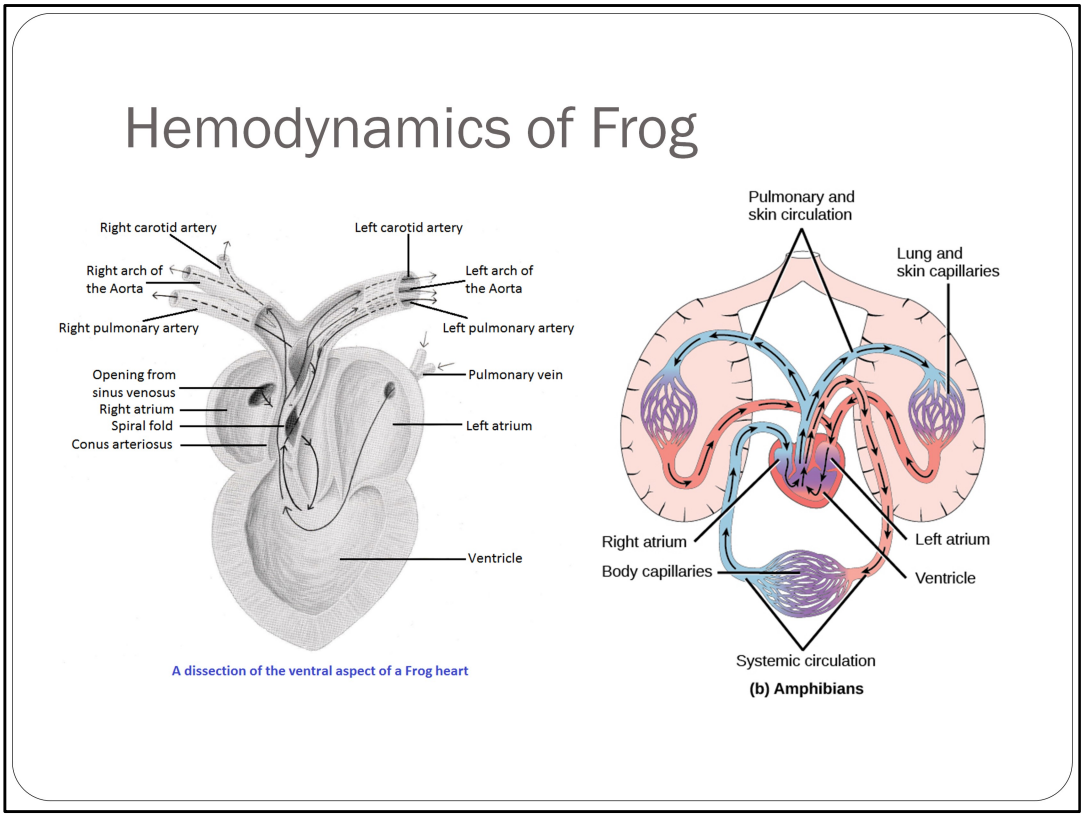
While obviously adequate to the fish's needs, this is not a very efficient system. The pressure generated by contraction of the ventricle is almost entirely dissipated when the blood enters the gills.

- Blood (venous) collected from throughout the fish's body enters a thin walled receiving chamber (sinus venosus) partly by negative pressure of pericardial cavity
  - first in the sinus venosus through paired common cardinal veins (ducts of cuvier) and paired hepatic vein
  - then >>>> forced into the atrium.
- As the atrium relaxes or contracts, the blood passes through a valve into the thick walled, muscular ventricle. A valve also protect back flow of the blood into SV.
- Contraction of the ventricle forces the blood into the bulbus arteriosus (Actinopterygians) /conus arteriosus (Elasmobranchs)
- Then it enters into the capillary networks of the gills where gas exchange occurs.
- The blood then passes on to the capillary networks that supply the rest of the body where exchanges with the tissues occur.
- Then the blood returns to the atrium.



❑The right atrium receives deoxygenated blood from the blood vessels (veins) that drain the various organs of the body through sinus venosus

❑The left atrium receives oxygenated blood from the lungs and skin (which also serves as a gas exchange organ in most amphibians) via pulmonary vein.

❑Both atria empty into the single ventricle.

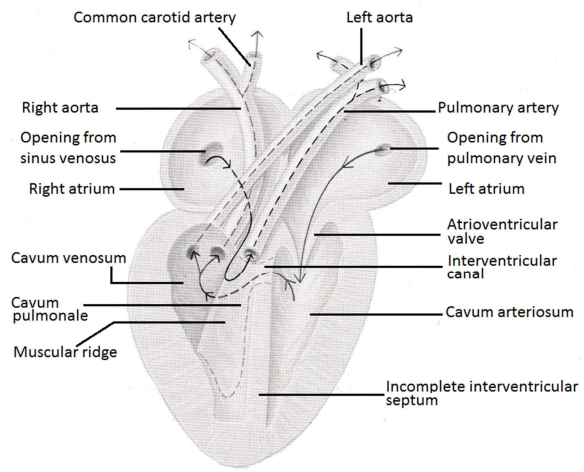
❑So, when the ventricle contracts

- •Oxygenated blood from the left atrium is sent, relatively pure, into the carotid arteries taking blood to the head (and brain);
- •Deoxygenated blood from the sinus venosus, the right atrium and the right side of the ventricle is sent, relatively pure, to the pulmocutaneous arteries taking blood to the skin and lungs
- •In the lungs fresh oxygen can be picked up and the oxygenated blood is returned to the left atrium (or left side of the single atrium).
- •This oxygenated blood passes into the ventricle and preferentially out to the arteries leading to the head and other somatic portions of the body.
- •Only the blood passing into the aortic arches has been thoroughly mixed, but even so it contains enough oxygen to supply the needs of the rest of the body.

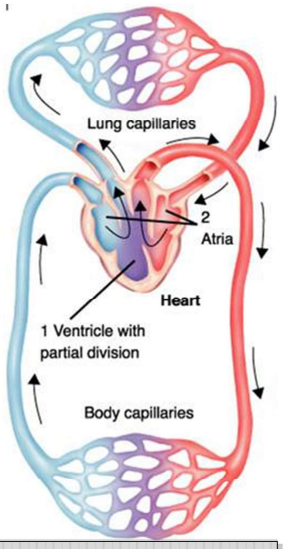
Blood in Ventricle: While this might appear to waste the opportunity to keep oxygenated and deoxygenated bloods separate, the ventricle is divided into narrow chambers that reduce the mixing of the two blood.

Note, that in contrast to the fish, both the gas exchange organs and the interior tissues of the body get their blood under full pressure.

Hemodynamics of Lizard



A dissection of the ventral view of the heart of a lizard

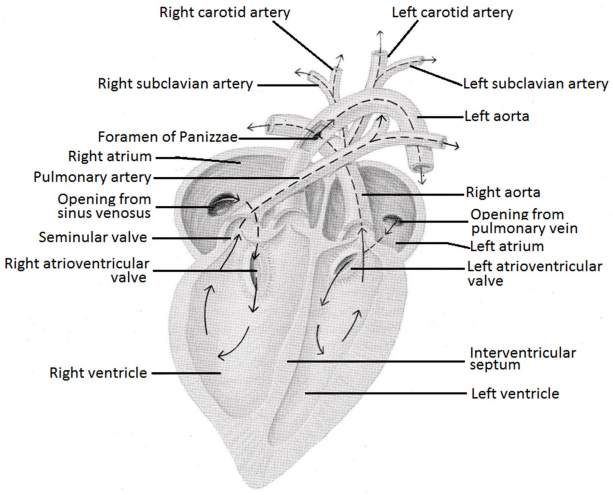


Right side oxygen POOR, left side Oxygen RICH

Veins (Blue)- Deoxygenated blood; Arteries (Red)- Oxygenated blood

- The two atria are completely divided by interatrial septum
  - Right atrium receives deoxygenated systemic venous blood from the sinus venosus and Left atrium receives oxygenated blood from the pulmonary veins
- Lizards have a muscular septum which partially divides the ventricle
  - Left side which receives blood (oxygenated) from the left atrium is called Cavum arteriosum and Right side which receives blood (deoxygeneted) from the right atrium called Cavum venosum; Narrow portions between these two cavae is called the interventricular canal
  - The ventral diverticulum of cavum venosum is called Cavum pulmomnale (carry deoxygenated blood), from which pulmonary artery goes to the lungs.
- When the ventricle contracts, the opening in the septum closes and the ventricle is momentarily divided into two separate chambers.
  - First blood to leave ventricle is deoxygenated which entered from right atrium>cavum venosum> cavum pulmonale
  - As the ventricle contracts more, the cavum pulmonale is closed off by the muscular ridge, and oxygeneted blood from cavum arteriosum enters into the interventricular canal, forcing the blood to the right and left aortae
- This prevents mixing of the two bloods.
  - The left half of the ventricle pumps oxygenated blood (received from the left atrium) to the body.
  - The right half pumps deoxygenated blood (received from the right atrium) to the lungs.

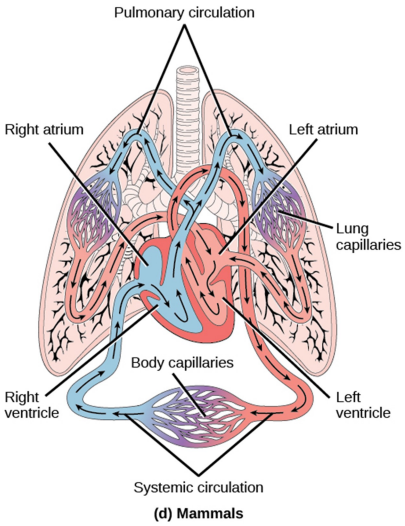
Hemodynamics of Crocodiles



A dissection of the ventral view of the heart of an alligator

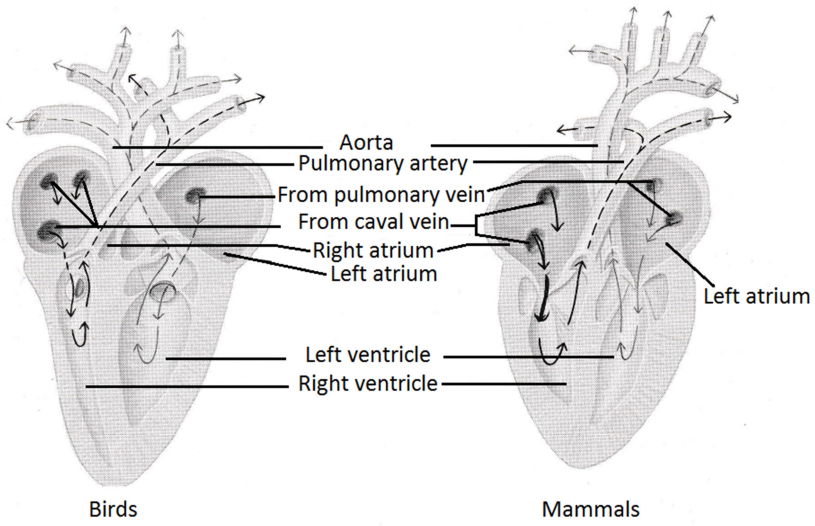
Hemodynamics of Birds and Mammals

- The septum is complete in the hearts of birds, crocodiles, and mammals providing two separate circulatory systems:
  - Pulmonary for gas exchange with the environment and
  - Systemic for gas exchange (and all other exchange needs) of the rest of the body.



The efficiency that results makes possible the high rate of metabolism on which the endothermy ("warm bloodedness") of birds and mammals depends.

Hemodynamics of Birds and Mammals



Thank You

Read, Write and Draw