Vertebrate Physiology 437

1. Circulation (CH12)

2. Announcements
   exams returned Tuesday
   seminars etc.

3. Jokes from the audience...

(c) Ventricular systole
Aortic valve  Left atrium
Left ventricle

12-10 Randall et al.
Name that student/TA/person:

Amber Roberts (bandanna!)
Bret Pasch (your TA)
Vickie Emmanuual (AZ cancer center)
Term Paper Tips:

- **Physiology and science** should be subject, not researchers and experiments
- Hanging your paper on a question or a problem helps give direction and focus
- More physiology
- Subheadings often helpful

- More sophisticated Future Directions, including gaps in current knowledge, flaws in current studies, proposed detailed experiments, think outside the box

- Synthesize, not serial book reports
- Abstract, role is summary of entire paper, not an intro to the intro

- Pronouns to be avoided (its, these, this, ...which, there are)
- Passive voice to be avoided (e.g., Avoid passive voice preferred)
- Leading and following zeroes (0.5, .5, .50)
- Page numbers
- Citation format (Journal of Physiology)

- Turn in old, graded work with each new version

- Peer editing (read quickly, then read for content and writing, lots of comments)
  - code names
Vertebrate Circulation (too big for diffusion!)

Heart is main propulsive organ

Arterial system
- distributes blood
- regulates pressure

Capillaries
- transfer between blood and tissues

Venous system
- return blood to heart
- storage reservoir

Divided into Central and Peripheral

Focus on Mammalian Circulation with some exceptions
Circulatory Roles and Components

Valves control direction of blood flow

Smooth muscle controls diameter of peripheral vessels, thereby altering resistance and flow to different tissues

Sherwood 1997
Circulatory Roles and Components

- Gases (CO₂, O₂)
- Nutrients
- Waste
- Hormones
- Antibodies
- Salts
- etc.

- Temperature Regulation

-Blood volume 5-10% of body volume
Development of Terrestrial Circulatory System:

**gills** simple (and linear):
1. Blood goes to gills
2. O2-rich blood goes to tissues
3. O2-poor blood goes to heart
4. Blood gets pumped back to gills

**lungs** more complex because get 2 circuits in parallel:
1. **Pulmonary** circuit (lower pressure)
2. **Systemic** circuit (higher pressure)
Fish Circulation through gills
Addition of lungs more complicated.

Water vs. air.
Two parallel closed circuits:

1. Pulmonary (lower press.)
2. Systemic

Note venous reservoir
Tissue Beds in Parallel, not Series

All cells within 2-3 cells of a capillary
Can control amount of flow to each tissue independently
In addition to Heart,

Blood also moved via
- Elastic recoil of arteries
- Squeezing of vessels during body movement
- Peristaltic contractions of smooth muscle in vessels
Begin

Superior and inferior venae cavae

Right atrium

Right AV valve

Right ventricle

Pulmonary valve

Pulmonary trunk, pulmonary arteries, capillaries of lungs, and pulmonary veins

Left atrium

Left AV valve

Left ventricle

Aortic valve

Aorta

Mammalian Heart

Systemic arteries, arterioles, capillaries, venules, and veins

No valves as Enter Atria

14-14,
Vander 2001
**Non-Mammalian Heart Examples:**

Amphibians and Reptiles (except crocodilians) with 3 chambers (= one ventricle, two atria)

- incomplete ventricular septum
- BUT separate rich and poor blood
- AND alter pressure in systemic and pulmonary
- able to alter flow to systemic or pulmonary circuit
Cardiovascular System

Amphibians:

only vertebrates where $O_2$ poor blood to skin (as well as to lungs)

adults with paired pulmocutaneous arteries divide into two branches
1. Pulmonary
2. Cutaneous (to flanks and dorsum)

skin provides 20-90% $O_2$ uptake
30-100% $CO_2$ release
**Cardiovascular System**

**FROG Heart** (see 12-17)

conus arteriosus
w/ spiral valve

trabeculae (create channels)

role of Tb and HR

Pough et al., 2001
Fig 6-8
Cardiovascular System

Reptilian Heart (not crocs; see 12-18 and -20)

(no conus arteriosus, no spiral valve)

2 systemic arches and
one pulmonary artery
from single ventricle

BUT, single ventricle functions as THREE

3-chambered heart anatomically
5-chambered heart functionally

RAA = right aortic arch
LAA = left aortic arch
PA = pulmonary artery

Muscular Ridge

RA = right atrium
LA = left atrium

Pough et al., 2001
Fig 6-9a
Reptilian Heart (not crocs) not “primitive”

RAA = right aortic arch
LAA = left aortic arch
PA = pulmonary artery

3-chambered heart anatomically
5-chambered heart functionally

IVC = intraventricular canal
AVV = atrioventricular valve

Muscular Ridge
CP = cavum pulmonale
CV = cavum venosum
CA = cavum arteriosum

Pough et al., 2001
Fig 6-9
Reptilian and Amphibian Circulation

Cardiac Shunts (in 3-chambered heart)

1. temperature regulation
2. breath holding (diving, turtle in shell, inflated lizards)
3. stabilize $O_2$ content of blood when breathe intermittently

R to L

$O_2$ poor to systemic via aortic arches
(short delay between valves opening)

L to R

$O_2$ rich to pulmonary artery
(longer delay between valves opening)
Mammalian fetus:

**Ductus arteriosus** (R -> L shunt, lung bypass)
- pulmonary artery to systemic arch
- when lung inflate resistance down
- when lose placental circ. resistance up
- closes at birth

**Foramen ovale** (interatrial shunt R -> L)
- hole in wall between atria
- closes at birth
Bird chick:

**Chorioallantois**
= network of vessels under shell surface

**MLQ**

**Interatrial septum**
-R -> L shunt, lung bypass
-closes after hatching
Electrical Activity in the Mammalian Heart

Influenced by autonomic NS
Cardiac Cells electronically linked by Gap Junctions

(except from atrial to ventricular cells...)
Electrical Activity in the Mammalian Heart

(see 12-12)

**FIGURE 14-17** Vander 2001

Sequence of cardiac excitation. The blue color denotes areas that are depolarized. Impulse spread from right atrium to left atrium is via the atrial muscle cells where the atria contact each other in their shared wall.

Adapted from Rushmer.
Recall AP and refractory period differences...