I. Muscular system

(Your text doesn't do a particularly good job with the muscular system, and only mentions them in passing when it discusses the skeletal system.)

Starting with trunk muscles:

myomeres and myotomes: occur mostly between the pectoral and pelvic girdles

segmented (myomeres occur 1/vertebra)

allow for undulation (side to side movement of body).

divided into:

epaxial (dorsal muscles)

hypaxial (ventral muscles)

hypaxial muscles consist of:

internal oblique

external oblique

(these allows for greater flexibility)

transverse abdominals (flat across belly (belt like))

rectus abdominus (run lengthwise down belly)

these muscles are obviously better developed in limbless species (e.g., caecilians).

Neck:

Frogs - poorly developed. Frogs basically can't move their head/neck (don't really have a neck).

Salamanders - still poor, but some head movement is possible.

Limbs:

Intrinsic - muscles found only in limbs (insertion and origin entirely in limbs)

First found in amphibians.

Extrinsic - muscles originate in body, insert in limbs.

Branchial muscles:

These are derived from the muscles controlling gill arches.

Some have been modified and are used in the head and neck.

In essence very similar to the arrangement found in fish.

(in larva, may function in gill arches).

II. Digestive system.

Note that the digestive system is a tube going through the body.

Technically, what is inside the digestive system is outside the body.

Buccal (= oral) cavity:

teeth - in addition to being pedicellate, amphibian teeth can be described as being:

homodont - all teeth are the same

conodont - teeth are cone shaped

function mostly to hold prey.

no real salivary glands, though some more terrestrial amphibians do have glands that can moisten food.

intermaxillary gland

best developed in some frogs, although also prominent in some salamanders.

secretes a sticky substance that can help frogs and salamanders capture prey with their tongue.

tongue:

varies:

in some frogs almost non-existant (e.g., Pipidae).

in others very well developed. Some frogs and many salamanders can project their tongue for considerable distances to capture prey (see intermaxillary gland above).

Esophagus -> Anus:

Overall structure here is similar to humans, with some differences:

Esophagus:

Uses peristalsis to move food into stomach

Stomach:

Thick muscles and glands provide initial digestion

Small intestine:

duodenum:

gets digestive enzymes from pancreas, gall bladder & liver

rest:

absorbs nutrients. Not as folded as in mammals.

in most amphibians is directly continuous with the large intestine

some frogs have a valve between the two intestines.

Large intestines:

function in water re-absorption.

rectum:

storage area for feces.

Cloaca:

Combined chamber that gets material from digestive, excretory and reproductive systems.

III. Circulatory system

Closed circulatory system (virtually all Chordates).

Larval stages:

Similar to fish:

heart pumps blood to gills, from there oxygenated blood is taken to body

eventually deoxygenated blood is returned to body.

Adults:

Three chambered heart:

right atrium collects blood coming back from body, pumps blood into single ventricle.

ventricle pumps blood both to body and to lungs.

contains ridges and connective tissue that can modify the flow of blood to increase or decrease mixing

this can occur even within the same species depending on the activity.

remember that amphibians rely heavily on cutaneous ("skin") respiration.

left atrium collects blood from lungs and pumps it into the ventricle.

Blood pressure is very low in amphibians.

Blood vessels:

Somewhat similar to humans: carotids, dorsal aorta, jugulars, etc.

This does vary, based mostly on the extent of cutaneous breathing.

We'll get back to this when we look at the respiratory system.

Blood cells:

Red blood cells (erythrocytes):

Mostly nucleated (some salamanders have a few un-nucleated erythrocytes)

Fairly large (some of the largest known).

Move oxygen and carbon dioxide around using hemoglobin.

White blood cells (leucocytes):

Basically similar to humans, and divided into various subtypes such as lymphocytes, monocytes, etc.

Thrombocytes

As the name suggests, these are involved in blood clotting (related to platelets, but different).

Plasma (not a part of the blood cells) is colorless in amphibians:

(presumably carries the usual nutrients, hormones, and such around the amphibian body).

contains blood cells

Lymphatic system:

very well developed in most amphibians.

collects fluid (mostly plasma) and blood cells (except erythrocytes) that have leaked out of the circulatory system.

this fluid is collected and using a one-way network is returned to the circulatory system.

amphibians actually have “contractile” structures in the lymphatic system that function as “hearts” (with valves to ensure one-way movement) that can help speed the movement of lymph fluid back to the circulatory system.

Frogs and salamanders - up to 20 “hearts”

Caecilians - over 100 “hearts”

lymphatic system is also very important in the immune system and helps fight off infections (lymphocytes “live” in the lymphatic system when mature).

lymph fluid (particularly in frogs) can also be found flowing just underneath the skin.

this helps keep the skin moist (respiration).

IV. Respiratory system

Amphibians go through metamorphis:

As juveniles have gills (no lungs)

Adults loose gills (with a very few exceptions)

Nares:

openings to the outside that bring air into the body.

connected internal in the pharynx to the choanae (internal nares).

amphibians are the first group with choanae.

pharynx:

location where air and food passages cross / come together.

entrance to trachea is controlled by glottis.

glottis surrounded by epiglottis that can close off glottis.

larynx:

first part of trachea - also “voicebox”

as might be obvious, it's best developed in frogs.

trachea:

after the larynx, usually divides into bronchi that go off to each lung.

however, in most frogs the trachea are so short they never gets a chance to branch off into bronchi.

lungs:

fairly primitive - not many alveoli.

“ball” like structures surrounded by capillaries, but not nearly as sophisticated as alveoli.

not really subdivided (lungs in mammals an birds are often partitioned).

respiration:

the simple version: air is drawn into the throat, and then pumped into the lungs (positive pressure breathing).

the complicated version (that describes in more detail how air is passed back out of the lungs) is in your text if you're interested.

vocalizations:

fairly obvious in frogs (you'll get a frog call exam!)

serve three main purposes:

1) warning calls/croaks. Made by both sexes

2) contact calls (territorial). Also made by both sexes

3) breeding calls (choruses). Made only by males to attract females.

vocalizations are aided by vocal sacs (sac like pouches in throat area).

can actually croak underwater by re-using air (choanae have valves that can close off so air can be re-used).

a few salamanders can vocalize:

Dicamptodon ensatus (California giant salamander)

aortic arches:

branches of the circulatory system that take blood to the body

ancestral vertebrates had 6 arches. These become modified in amphibians:

1 & 2: often lost

3: becomes common carotid artery

4: becomes part of systemic system (e.g., aorta)

5: lost except in lungless salamanders

6: develop into pulmonary veins and arteries.

but exactly what they do in amphibians depends on how the amphibian breathes:

strict gill breathers - first four pairs are kept.

air breathers - first two are modified, 6th pair is kept.

skin breathers - 6th pair is lost.

miscellaneous comments:

Several amphibians loose lungs and can breathe entirely through their skin (lungless salamanders, Plethodontidae).

Hellbenders (*Cryptobranchus alleganiensis*) have extensive folds to increase the surface area of their skin.