Excretory system:

The excretory system in amphibians has most of the parts we're familiar with, but isn't nearly as efficient.

- mostly due to low blood pressure.

- still, a typical nephron has:

glomerulus

Bowman's capsule

proximal tubule

“thin section”

distal tubule

- this eventually drains into the collecting duct which takes urine to the cloaca.

from the cloaca, urine enters the bladder and is stored until it's expelled.

(bladder is anterior to ureter coming from kidneys)

Kidneys have two main function:

1) osmoregulation

Salt-water balance:

Amphibians can recover water through drinking and by absorbing water through their skin (cutaneous drinking, as your text calls it).

Urine is often highly dilute (most ions are re-absorbed)

This makes sense as they are generally living in fresh water and need to remove excess water.

Amphibian skin is generally very water-permeable, and in addition to recovering water, many amphibians have behavioral adaptations that help:

moving to water

seeking out more humid areas

exposing a minimum amount of their surface area

2) waste removal

amphibians remove urea as a waste product (greatly reduced toxicity compared to ammonia)

Kidneys become recognizable for the first time in amphibians (fish kidneys are just strips of tissue along the vertebrae).

Most obvious in frogs, but clearly visible in salamanders and caecilians.

in some salamanders and caecilians kidneys are still very elongated.

Reproductive system:

Females:

Ovaries are thin walled and sac like.

follicle and egg found on the inside surface of the ovaries.

egg released into oviducts (ciliated).

egg covering (gelatinous) is added to egg as it travels down oviduct

end of oviduct is enlarged to store eggs

opens into cloaca

Most amphibians are oviparous - lay eggs

A few are ovoviviparous - eggs develop inside female.

this term seems to have fallen out of use lately, but is still appropriate

Some Toads.

A very few are actually viviparous - some females provide nutrients and nourish the eggs with oils (fewer than 20 species world wide).

Some members of the family Salamandridae

More than half of Caecilians

Some female salamanders have a spermatheca:

Pocket on the side of the cloaca used to store sperm (more on this when we look at reproductive behavior).

Males:

Sperm production takes place in the seminiferous tubules

There are several different descriptions of what happens next, so we'll keep it simple:

Using various ducts (depending on the source, these are called the Wolffian duct, Bidder's canal, or the usual epidydimis/vas deferens (or even some combination

thereof)), sperm are transported to the cloaca.

It is true that the sperm eventually join the duct coming from the kidneys.

Bidder's organ:

essentially non-functional ovaries that occur is some males.

however, if testes are removed, these can develop into functional ovaries.

a few amphibians seem to do this anyway (common reed frog from Africa)

Nervous system

Overall, the amphibian nervous system isn't much better than that found in fish

Only limited “higher” functions due to small cerebrum (text says about half of the brain is made up of the cerebral hemispheres, but the picture shows a much smaller proportion).

Cerebrum also shows only limited folding

Many of their reactions are instinctive.

Cerebellum is much better developed

(Motor functions)

Sensory part of brain is fairly decent is size; amphibians have decent sensory organs.

olfactory and optic lobes are fairly prominent.

Amphibians have 10 cranial nerves that serve mostly the head and upper body

These originate in the brain and serve in a similar way as the spinal nerves.

Spinal cord travels from the base of the brain to the base of the spinal cord in salamanders and amphibians, but stops before the pelvic girdle in frogs

Spinal nerves come off in pairs between vertebrae. Have a dorsal sensory branch and a ventral motor branch.

Frogs use bundles of spinal nerves to serve areas further back.

Skin receptors:

Skin contains the usual receptors:

mechanoreceptors for pressure and touch

pain receptors

thermoreceptors

Larval amphibians (and some adults) have a lateral line system:

Used to sense pressure changes in water (e.g., flow, depth, and movement)

Served by cranial nerves

Newts keep their lateral line system during their terrestrial phase.

Not found in animals after amphibians (not needed out of the water).

Electrical sensors exist in the heads of some caecilians and salamanders:

Sense objects in their surroundings (particularly other animals).

Ears:

Generally consist of a middle and inner ear.

Outer ear is usually missing, or only a slight indentation before getting to the tymanum.

Tympanum is actually missing in all except most frogs.

Middle ear:

Actually has two pathways for sound:

tympanum - stapes for airborne sounds (assuming you have a tympanum)

stapes is a single bone

jawbone transmission

Both of these transmit sounds to the inner ear (through the oval window or "fenestra ovalis")

Inner ear:

No cochlea present, but have similar but simpler structure (lageena) used to hear.

Also find semi-circular canals and utricula:

Semi-circular canals used to detect motion

Utricle used to detect balance

These are better developed than in fish

Eyes:

Present in all amphibians, though in some they have degenerated considerably:

Caecilians only have degenerate eyes (beneath the skin, and in a few cases even beneath the bone)

Some salamanders have degenerate eyes (cave dwelling salamanders)

Frogs have the best developed / most advanced eyes

Basic eye structure is similar to humans, but there are some important differences:

Sclera, retina, etc (see diagram)

Picture in text isn't very good here, and is more appropriate for reptiles.

Focusing is done differently:

Lens is moved backwards or forwards in the eye to focus (we change the shape of our lens)

Retina

Rods and cones exist, though cones are limited and so is color vision

Related structures:

lacrimal glands (tear glands) - help wash eyes. First in amphibians.

Nictitating membrane - 3rd eyelid. Transparent. Covers eyes when in water.

First animals to have moveable eyelids (though not found in all amphibians)

Harderian glands - are oil glands that help keep eyeball flexible

Some Ambystomid salamanders have light receptors in their skin.

Smell and taste:

Taste buds occur on the tongue of amphibians. Appear to be sensitive to salt/acid/bitter/water

Not well studied

Smell is mostly through Jacobson's organ

Air is brought in through the nares.

Jacobson's organ sits at the roof of the mouth (also known as vomeronasal).

Consists of a pouch that is innervated with nerve endings and used to detect smells.