

## Amphibian anatomy / physiology

### I. General characteristics:

Aquatic larvae, terrestrial (sort of) adults.

Adults usually stick close to water and could be said to live a semi-aquatic existence.

Some (e.g., some toads, lungless salamanders) are more fully terrestrial, others (e.g., mudpuppies) never leave the water and are strictly aquatic.

We'll learn more about this later.

Reliance on water does not mean they're restricted in habitats - some are found deep in deserts.

Marine environments are pretty much the only habitat where they're not found, although even here there are some exceptions:

*Rana* (now *Fejervarya*?) *cancrivora*

Crab eating frog found in south east Asia.

Can tolerate salt water as it goes diving for crabs.

Does this by increasing urea concentration in its bloodstream.

*Bufo marinus* (surprise! it's still *Bufo*!)

Marine or Cane toad.

Can tolerate brackish water.

Originally from Central and South America

Now found in Australia, Florida, and elsewhere where it has become a serious pest.

### II. Skin & integumentary system:

Amphibian skin is made up of four layers:

The outside layer (stratum corneum) is mostly composed of dead keratinized cells (your text labels this and the next layer "epidermis" in fig. 2.9).

This layer is first found in amphibians.

Helps protect against water loss - this layer is thicker in more terrestrial amphibians like Toads.

Next the stratum germinativum

Layer that divides continuously to replace epidermis.

## Stratum spongiosum

Contains blood cells, nerve endings, etc.

## Stratum compactum

Dense layer that connects skin to connective tissue underneath.

Connection is variable in terms of “how well connected” the skin is.

Frogs - only loosely attached

Others - may be much more tightly connected.

Glands - as mentioned previously, amphibians have two types of glands:

mucous - help keep skin moist

- aid in respiration and cooling

granular (= poison) - obviously function in defense

- can provide extremely efficient protection:

- *Bufo marinus* - one of the reasons it's a pest is because pets (dogs mostly) catch and chew on it. The poison is strong enough to kill dogs.

- Dendrobatidae - poison arrow frogs. Extremely toxic, although research has shown they get most of their toxins from their diet (ants).

- Salamanders are generally not as toxic as frogs

- many will have a large parotid gland which is a concentration of poison glands right behind the head (usually right behind the eyes).

others:

tubular glands in Hylid frogs to help in climbing (secrete sticky stuff)

mental glands in some salamanders - male pheromones

## Other structures

Scales - with a few exceptions, are not found in amphibians.

Two families of caecilians have dermal scales.

It's thought to be a leftover from fish, but there's some argument about this (reptile scales have a different origin).

Claws - several frogs have “clawlike” tips on some of their toes. These are derived from keratin (which is kind of typical)

Spadefoot toads, African clawed frog, Pipid frogs

Claws are derived from a different skin layer than “real” claws.

### Color (pigmentation)

Some amphibians can change color fairly quickly, others can not, some (cave salamanders) don't have any pigmentation.

There are several different kinds of cells that provide color, all lumped under the general heading of “chromatophores”.

What they are called can vary based on whether or not one is interested in the color produced or in the structure of the cells (or the reference one uses).

In general, there are several different types of cells that provide color.

Melanophores are at the base of these and can lighten or darken fairly quickly, which can change the color of the animal.

### Ecdysis (molting)

The skin in amphibians is shed fairly regularly, although the timing can vary widely.

Most amphibians will eat their skin once they've shed.

Shedding involves only the outside layer (stratum corneum) of the skin).

### III. Skeletal system.

Skeleton is made up of cartilage in juveniles, which ossifies (“turns to bone”) in the adults.

Skull of amphibians is often flattened, with few bones in the cranium.

Upper jaw is directly hooked into the skull (termed “autostylic”)

(Jaws are derived from gill arches in primitive fish).

#### Teeth:

##### Upper jaw:

Teeth are found on maxillary and premaxillary bones (see 2.16 in text).

Also found on the roof of the mouth (vomerine, parasphenoid, palatine).

##### Lower jaw:

composed of the dentary or pseudodentary.

(lower jaw is not fused in amphibians)

## Vertebrae:

Atlas (first vertebra) articulates with two “occipital condyles” on the lower part of the skull (same as in us).

There is no axis (so head rotation is limited).

Number of vertebrae is very variable:

Frogs: 9 - 10

Caecilians: up to 200

Salamanders: in between (between 10 - 60 “pre-sacral” vertebrae)

Shape of vertebrae are used diagnostically (i.e., for classification):

amphicoelous - concave on both sides

procoelous - concave on anterior side

opisthocoelous - concave on posterior side

There is a sternum (first found in amphibians), but the ribs do not connect to the sternum.

This is termed free floating ribs.

Some frogs may not have ribs.

## Pectoral and pelvic girdles:

### Pectoral girdle:

Not directly attached to the vertebral column, so has lots of muscular support.

Two types:

arciferal - almost all frogs. More flexible. Ventral part of pectoral girdle is not fused. Good for climbing and burrowing.

fermisternal - everyone else and true frogs. Less flexible, but more robust.

### Pelvic girdle:

anchored to vertebral column.

best developed in frogs:

only have a single sacral vertebra - termed an urostyle.

Girdles do not provide much support to amphibians (unlike in more modern tetrapods).

Legs:

Frogs - front and back

Salamanders - most also have front and back:

Sirens only have front legs

Amphiuma has very reduced legs (some believe that they are in the process of losing their legs).

Caecilians (“Apoda”) have lost their legs

Toes:

Usually 4 front, 5 rear (although this can be modified).

*Hemidactylium scutatum*, the four toed salamander has four digits on its hind limb and is found around here.

*Eurycea quadridigitata* is another example from the southern U.S. (into Oklahoma)

Some frogs and toads have a “prehalix”, an extra digit inside the foot.

Part of the foot/toe may be heavily keratinized to help in digging (particularly in spadefoots and some toads)

Aneidis (e.g., *Aneides aeneus*) have square toes

Regeneration:

Salamanders can regenerate their feet and tails (if lost). Frogs can't.

Fins:

A few species have caudal fins as adults (e.g., mudpuppies, genus *Necturus*)

These fins are not supported by rays like in most fish.

Hyoid:

Just a brief mention -

Part of the skeleton that supports the tongue.

Generally remains cartilaginous, though there are exceptions, particularly in salamanders.