**Class Amphibia - "dual life" – Ch. 25**

**Revised from 2011 Book (15th edition) Updated 14 January 2012**

- salamanders, frogs, toads, mud puppies

**Characteristics (p. 137)**:

1. First terrestrial class of chordates (insects and plants moved to land before amphibians)

2. Ossified skeleton

3. Usually 4 limbs (**quadrupedal**), feet often webbed

4. Respiration across gills (in larvae and some aquatic adults),

lungs, skin, and pharyngeal region

5. **3-chambered heart (2 atria, 1 ventricle) with double**

**circulation** (pulmonary circulation goes to lungs; systemic

circulation goes to rest of body)

6. Epidermis is smooth, moist with many mucous glands; no

scales (in most species); might have **poison glands;**

**chromatophores (pigment cells)** are common in skin

7. Most go through metamorphosis:

**aquatic egg--> aquatic larva--> terrestrial adult**

8. Terrestrial adult is usually oviparous; aquatic larva

(tadpole) has external gills, strong tail, and later line

sensory system; eggs with jelly-like covering; adult may

lose tail and develop lungs

9. Mouth is usually large; have upper and lower "teeth"; 2

nostrils that open into anterior part of mouth cavity

10. Ectothermic

11. Sexes separate (dioecious)

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**Movement onto Land:**

**Physical Contrast Between Aquatic and Land Habitats**

1. Greater oxygen content of air -- air has about 20% more oxygen

than does water

2. Water has greater density than air -- water is about 1000x

denser than air and about 50% more viscous

- water buoys up the body, so in the move to land,

there was a need to develop strong limbs to support

the body on land

3. Air temperature changes more than does water temperature

4. Land habitats are more variable

5. Eggs and young (supposedly) can be better protected on land

than in water

**Origin and Relationships of Amphibians**

1. Appearance of lungs - Devonian Period (beginning about 400

million years ago) had dry/wet periods -- most survivors of

this period (including lobe-finned fishes and lungfishes)

developed lungs as outgrowth of pharynx; developed blood

supply to lungs -- had systemic and pulmonary circulations

2. Development of limbs for travel on land-- during Devonian,

animals needed limbs (stubs) to get from pool to pool (as in

the lobe-finned fishes)

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**Earliest Amphibians**

- lobe-finned fish **(Rhipidistians)** were probably the ancestors

of tetrapods (and hence, modern amphibians)

- some books mention that the earliest group of amphibians were the **Labrinthodontia**, which were a distinct salamander-like group of the late Devonian; our new book does not mention it, and another book mentions that there is a little controversy about this group and and another group; in any case, one of the earliest tetrapods was ***Ichthyyostega***, whether it is a labrintodont or not:

***Ichthyostega*** - (was one of the first tetrapods);

350-million-year-old fossil; had adaptations for land:

- jointed limbs for crawling on land [old books

said pentadactyl limbs (5 digits), but your

book seems unclear about this]

- more advanced ear structure for airborne sounds

- lengthening of snout; this improved olfactory

powers for detecting dilute airborne odors

- still fish-like in appearance; had tail with

fin rays and opercular (gill) bones

**- Carboniferous Period (about 345-280 million years ago):**

**- called "The Age of Amphibians"**

- conditions favored amphibians; moist, warm climate

- amphibians species radiated; lots of things to eat, lots of niches available

- water everywhere; there was little selective

pressure to encourage movement to land; they

improved adaptations for living in water

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**Amphibians' Contribution to Vertebrate Evolution**

- change from gill to lung breathing

- strong limbs

- move from lateral line system to better sense of smell,

hearing

amphibians retained some aquatic characteristics:

- still need moist skin for breathing

- ectothermic

- still need water for reproduction (eggs and most

larvae need water)

**Classification:**

**1. Order Gymnophiona (= Apoda) -- caecilians;** they have worm-like

bodies; no limbs; terminal anus; found in tropical forests

of South America, Africa, SE Asia

- limbs and limb girdle absent

**2. Order Urodela (=Caudata) -- salamanders, newts**

**3. Order Anura (= Salienta) -- frogs, toads**

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**Order Urodela (= Caudata) (visible tail) - salamanders, newts**

1. Salamanders and newts are the least specialized of all

amphibians

2. Found in most temperate and tropical regions

3. Many species occur in North America

4. Primitive limbs - set at right angles to body with fore and

hind limbs of about equal size

5. Limbs may be rudimentary

6. Have a low metabolic rate; eat only moving prey

7. Reproduction - eggs of most salamanders are fertilized

internally, usually after the female picks up a packet of

sperm (called a spermatophore) that male places on a leaf or

stick

- terrestrial species -- lay eggs in moist places (under

logs, rocks, etc.)

- aquatic species -- put eggs in water

- larvae resemble parents (not like in toads, frogs); they go through metamorphosis, but it is not so obvious

7. Respiration - they hatch with gills, but gills are replaced by lungs in most adults (except in aquatic forms or those that

fail to undergo complete metamorphosis)

- some salamanders have neither lungs nor gills; they use

moist skin instead or the membranes inside the mouth

cavity

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**Paedomorphosis** = displacement of ancestral juvenile features to

later stages of the ontogeny of descendants

(translation = descendents retain into adulthood features that

were present only in the pre-adult stages of their ancestors);

the most dramatic form of paedomorphosis occurs in those species

that become sexually mature while retaining their gills, aquatic

life habits, and other larval characteristics--such as found in the mud puppy; these nonmetamorphic species are said to be **perennibranchiate** (i.e., permanently gilled)

Some books use the term **neoteny** instead of **paedomorphosis**,

but I don't think they are exactly the same thing;

**neoteny** = attainment of sexual maturity in the larval condition

You will sometimes see the following terms:

1) **obligatory neoteny** - permanent larva; this is a

genetically-fixed condition in which the developing tissues

fail to respond to thyroid hormone (which in other amphibians

stimulates metamorphosis; example = mud puppy **(Necturus)**

2) **facultative neoteny** - some salamander species can become

sexually mature and breed in the larval state, but they may

metamorophose to adults if environmental condition change

(example - American axolotl)

**Thyroxine** - is the hormone essential for normal metamorphosis in

all amphibians; in nonmetamorphosizing species, it seems the

pituitary gland does not release the hormone **thyrotropin**, which is

required to stimulate the thyroid gland to produce thyroxine

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**Order Anura (means "without tail") (= Order Salientia - means**

**"leaping") - frogs and toads** (without tail)

1. Locomotion is by hopping

2. No tail in adult (in most species)

3. Striking metamorphosis (Fig. 25-25) (read and know from book)

4, Neotony/paedomorphosis - neither occurs in this group

5. Aquatic reproduction

6. Water-permeable skin; mucous glands; some have serous glands that make a watery poison -- irritates predators; poison

varies; Dendrobates (South American frogs used to make

poison arrows) are more poisonous than sea snakes & arachnids

7. Ectothermic

8. Frogs breath by **"positive pressure breathing"**; floor of mouth lowers, air comes in; nostrils close and floor goes back up, forcing air into lungs

9. Frog brain is primitive -- Figs. 25-21, 25-22

10. 12 families of frogs/toads; best known families in North

America:

**- Family Ranidae - best known frogs**

**- Family Hylidae - tree frogs**

**- Family Bufonidae - true toads**

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**Habitats and Distribution** (of frogs and toads)

- Genus Rana - most successful and abundant frogs

- solitary usually - except during breeding season

- most in temperate or tropical regions

- most hibernate in water in soft mud of pools, streams

- reproduction -- **amplexus** - male grabs female; as female lays

eggs, male fertilizes them (external fertilization); (Figs. 25-24, 25-25)

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Skin color in frogs is produced by special pigment cells called

**chromatophores** -- located mostly in dermis; 3 types of

chromatophores are:

(many frogs can adjust their color to blend with surroundings)

**1. xanthophores** - uppermost in skin; contain yellow, orange, or

red pigments

2. beneath these xanthophores are **iridophores** which contain

silvery, light-reflecting pigments

3. lowermost are the **melanophores** which contain black or brown

melanin