

# AMPHIBIAN ANATOMY

WFS 433/533  
2/5/2013

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## GOALS AND OBJECTIVES

- To provide students with a basic understanding of amphibian anatomy and basic body structures
- Learn basic components of amphibian anatomy
  - Integumentary system
  - Musculo-skeletal system
  - Circulatory system
  - Nervous system
  - Reproductive system
- Discuss unique amphibian body structures

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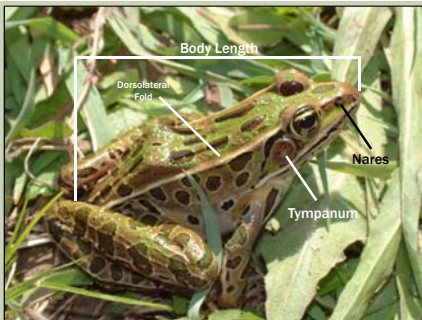
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## ADULT ANURAN BODY FORM



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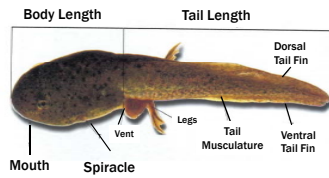
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### LARVAL ANURAN BODY FORM



Neimiller and Reynolds 2011

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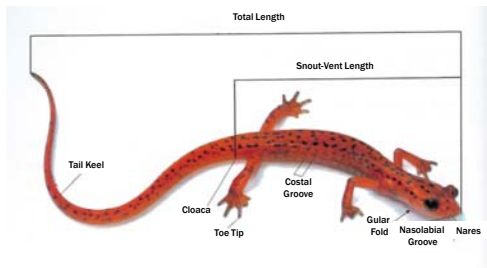
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### ADULT SALAMANDER BODY FORM



Neimiller and Reynolds 2011

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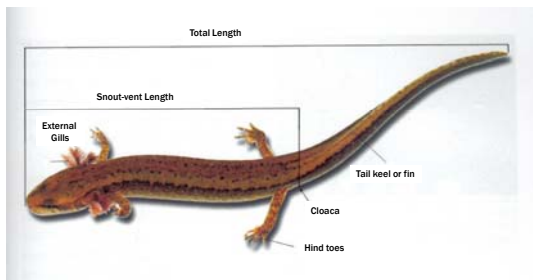
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### LARVAL SALAMANDER BODY FORM



Neimiller and Reynolds 2011

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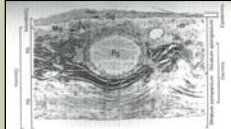


## AMPHIBIAN INTEGUMENT

- Important for multiple processes
  - Osmoregulation
  - Respiration
  - Thermoregulation
- Outer epidermal layer, Stratum corneum
  - Single layer of flattened cells
  - Keratinized in most amphibs.
  - Not keratinized in obligate neotenic
- Layer underneath, Stratum germinativum
  - 8-10 cells thick
  - Mitochondria rich; used during sloughing
- Dermis, also 2 layers
  - Stratum spongiosum; pigment bearing
  - Mucous glands and granular glands
  - Stratum compactum



Vitt and Caldwell 2011




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## AMPHIBIAN INTEGUMENT

- Number of mucous and granular glands differ
  - Mucous glands abundant dorsally
  - May be related to habitat differences
  - Granular glands spec. located (head, neck, etc.)
- Mucopolysaccharides are secreted to keep the skin moist
  - Secreted spontaneously
- Granular glands secrete after stimulation
  - Composed of peptides and alkaloids
- *Phyllomedusa*; lipid glands protect against desiccation
  - Microhylidae; breeding glands

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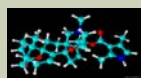
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## AMPHIBIAN INTEGUMENT

- Clusters of granular glands in some amphibians
  - Mental gland in *Plethodontid* salamanders
  - Thumbs of breeding male frogs (nuptial glands)
  - Dorsal warts and paratoid glands in true toads
- Toxic secretions tend to be amines and polypeptide in structure
  - *Phyllomedusa*
  - Dendrobatids (Batrachotoxins and simpler alkaloids)
  - Toxins linked distinctly to taxonomy
  - Distinctly linked to rearing conditions
- Other structures useful for camouflage and water runoff




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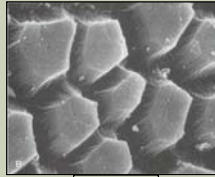
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## AMPHIBIAN INTEGUMENT

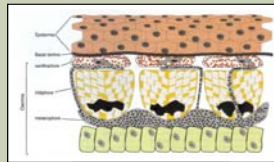
- Keratinized toe-tips are present on some salamanders
  - Provide traction and grip in slippery environments
  - Mainly aquatic families
- Webbing in aquatic and arboreal frogs
  - Swimming and arboreal adaptations
- Adhesive toepads (columnar cells)
  - Aided by capillary action



Wells 2007

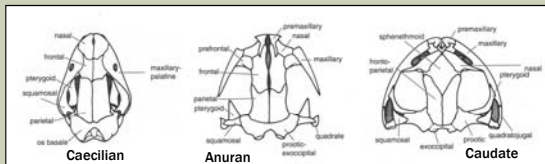
## AMPHIBIAN COLORATION

- Coloration due to chromatophores
  - Primarily located in dermis
  - Epidermal (melanophores)
- Dermal chromatophores
  - Dermal chromatophore unit
  - Xanthophores (yellow, orange, red)
  - Iridophore (bright colors)
  - Melanophore (Eumelanin + red)
- Color changes.....
  - Rapid changes (hormonal stimulation)
  - Slow changes (morphological stimulation)



Vitt and Caldwell 2010

## SKULL MORPHOLOGY

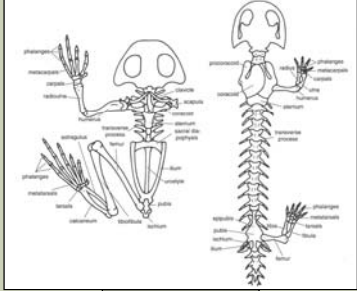


- Caecilians – fused skull structure
- Anurans – reduced skull structure
- Caudates – re-enforced rounded skull structure
- The skull and jaw contains the chondrocranium, splanchnocranium, and dermocranium

Duellman and Trueb 1986



### SKELETAL STRUCTURE



- Anurans
  - Urostyle
  - Femur
  - Tibiofibula
  - Metatarsals
  - Phalanges
- Caudates
  - Pubis
  - Vertebrae
  - Reduced arm and leg bones

Vitt and Caldwell 2010

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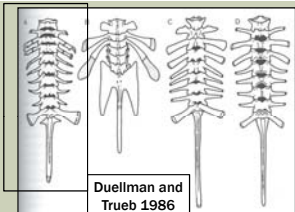
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### SKELETAL STRUCTURE



Basal Condition →

Duellman and Trueb 1986

- Ribs only occur in three families (leiopelmatidae, discoglossidae, Ascaphus, pipidae)
- Anurans - Most between 5-8 presacral vertebrae
- Ascaphus (A), basal condition (9 presacral vertebrae)

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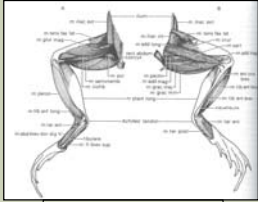
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### MUSCULATURE



Duellman and Trueb 1986

- Lengthened bone structure and heavy musculature in hindlegs
- Bone and muscle structure is variable among species
- Straightening of legs transmits propulsive force to propel the frog forward

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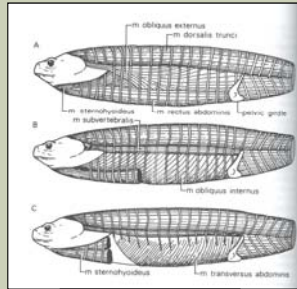
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## MUSCULATURE



Duellman and Trueb 1986

- Provide support for the viscera
- Flex vertebral column in many directions
- Permits lateral undulations
- Skull innervations control head movements

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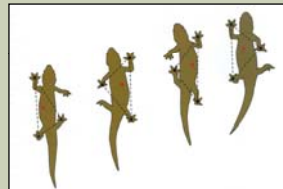
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## AMPHIBIAN LOCOMOTION



Vitt and Caldwell 2010

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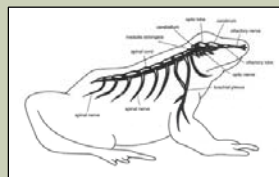
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## NERVOUS SYSTEM

- Primitive nervous system
- Brain (3 major sections)
  - Frontbrain
  - Midbrain
  - Hindbrain
- Cranial and spinal nerves
- Autonomic nervous system
  - Sympathetic and parasympathetic
  - Opposite effects
  - Sympathetic (halt processes); parasympathetic (begin processes)



Vitt and Caldwell 2010

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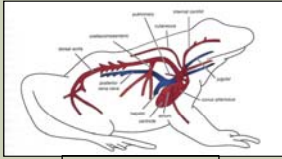
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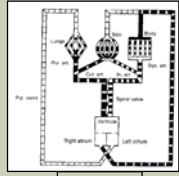




## CIRCULATORY SYSTEM



Vitt and Caldwell 2010



Wells 2007

- Internal carotoid - supplies the upper jaw and cranium
- External carotoid - supplies the tongue muscles and lower mouth
- Dorsal aorta - supplies major organs and lower trunk
- Pulmonary aorta - to lungs (if present)
- Posterior vena cava - Responsible for returning blood back to the heart

## RESPIRATORY SYSTEM

- Lungs, gills, and skin
  - One, two, or all modes of respiration
- Majority of amphibians
  - Nares - nasal openings (opens into buccal cavity)
  - Buccopharyngeal Cavity - Inner cavity of the mouth (highly vascularized)
  - Larynx - part of the sound production system in anurans
  - Lungs - paired respiratory organs



## RESPIRATORY SYSTEM

- Most species lungs are well-developed
  - Present in most, if not all anurans (vary in size)
  - Greatly reduced in stream-dwelling salamanders
  - Absent in Plethodontids
  - Some aquatic species, lungs function more as a buoy
- Amphibians respire via a force-pump mechanism
  - Buccal cavity is elevated and depressed via musculature
  - Repeated patterns of opening and closing of nares and glottis
- Efficiency of cutaneous and branchial respiration related to skin moisture and capillarity

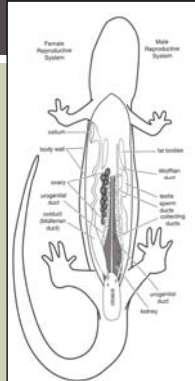


Plethodon dorsalis



## REPRODUCTIVE AND URINARY ANATOMY

- Ovaries and oviduct - Ostium
- Testis and sperm collecting ducts
- Kidney
- Urogenital duct
- Cloaca



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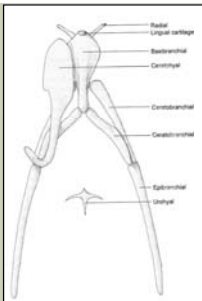
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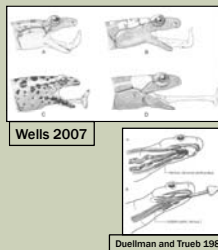
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## FEEDING MORPHOLOGY



Wells 2007



Wells 2007

Duellman and Trueb 1986

- Hyolingual apparatus
- Tongue morphology greatly derived
- Tongue projection variable

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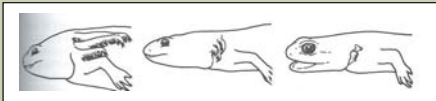
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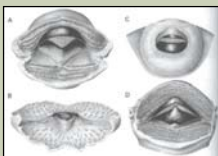
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## FEEDING MORPHOLOGY



Duellman and Trueb 1986



Duellman and Trueb 1986

- Salamander larvae - adult-like mouthparts
- Anuran larvae - scraping mouthparts
- Mouthpart morphology differs depending on feeding strategy

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### ADAPTATIONS FOR BURROWING



Keratinized Spade



Re-enforced skull sutures



Pointed Snout and reduced limbs

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### ADAPTATIONS FOR CLIMBING



Dorso-ventral compression



Toe-pads



Lengthening of leg bones

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### DEFENSE



Noxious skin secretions



Aposematic coloration

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### ADAPTATIONS FOR AQUATIC LIFE



Reductions of lungs



Major skin folds

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### ADAPTATIONS FOR AQUATIC LIFE



Tongueless



No vocal chords or vocal sacs

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### TERRESTRIAL LIFE



<http://www.google.com/imgres?um=1&hl=en&biw=1440&bih>



<http://www.geocities.com/plethodon.cinereus/>

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## ARBOREAL LIVING



Intercalary Webbing



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## CAMOUFLAGE



<http://pixdaus.com/single.php?id=161600>



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