


Diapsida

Diapsida
(Reptilia, Sauropsida)



BIO 2135 Animal Form and Function

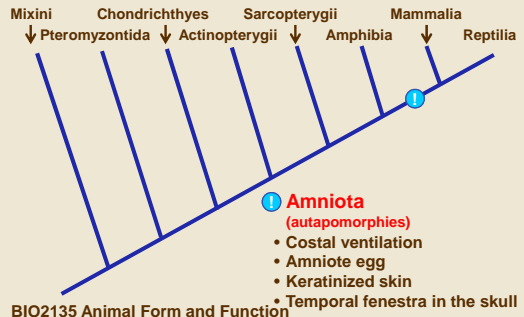
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diapsids!

birds and reptiles were not together - classes of aves and reptilia
 morphological traits were weighted - since birds looked so different from reptiles
 became clear that birds were reptiles - closes to crocodiles
 sauropsida to put birds and crocodiles together (have one systemic arch, 4 chambered heart)
 diapsid for skull organization

Vertebrate phylogeny



Mixini Chondrichthyes Sarcopterygii Mammalia
 ↓ Pteromyzontida ↓ Actinopterygii ↓ Amphibia ↓ Reptilia

Amniota
(autapomorphies)

- Costal ventilation
- Amniote egg
- Keratinized skin
- Temporal fenestra in the skull

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mammalia - synapsids
 reptilia - diapsids

terminal groups for the evolutionary tree
 -share amniote tree - move up on land and have eggs on land - put a shell around them
 ventilation of lungs are different and skin is waterproofed
 and the opening of the skull is different

Amniote egg

- Membranes
 - Yolk sac
 - Amnion
 - Allantois
 - Chorion



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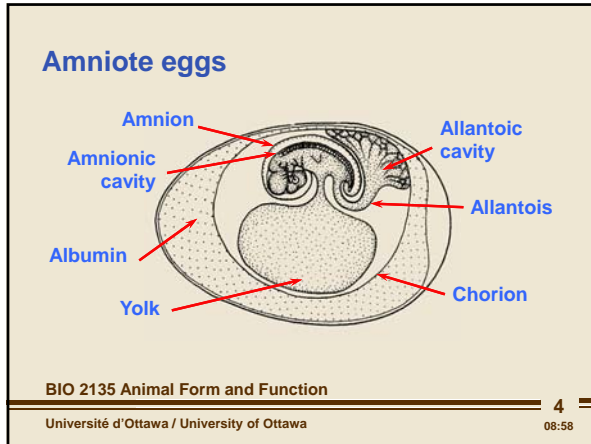
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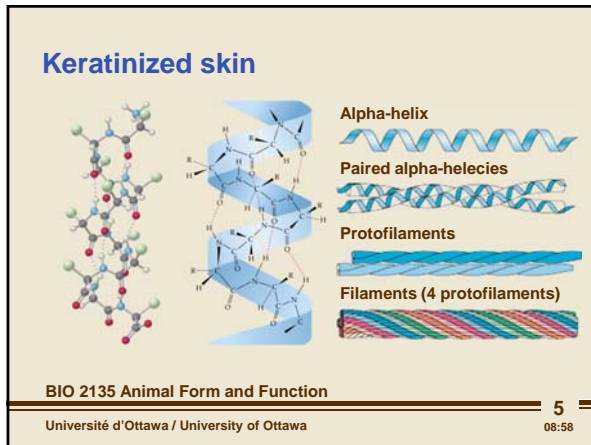
amniote eggs

-have a set of membranes
 -amnion surrounds the embryo

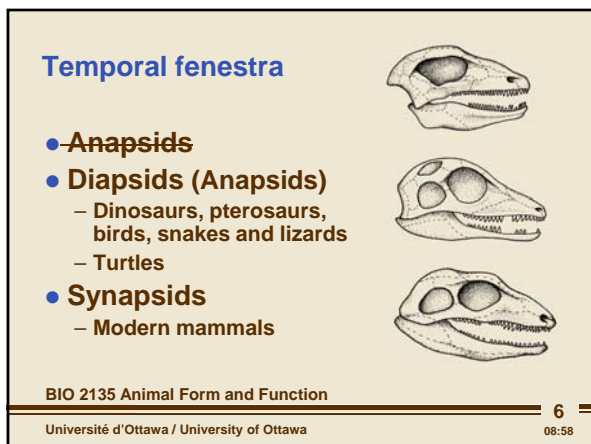
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sit in an amniotic sac- filled with water where it will live
 in egg have yolk for nutrients - membrane around the yolk
 another set of membranes called the chorion will have albumin- protein that have amino acids
 when it breaks down makes metabolic water
 final membrane that grows from where the anal opening will be - allantoic - where nitrogenous waste will build up
 want it to have low toxicity so it makes uric, so its not toxic in mammals it is urea



have keratin that has alpha helixes
 -wind together in pairs to make complex strands connected to each other by disulfide bonds - make it nearly indigestible
 -give animal waterproofing (oils and fat) and prevents it from getting scratched when it gets rubbed
 two forms
 -packed alpha helices
 -pleated beta sheets
 scales, claws, beak,




originally on the fish - not a lot of musculature associated with the jaw-any musculature attached to the jaw were inside the cranium (inside the head)
 now have very powerful jaw and musculature associated with it
 wont have space for brain when jaw closes if it is mostly muscle - if they are contracting there are going to be putting pressure on the brain inside the cavity as well
 solution take the muscles and put the mass at the top of the head and have a tendon that will attach to the jaw to move it
 1-sent tendon to the muscle to the top of the head (synapsids)
 2-had 2 tendons that would attach to the top of the head (diapsids)
 -result to one or two openings
 turtles didnt have holes in their head- so they were put at the bottom /at the base of the lineage/primitive
 -they just fused their bones together to make their shell, dont have teeth in their weak jaw
 turtles are derived diapsids based on molecular work

Diapsida

Major diapsid groups

- **Archosauria**
 - Pterosaurs (e)
 - Dinosaurs (e)
 - Crocodiles and birds
- **Lepidosauria**
 - Snakes, lizards, and turtles (?)



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two major diapsid lineages

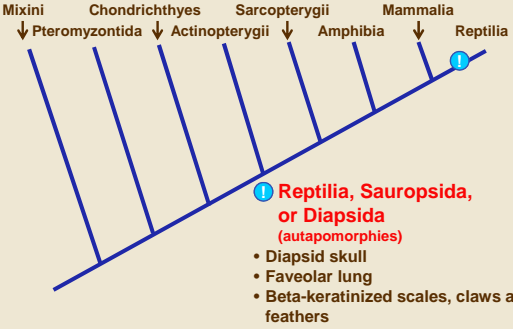
archosauria - all have 4 chamber hearts, gizzard in digestive tract with stones to break down their food - flying dinosaurs

crocodiles and birds

lepidosauria - not as diverse

snakes, lizards - can tell by the scales organization

Vertebrate phylogeny



Mixini
 ↓ Pteromyzontida

Chondrichthyes
 ↓ Actinopterygii

Sarcopterygii
 ↓ Amphibia

Mammalia
 ↓ Reptilia

① **Reptilia, Sauropsida, or Diapsida**
 (autapomorphies)

- Diapsid skull
- Faveolar lung
- Beta-keratinized scales, claws and feathers

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diapsid have diapsid skull

keratin skin - beta sheet

have faveolar lung/septal lung that is divided with septa that have holes in them

in mammals have aveolar lung with aveoli sacs that can puff up and contract air is being brought in and passed through many channels of the septa give huge surface area for most gas exchange - follows a directional path

Scales and feathers



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feathers and scales are the same thing - homologues, directly derived from skin

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Beta-keratinized scales, claws and feathers

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scales are keratinized mass of material that grows from the base making a disk-like structure that ranges in size

Growth of a feather

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feather, instead of growing from the base, get a ring of cells that produced a keratinized tubular structure -bristles

Evolution of feathers

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remnants of feathers in ambers

original feather was a cylindrical shaft of keratin -a bristle

bristles started to branch at their base

fuzzy surface, can insulate - way to hold on to body heat when temperature got cooler

started to bristle at the top

the bristles started to lock together - contour feather

bristles originated in dinosaur - use them for mating

contour feathers protect the smaller feathers underneath - keeping them warm

-become asymmetrical -shorter side and longer side (leading edge smaller than the trailing edge- adaptation that is needed for flight

occurred multiple times in the diapsid lineage

-thought that only feathers were associated with bird, but they were also common in dinosaurs

-oldest form as a bristle, before branching off

6- contour feather that protects the feathers underneath

like other keratinized structures, they are non-living tissue that need to be moulted and replaced

diapsid use beta keratin sometimes mixed with alpha keratin to produce scales or feathers

-two homologous structure, same origin (scale=disk-like structure, feather= cylindrical structure)

feathers- thought that they were only associated with birds (reason for division to avies) but feathers are also found

in various groups in the dinosaurs

all keratinized structures have to be moulted - structures that need to be replaced as they get

damaged

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Feather structure

The diagram illustrates the hierarchical structure of a feather. On the left, a whole feather is shown with labels for the **Vane**, **Shaft**, and **Quill**. On the right, a detailed cross-section shows the **Shaft** branching into **Barb**, which further divides into **Barbule**, which are held together by **Hooklets**.

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contour feather composed of barb and barbules that hold them together
-not living tissue, dried keratinized tissue
-can push against the air for flight
- tissue is not alive need to keep them moist to prevent them from being brittle - need to relink the barb and barbules by grooming
uroptygia that secrete oils that will be used to groom their feather so they don't become brittle

Feathers

- Bristles
- Down feathers
- Contour feathers
- Filoplumes

The image shows four different types of feathers: a large contour feather, a soft down feather, a long bristle, and a small filoplume.

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can pick up sensory information by how they bend the skin

Mouling

The left photograph shows a green snake in the process of shedding its skin, with a piece of the old skin being pulled away. The right photograph shows a blue bird perched on a brick, likely during a moulting phase.

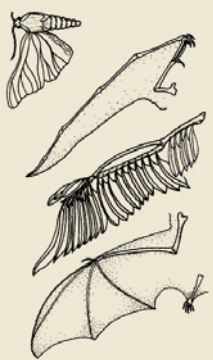
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since feathers are dead and become brittle
need to moult - can take up to 3 years to replace all of their feathers
both birds and reptiles moult

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Origins of flight

- Insects
- Bats
- Pterosaur flight
- Bird flight 2 theories
 - tree-down theory
 - ground up theory






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in diapsid- get two groups that end up with flight
-pterosaur - flying dinosaur - but not the same lineage as birds

Pterosaur flight
Video 6:00





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pterosaurs are quadrapeds- walk on all fours
using hind limbs - to walk on their knuckles and the fourth digit, extend upwards to support a large membranous sheet of skin (attaches to the back leg from the extended digit) making the wing that will be used for flight
tail becomes a problem- destroy aerodynamics of the wings - best fliers will lose their tails
have competition- archaeopteryx

Archaeopteryx (Transition fossil)



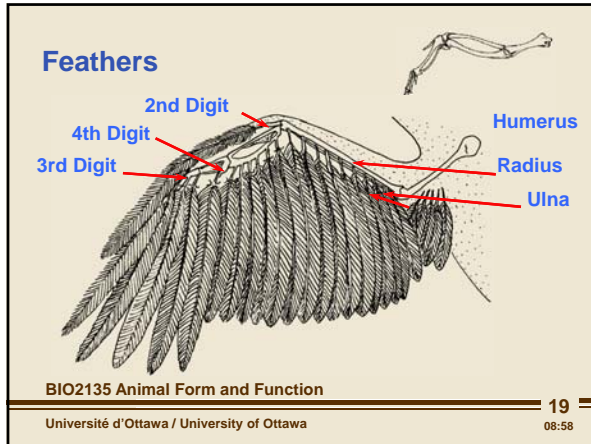
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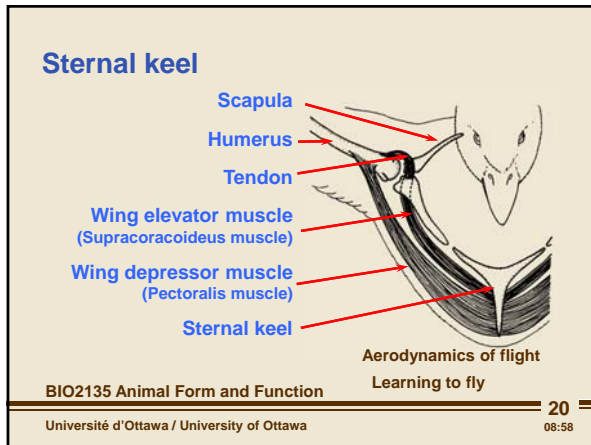
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transition fossil - flight is created by the pectoral limbs only
animal can specialise, use the hind limb just for walking
flight that is achieved by this group with the use of feathers instead of skin wings only associated with only the front limbs - give a distinct advantage

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end up with typical wing that we see today
 -have a reduction of bones in the fore limbs (lose first and fifth digit, others are minimized)
 just an appendage to attach the contour plate feathers to create a large surface area that can be used for lift and structure is lightweight
 adapt the animal to become nice and light



can see concentration of flight muscles at the center core of the body
 develop a large center of mass that contain all of the viscera, flight muscles and the lifting structure/
 wings are located above that - lifting the center of mass every time they fly
 -inner muscle is for lifting the wing
 -outer muscle is for the power stroke - push the wing against the air for lift
 both attached to the sternum
 -requires a lot of metabolism

Body temperature

		Heat source	
		External	Internal
Regulation	No	Ectothermic heterotherm	Endothermic heterotherm
	Yes	Ectothermic homeotherm	Endothermic homeotherm

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warm blooded and cold blooded
 -want to know if animal body can regulate its body temperature around a set point (temperature that stay around the same)
 all of life processes are enzymatic (enzymes speed up with heat and slow down with cooling),
 important to be able to regulate body temperature for metabolic activity - advantage
 two ways to add heat to the system if necessary
 -internal heat endothermic - muscle movement -shivering when cold is a way to burn ATP to give off heat to stay warm
 -external heat ectothermic - bask in the sun to warm up (reptiles do this to absorb the heat around them to regulate their body temperature)
 behavioral modification can generate good body temperature
 -large animals move in and out of warm environments to regulate temperature - homeotherms - regulate their temperature and get heat externally
 -can get heat externally but cannot regulate them = heterotherm (cold blooded)
 -have endothermic and homeotherm (warm-blooded)
 there are heterotherms that are able to tolerate fluctuations in body temperature even though they generate heat internally (camels- typically overheat, dont have a set point temperature)
 also other organisms that can regulate body temperature even though they cant generate heat internally

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Environmental heat exchange

- **Loss**
 - Respiratory evaporation
 - Surface evaporation
 - Conduction
 - Long wave radiation
 - Convection (wind)
- **Gain**
 - Radiant
 - Metabolic
 - Conduction

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stegosaurus - big animal have big plates on the back that are highly vascularized
 -porosity in the plates that represent blood vessels and capillaries - were able to shunt blood up to the plates to absorb heat and return it to the body to keep it warm
-to keep it cool, it would shut the blood off from that surface so it wouldn't absorb heat when it didn't need to or if it was too hot it would move into the shade, send blood to the plates to be used as a radiator
 this animal probably didn't have a fluctuating body temperature - because they were able to keep it constant behaviorally
 small diapsids would lose their heat quickly because that have a large surface to volume ratio
 -possible reason for feathers as insulation in none avian reptiles
if you look at the bone, dont see them growing in different temperature
 growth was stable - if not, would have seen differentiate rings of growth in bones (see them in smaller ones)
homeothermic - for birds but reptiles as well (mastered behavioral modification)
 heat was easily lost - radiate off the body, from wind
 gaining heat- from sun, conduction by sitting on something warm
those that don't do that are metabolic and endothermic

Walking and respiration

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movement - amphibians were unable to solve this
 intercostal muscles for breathing are the same in diapsids and synapses
 -expand the rib cage to pull air into the lung
first reptile inherited old walking motion
 -move opposite legs forward
 the way the pelvic girdle interact with the rib cage it would still compress the ribcage on one side, and vice versa
 -cancels the rib cage from expanding - cant breath
 -compressing the rib cage on one side would force air in one lung into the other lung
end up mixing air between the lung - need to be solved
 -stand on two feet

Crocodiles

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primitive diapsid - crocodile
 -solve issue but can still walk with bending side to side
 -instead of using intercostal breathing -have diaphragm muscle that is attached to the liver, attached to the lung - have a connection between the internal organs
 crocodiles change the position of the pelvic bones (tilt them back) that will pull the muscle back, that pulls on the liver, which pulls on the lungs - fills them with air as it walks
 -vice versa- leads to pushing the air out of the lungs
 by moving hind limb, can aerate their lungs (pelvic girdle)
 aeration is a byproduct of movement
 -when they start to move - see that that they hyperventilate
 can do this underwater as well

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Turtles and tortoises



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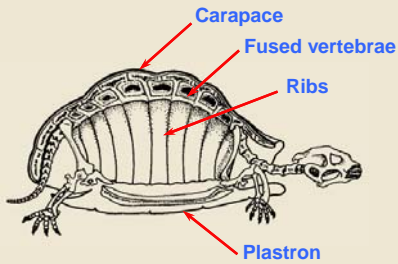
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turtles have taken all of the bones of the body and fused them together

Turtle skeleton



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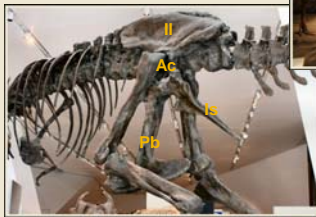
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bones fused together to make the carapace on the top and plastron underneath (fused ribs)
 dont have intercostal muscles - end up doing the same thing as the crocodiles
 -can change the size of thoracic cavity by moving the finds legs

Extinct Diapsids Saurischian dinosaurs



Albertosaurus, Tyrell

- Pb pubis
- Is Ischium
- II Ilium
- Ac Acetabulum

T rex, ROM

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two separate lineages that become bipedal

-saurischians and ornithischians

only difference is the positioning of the bones of the pelvic girdle of the bipedal stance

the pubic bone- pb and the ischium - is

ischium points backwards and pubis points forward and down or directly forward

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Extinct Diapsids
Saurischian dinosaurs

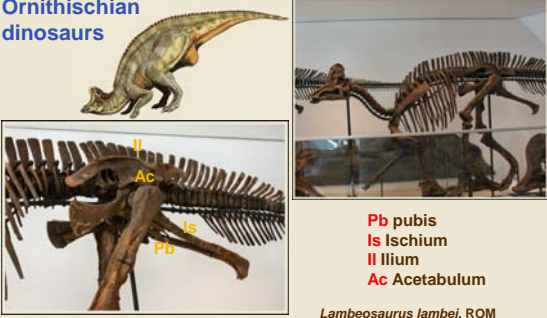


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Extinct diapsids
Ornithischian dinosaurs



Pb pubis
Is Ischium
Il Ilium
Ac Acetabulum

Lambeosaurus lambei, ROM


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in ornithischian - pubis and ischium point backwards
shows that bipedalism arose twice - two different solutions found in dinosaurs for walking
-herbivore called the bird hip dinosaur = similarities in birds
but birds evolved from saurischian

Extinct diapsids
Ornithischian dinosaurs



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Skeletal organization

Neck vertebrae

Sternal keel

Fused trunk vertebrae

Reduced tail vertebrae

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with bipedalism -further reduction in bones
 -birds end up with fused vertebrae, lose the tail, bones are filled with air (becomes lighter)
 cervical vertebrae/neck vertebrae becomes flexible
-birds cant move eyes, they are fix in one spot = can only see by moving their head around

Perching

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all birds have developed a hind limb for perching - always have one toe that is pointing backwards
 -give them a good grip

Air sacs

Lungs

Trachea

Anterior air sac

Syrinx

Posterior air sac

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faviolar lung associated with the diapsids
 a lung that have wall/septa with tubes and tunnels through them instead of air sacs that expand
 -dont have intercostal muscle to contract and expand their lungs
-contract and expand a series of air sacs - pump air into the lung in one direction and blood in the other direction to get good extraction

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Avian lungs

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have a set of anterior and posterior air sacs

as the bird expand the intercostal muscles- expand both air sacs
 posterior air sac will pull new air in - anterior air sac pulls air that was already in the lung from the posterior air sac
 when contract- squeeze posterior air sac to push air into the lung then anterior will squeeze the air back out
 set of valves will control where the air will travel so air won't go back out
 birds have elevated temperature to deal with metabolism with flight

Bird songs – the syrinx

1,3,5,7 and 9 cartilaginous tracheal ring
 5 and 6 membrane
 4 pessulus

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air moving through the system create sound - syrinx- set of membranes with 4 producing sound organs found at the top of the main tracheal trunk

bird can control how floppy those membranes are - can make 4 sounds at the same time
 -have complex sounds and sound to be able to communicate with their group

Circulatory system

- 3 chambered heart
 - Most reptiles
- 4-chambered heart
 - Crocodiles and birds

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circulatory system move to 4 chambered heart - have incomplete septum in the ventricle
 -lung fish had spongy tissue that would prevent blood from mixing

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Reptilian heart

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septum in the ventricle only becomes complete in the crocodiles and the birds
-so when ventricle contract blood will sent to both systemic and lungs

Circulatory system

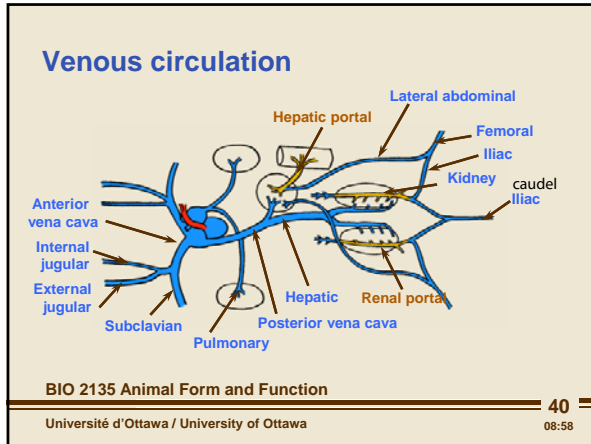
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Arterial circulation

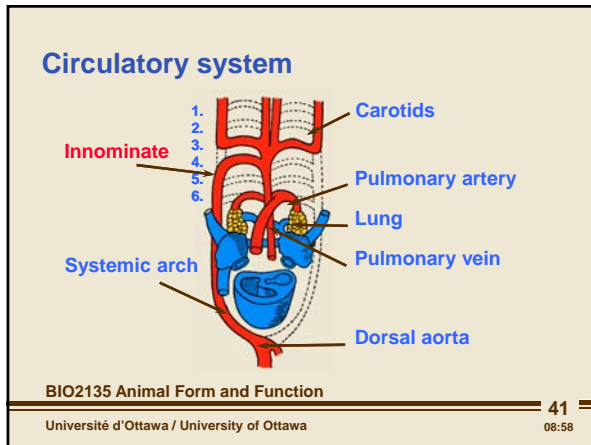
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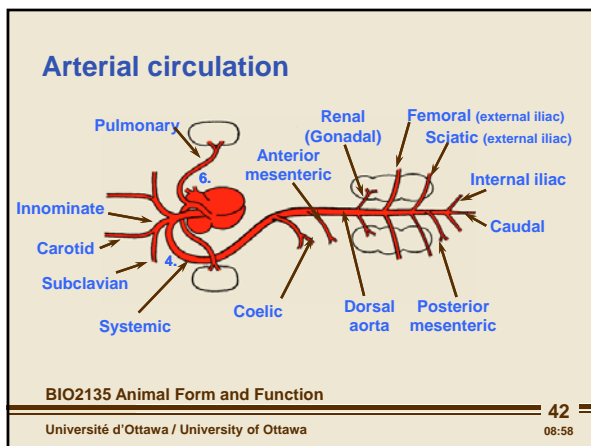
general reptile with three chamber septate heart
-now have 2 systemic arches that have carotids moving forward
4 to the systemic/body, 6 to the lungs

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venous system is being simplified as well
 have jugular bringing blood back from the front, the subclavian from the limb and one from the lungs
 now have one large posterior vena cava that collects it from the whole body





become even more simple in birds- instead of having duplicate systemic arch - only have one that is to the right
 -only a single blood root all the way through the body that will deliver blood to the posterior and anterior end
 end up with one innominate - a systemic arch that branches to everything
 -one large branch that goes to the back and the front with branches that supply the other parts of the body

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Venous circulation

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venous system is also simplified with the posterior vena cava accepting blood from the legs, kidneys, tail, through the hepatic and back to the heart -no lateral blood vessels
 same thing in synapsids but it will be on the left side instead of the right

Crushing jaws

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crushing jaw - holes in the skull to move the muscles masses to the surface of the skull
 - teeth are the same - jaw is to tear apart pieces, not to cut - like sharks
 gulp their food- have highly modified stomach - gizzard- filled with stones to help with digestion
 -didn't chew/pre-process it before swallowing it like synapsids


Snake venoms

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snakes dont have appendages- cant grab onto their prey = need to find a way to immobilized them
 constrictor to wrap their prey to suffocate them
 use venom

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Snake's jaw



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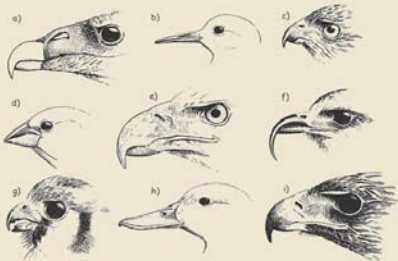
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in snakes, the bone that is typically attaches the jaw to the skull is detached - have two hinges in the jaw
can open the jaw really wide and swallow its prey whole
when they consume food, if they can alter their behavior to keep themselves warm by ambient temperature by being on warm rock

uses minimal amount of energy from the food to warm its body food will be converted to body mass, reproduction, etc
-put aside enough nutrients in liver to do nothing

Bird beaks



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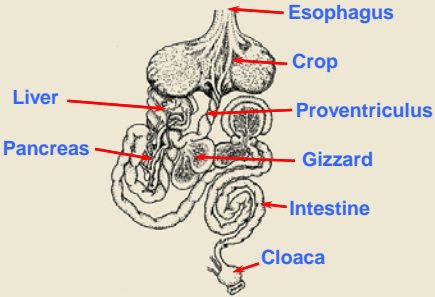
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modifications in bird jaw -keratinized jaw to lighten their bodies

bird beak shape can change depending on their diet

Digestive system



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once the food is in, stomach is modified into a gizzard with rocks so that it can grind the food

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Reproduction



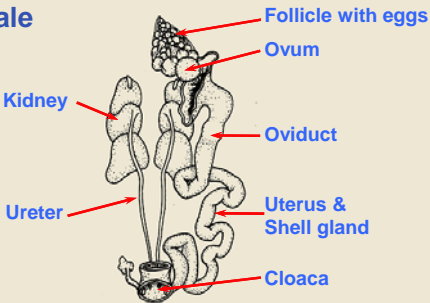
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eggs are leathery which reptiles will bury for protection, birds calcify their eggs add calcium and mineral salts (give protection and rigid shell)

Female



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only have one ovary that atrophies when it is not in reproductive season
when bird is ready to mate, ovary will grow and enlarge and will ready with eggs for fertilization

Parental care



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have adaptation to parental care
