

Reptiles

1) Amniotes

- a) Amphibians first moved onto land, however they couldn't really go that far. Amphibians are reliant on water for reproduction and oxygen transport.
- b) In order to fully have a terrestrial life style animals had to find a way to have offspring without the need for water
- c) Amniotes includes all vertebrates except fish and amphibians.
- d) Adaptions for amniotes
 - i) Fenestrae
 - (1) These are holes in the skull used for muscle attachment. Not living a life in water, suction feeding becomes an impossibility, so fenestrae increase bite force allowing better capture of prey in a terrestrial environment
 - (a) **Anapsid**- this is the earliest form with no openings. The only living amniote with this form is turtles, however recent genetic evidence has suggested that turtles secondarily lost their fenestrae.
 - (b) **Diapsid** – has two pairs of fenestrae. This is characteristic of birds and all animals considered “reptiles”
 - (c) **Synapsid** – has a single pair of fenestrae. This is characteristic of mammals.
 - ii) Amniotic egg
 - (1) This is the characteristic that gives the name to amniotes. The **amnion** encloses the embryo in fluid, cushioning the embryo and helping move metabolic nutrients/waste.
 - (2) Most are surrounded by a mineralized shell providing support, allows for gas exchange and limits water loss.
 - (3) Attached to the amnion are other membranes that store waste, provide nutrients, and works as a respiratory lung. All of these are needed for an egg to be laid out of the water.
 - (4) Though the amniotic egg allowed for more terrestrial life style, its most important role is that it allows for faster growing and larger offspring.
 - (a) Non amniotes have a jelly filled membrane and can support large eggs
 - (b) Amniotic eggs can be larger because they can transport oxygen further and the calcium filled shell can be absorbed by the embryo providing valuable nutrients for skeletal growth.
 - iii) Thicker more water proof skin
 - (1) Amphibians need a thin skin for effective gas exchange, but on land thin skin makes you vulnerable to dehydration.
 - (2) **Keratin** is a complex protein that is very hard. Amniotes use this to create barriers for physical protection.
 - (a) Hair
 - (b) Feathers
 - (c) Claws
 - (d) Beta keratin in reptile skin

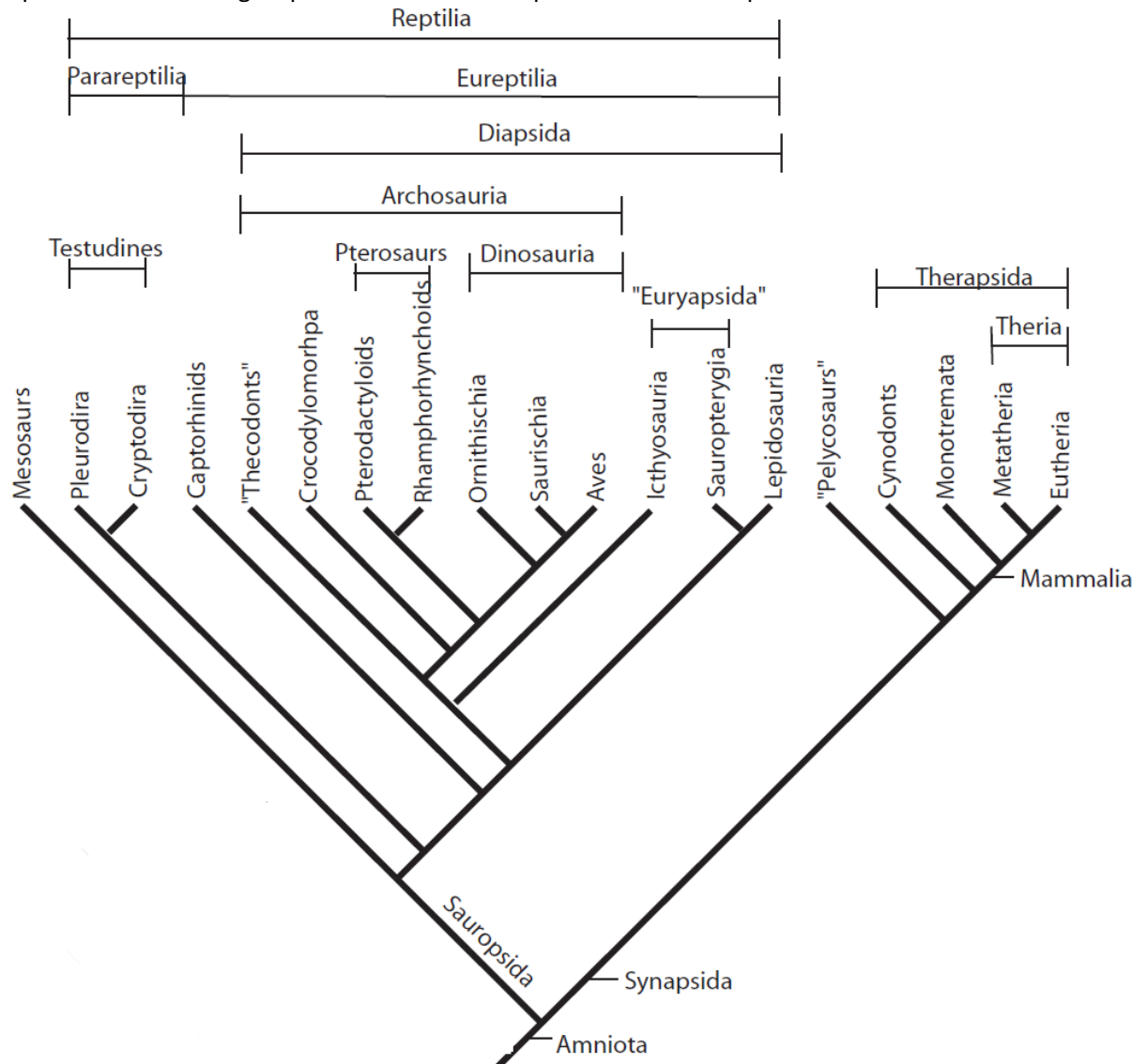
- (3) Having thick skin also restricts oxygen absorption so amniotes have to have better respiratory system.
- iv) Rib ventilation
 - (1) With better developed lungs there needed to be a more efficient means to get air in and out.
 - (2) Amphibians and air breathing fish need to push air into the lungs using a muscular pharynx. Amniotes pull air into their lungs called **aspiration**. They expand the thoracic cavity using rib muscles or pull the liver down with other muscles.
 - (3) The need for muscles to increase respiration probably influenced limb rearrangement and muscular development of the limbs leading to increased movement.
 - (4) Lungs are the primary respiratory organ for amniotes however some supplement with other organs
 - (a) Soft shell turtles
 - (b) Sea snakes
- v) High functioning cardiovascular system
 - (1) All animals the right atrium is separate from the left (when both are present) but the ventricle is may or may not be separated into two chambers
 - (2) Crocodilians are the only non-avian reptile to have a 4 chambered heart
 - (3) Non-crocodilian reptiles have a ventricle with a ridge like structure that partially separates the one ventricle in half.
 - (4) The incomplete separation of hearts is not a disadvantage because it allows blood to bypass the pulmonary system when it's not in use (like during diving under water).
 - (5) Though some mixing takes place in these types of hearts they are much more effective than amphibian 3 chambered hearts
 - (6) This separation of blood flow allows for higher blood pressure, which is needed to fight gravity and to support a more active lifestyle
- vi) Water conservation through excretion
 - (1) Ammonia is a byproduct of metabolism but is very toxic. Organisms that live in the water can simply dilute it to safe levels with water then pee it out.
 - (2) Terrestrial amniotes don't have a steady supply of water so this would be costly.
 - (3) Reptiles have limited abilities with their kidney. In mammals and many amphibians ammonia is concentrated in the kidney in the form of urea, but in reptiles it is passed into the bladder where water is reabsorbed leaving only a concentrated waste called uric acid.
 - (a) Because too much salt can be bad in the body and as a general rule water goes where salt goes, when the bladder absorbs the water it takes in many of the salts as well.
 - (b) Because of this many reptiles have salt glands located near the eye/face area to excrete salt from the body.
- vii) Heightened sensory organs
 - (1) The cerebrum and cerebellum is enlarged in amniotes which means they can coordinate sensory information with muscle control during locomotion

(2) Vision tends to be excellent in amniotes

(3) Smell however tends to be reduced

e) Reptile classifications

i) Reptiles are a diverse group but their relationship is a lot more complex



ii) From the above we can see the relationship of the modern and extinct reptiles

(1) You will not have to remember this clad but just for understanding ill "translate" some of these names for you so you can see the relationships

(a) **Aves**- birds

(b) **Saurischia** – lizard hipped dinosaurs

(c) **Ornithischia** – bird hipped dinosaurs

(d) **Testudines** – turtles

(e) **Pterosaurs** – Pterodactyls (flying "dinosaurs")

(f) **Crocodylomorpha** – crocodiles

(g) **Lepidosauria**- lizards, snakes

(h) **Sauropterygi**- long necked aquatic reptiles (think Nessie from lock ness)

2) Major reptilian groups

a) Testudines (turtles)

- i) Appear in the Triassic 220 million years ago
- ii) there are 327 species of turtles (22 in Georgia)
- iii) they lack fenestrae
- iv) In the US turtle is the generic term and tortoise is a terrestrial turtle
 - (1) Terrapin is just a turtle in new England
- v) Have a dorsal **carapace** (shell) and ventral **plastron** (breast plate)
 - (1) Made of two layers:
 - (a) Keratin outer layer (like a big finger nail)
 - (b) Bone inner layer (this is basically their ribs)
 - (2) Because ribs are fused to shell they cannot expand to breath. Turtles must use their arm muscles to force air in and out.
- vi) All turtles reproduce internally and bury their eggs in moist sand/soil
 - (1) The sex of a turtle is dependent of temperature
 - (a) Low temperatures = males
 - (b) High temperatures = females
- vii) most feed on sea grasses and or small invertebrates
- viii) turtles can be long lived
 - (1) Galapagos tortoise more than 150 years
- ix) 51% of known species of turtles are endangered
 - (1) Habitat loss
 - (2) Harvesting for food
- x) Interesting
 - (1) Turtles were one of the first creatures in space (2 Russian tortoises on Zed 5)
 - (2) Alligator snapping turtles use fishing lures
 - (3) The African helmeted turtle hunts in packs

b) Snakes and lizards

- i) Most recent of reptile evolution
- ii) Make up about 95% of all known non-avian reptiles
- iii) Have diapsid skulls
 - (1) This allows the jaw to open and close but it also allows the from part of the brain case to pivot open and close
- iv) Lizards
 - (1) Extremely diversified group
 - (2) Lizards have an ear opening which is lacking in turtles and snakes
 - (3) Lizards feel right at home in the hot deserts because they store fat directly under the skin to prevent water loss
 - (a) The gila monster stores fat in its tail so that when the environment is lacking in food or water it can burn the fat to make energy and metabolic water

- (4) Most lizards are predacious feeding on small insects to large deer even
 - (5) The largest of the lizards is the komodo dragon (10 ft and 150lbs)
 - (a) They also have venom glands in their lower jaw.
 - (b) Their saliva is a crimson red
 - (c) Consume only 12 meals a year
 - (6) some lizards can detach their tails for defense
 - (a) This lead to Frankenstein!
 - (7) Chameleons can shoot their tongue out the whole length of their body to capture prey and they change color to communicate and hide
 - (8) Mating is sexual and can have many complex mating rituals
 - (a) Fence post lizard
- v) Snakes
- (1) Limbless and lack pectoral/ pelvic girdles
 - (a) Boas and pythons
 - (2) They have many ribs with many vertebrate to support their weight against gravity (200-400 vertebrae; humans have 33)
 - (3) Smell is incredibly advance on snake and many other lizards.
 - (a) **Jacobson's organs** are located in the roof of the mouth, these are full of olfactory nerves to detect smell. The forked tongue collects chemicals from the air and drags them over the organ to smell them.
 - (4) The skull of a snake is loosely connected by a stretchy elastic tissue. This allows the snake to eat prey much larger than its head
 - (a) Snakes cannot dislodge their jaw like is commonly told, however they can open there mouths up just shy of 180 degrees and move the left side of the jaw independently from the right side to force prey down the throat.
 - (b) Their lungs are elongated and along the back so even when swallowing they are still able to breath
 - (c) Most snakes eat live prey which can be dangerous since live prey can scratch and bite, so these species focus on smaller prey like worms and insects.
 - (d) Snakes that feed on larger animals usually developed some sort of adaptation to neutralize its prey such as venom or constriction
 - (e) Venomous snakes only represent 20% of all snakes. (except in Australia where venomous snakes outnumber non-venomous 4:1)
 - (i) Venom glands most likely evolved from salivary glands. Even non-venomous snakes produce enzymes to prevent blood clotting in their saliva.
 - 1. Be careful handling even non-venomous snakes infection is common from their bits and their teeth point inward, so if you try to rip it off, its likely a chunk of flesh will come with it.
 - (ii) There are many types of venom patterns including vipers with retractable long fangs, small permanent fangs, rear fanged, and a few variations in between
 - 1. In Georgia we have mostly pit vipers (copper heads, cotton mouths, and rattle snakes) with there characteristic heat sensing organ on their head.

2. The coral snake (our other venomous snake) has small fixed small fangs that are would be difficult to penetrate human skin. No fatality has ever been reported from this species even though it has the second most deadly snake venom in the world.
3. The most deadly snake in the world is not the biggest or most toxic it's the king cobra. A study showed at least 20,000 people die every year from cobra bites in Pakistan, india, and neighboring countries.

(5) Reproduction

- (a) Snakes mostly lay eggs, however some give live birth retaining the egg internally to keep warm

(6) Conservation

- (a) Snakes do great things for us like keeping pest populations in check
- (b) Many snakes eat the snakes you don't want around
- (c) Unfortunately these snakes look like the venomous kind so people kill them
- (d) As a general rule if the snake is not threatening you or in a place that can harm you or someone else then leave it be, especially if it is in the woods or streams (that's where it belongs).
- (e) Of course the most important rule is, if you don't want to be bit don't pick the snake up, all species will bite to defend themselves and if you don't know how to tell the difference between a water snake and a water moccasin it's a bad idea to go for the trial and error option
- (f) 65% of all snake bites in north America are on the hand and from people picking them up (4 out of the 5 fatalities from snake bites in USA were from handling the snake, 3 were from religious purposes...)

vi) Alligators/crocodiles

- (1) Closely related to dinosaurs and birds
- (2) They have remained unchanged for over 200 million years
- (3) All have big reinforced very muscular mouths with teeth that are attached to the jaw!
- (4) The biggest crocks get well over 2000lbs and 20ft long (Nile crocks of Africa and salt water crocks of Australia/Indonesia)
- (5) Alligators are far less aggressive than crocodiles. Lucky for us the only species of alligator is here in north American and only one species of crocodile is here (but very limited to the far south of the everglades)
 - (a) Alligators have wider snouts, bottom teeth fit into the upper jaw, no salt gland
 - (b) Since 1970 there have only been 23 alligator fatalities on people and many of these were people messing with the alligator (or jumping on it while trying to evade the police)
- (6) Of all the reptile alligators have the most advanced heart
 - (a) It has a 4 chamber (2 atrium, 2 Ventricles) heart. Its blood come in the right side goes to the lungs for oxygen comes back the left side and out to the body.
 - (b) However if it is submerged it has a special artery that prevents blood from going to the lungs.

- (7) Reproduction is sexual and females lay eggs in nests
 - (a) They guard their nest fiercely and when the eggs hatch they protect the young for upwards of 2 years.
 - (b) Nest temperature determines sex as well
 - (i) Low= female
 - (ii) High=male
- vii) Other groups
 - (1) Dinosaurs were large reptiles that ruled the earth for almost 200 million years.
 - (a) In the recent years we are learning a lot more about this unique group of reptiles
 - (i) We once thought they looked dry, scaly, bland but new discoveries in tar pits have uncovered feathers (suggesting thermo regulation), tissue samples, and even skin pigments!
 - (ii) Some evidence suggest that dinosaurs had crops and gizzards like modern birds.
 - (b) Unfortunately Jurassic Park was wrong on many things
 - (i) Amphibian DNA would be a horrible choice for fixing broken Dinosaur DNA
 - (ii) Velociraptors were at best about 3.5-4 feet tall
 - 1. Utah raptor would have been about the size depicted in the movie
 - (iii) T-rex would have eaten everyone stuck on that road because its eye sight would have been phenomenal and even if it wasn't its smell would have been
 - (2) Pterosaurs
 - (a) Flying reptiles not dinosaurs
 - (i) This lineage is extinct they did not become birds
 - (ii) They came in toothy and non-toothy