

Phylum Chordata – Vertebrates

Reptilia

8000 species; 340 sp in US & Canada

1st vertebrates no longer tied to water, even for reproduction

→ truly terrestrial

very successful group today

occupy a great variety of terrestrial habitats

some have returned to ocean and freshwaters

largest living reptile:

eg. Komodo dragon (*Varanus komodensis*)

10 feet long; 300 lbs

eg. Australian saltwater crocodile

up to 23 feet long

eg. leatherback sea turtle

8 feet long; 1500 lbs

largest reptile ever:

eg. largest of all reptiles: *Seismosaurus hallorum*

("Earth-shaking lizard")

120+ feet long (37 m); 30-80 tons
→ largest animal ever to have walked on land

smallest living reptile

Caribbean lizard <3/4ths of an inch nose - tip of tail

but were much more abundant and diverse
~160-100MY ago

= age of reptiles (Mesozoic)

lasted >165 M Y

First Reptiles

reptiles arose from amphibian ancestors ~280 MY ago

while amphibian adults can live on land

they must have water to reproduce

complete independence from water didn't occur
until the evolution of a self contained egg
capable of storing water (=cleidoic egg or
amniotic egg)

the appearance of this new type of egg
allowed the evolution of **reptiles, birds &
mammals**

the earliest example of a true reptile was a lizard-like, partly aquatic animal

~1.5' long

probably ate mostly insects

→ shows characteristics of both groups

reptilian skeleton
still had lateral line system
probably didn't yet lay shelled eggs

shortly after reptiles arose, they began diversifying onto land at time of:

variable climate; tending to get drier

diversification of plants including flowering plants

Skin

tough dry skin with **scales**

same 2 basic layers: **epidermis** & **dermis**

epidermis much thicker than amphibians

contains lipids and waxy **keratin**

→ very effective water proofing
some of this keratin hardened into thick epidermal **scales**

****epidermal (not dermal) scales****

reptile scales ≠ fish scales
(epidermal) (dermal)

[scutes of turtles are modified scales]

→ protection from drying, abrasion, predators

shed periodically

reptiles scales are **homologous** to feathers and fur of birds and mammals

some extinct forms (dinosaurs & relatives) had feathers or hair in addition to scales

thick dermis with **chromatophores**

Skeleton & Support

new features appear in reptile skeleton:

fewer skull bones

teeth still simple and peg like but in more efficient and stronger jaws

→ more biting force

nasal cavity separated from mouth by shelf of bone = **palate**

limbs stronger, more flexible & closer to body

→ better designed for walking

toes with **claws**

Movement

more powerful muscles than amphibians

limbs are stronger and more flexible for walking

chameleons have opposable toes for arboreal life

one group of extinct reptiles could **fly**

some reptiles can glide:

eg. *Draco* = flying dragon

uses extended ribs

can glide up to 50'

eg. gliding gecko *Ptychozoon* sp.

eg. some gliding snakes

most land reptiles can **burrow** in to mud

eg. turtles and small lizards

most reptiles **swim** with ease

Feeding and Digestion

most reptiles are carnivores

jaws are more efficient for crushing and gripping prey

(fish use "suction" for feeding; their jaws are not very muscular; amphibians can't "chew")

tongue is muscular and mobile

→ used to help catch prey

tongue never attached to front of mouth

in some tongue serves as touch receptor

most reptiles have **teeth**

crocodilian teeth are constantly replaced

in some salivary glands are modified into **poison glands**

stomach often has pebbles to help grind food
(=gastroliths)→ common find at dinosaur sites

liver and pancreas produce wide variety of digestive enzymes

Respiration

Reptiles never have gills

since skin is thick and dry most reptiles depend completely on **lungs** for gas exchange

lungs are more developed, more folding, more surface area

→more efficient

air is sucked into lungs, not gulped

can expand and contract the rib cage to inhale & exhale

some have fully developed ribcage and sternum to facilitate breathing through lungs

still relatively low breathing rate since still cold blooded

(1/10th that of birds and mammals of same size)

but most can't breath while running since any of same muscles are used for both purposes

a few (crocodilians) with muscular **diaphragm**

also a few reptiles can exchange gasses through skin
eg. sea snakes, soft shelled turtles

also, aquatic turtles can "breath" through their mouth and cloaca
(can pump water in and out, highly vascularized)

no vocal cords like amphibians

→ reptiles can only hiss

Circulation

like amphibians, most with **three chambered hearts**

with 2 **atria** & 1 **ventricle**

but partial septum separates the ventricle

→ slows mixing of oxygenated & unoxygenated blood

two separate **circuits** of bloodflow:

pulmonary and **systemic**

the respiratory & circulatory systems of reptiles provides more oxygen to tissues than that of amphibians

more efficient heart; higher blood pressure

but still less efficient than that of birds and mammals

crocodilians have 4 chambered heart which completely separates the pulmonary and systemic circuits

overall, still low metabolic rate = cold blooded

(~1/10th rate of birds or mammals of same size)

some reptiles in past were warmblooded

Nervous System

more advanced than amphibians

similar to mammals in basic structure,
only smaller

cerebrum increased in size but no cortex
→ more complex behaviors

more complex behaviors

but still reptiles are not as dependent on their brain as mammals are

eg. motor functions in many reptiles is at least partly controlled by **ganglia** along spinal cord

cerebellum less important than in birds and mammals

eg a turtle lived 18 days after brain was removed

Senses

a. vision

is most important sense organ

eyes usually with 2 moveable eyelids

some with a 3rd → **nictitating membrane**

most reptiles are active during the day

→ have cones for good color vision

some have "third eye" **pineal eye** on top of head

→ detects light intensity and may control biological rhythms

b. smell & taste

also have well developed sense of **smell**

eg. crocodilians secrete a strong musk during mating season

→ olfactory epithelium

Jakobson's organ assists in sense of smell/taste

pits located on roof of mouth in lizards and snakes

→ forked tongue of snakes flicked then touched to Jakobson's organ to follow chemical trails

c. heat sensors

some snakes have IR sensors

→ can see body heat from warm blooded prey

d. hearing

similar but better than in amphibians
contain inner and middle ears

→ external tympanum and columella (stapes)

some lack tympanum and use bone adjacent to
jaw to detect sound in ground, not air

in lizards the tympanum is recessed into a canal

Excretion & Salt/Water Balance

more efficient (metanephric) **kidneys**

amphibians excrete N wastes as ammonia

→ requires lots of water to dilute it

most reptiles (and birds) secrete **uric acid**,
not urea or ammonia

→ requires much less water

most excess water is reabsorbed by bladder

reptiles, birds, mammals that live near sea cannot get

rid of all salt via kidneys

most have evolved salt glands (independently)

eg. marine iguana

→ salt gland empties through nostrils

eg. sea turtles

→ salt gland in orbit of eyes

eg. sea snakes

→ salt glands are beneath tongue

Reproduction

dioecious

but hard to tell male from female

a few have sex chromosomes:

in many the gene that controls gender depends on temperature during critical period of development

all have **internal fertilization** so don't need water for fertilization

1 or 2 copulatory organs

some snakes and lizards have 1 penis

most snakes and lizards have 2 penises (=hemipenes)

→ use only 1 at a time; depending in which

testis has more sperm

tauratauras lack any penis

→ press cloacas together

after copulation, sperm may remain in female for months or years before it is used to fertilize egg

a few are **parthenogenetic**

→ egg develops without fertilization

reptiles develop within an **amniotic egg**

(only found in reptiles, birds & mammals)

with protective membranes enclosing embryo

→ complete life support system

4 membranes: amnion → watery cushion

allantois → collects wastes

yolk sac → provides stored food

chorion → with allantois for respiration

don't need water for development

embryo & membranes are enclosed within a porous **shell**

can be leathery or hard shell

no reptiles pass through a free living larval stage

few living reptiles show parental care

but crocodilians do:

dig nest for 25-50 eggs

cover eggs

hatchlings often chirp

→ encourages mom to uncover nest

she picks them up and carries them to water

mom and dad respond to distress calls

some dinosaurs also showed parental care

many reptiles have well developed abilities to
regenerate missing body parts

eg. green anoles can lose tail

eg. glass snake: when pursued can break off its tail with a
sharp twist

the tail twitches and writhes to attract pursuer while
glass snake escapes

Kinds of Reptiles

today only 4 groups of reptiles (3 major, 1 minor)

during mesozoic more than 12 major groups of reptiles emerged and diversified including **dinosaurs**, along with shark-like reptiles (ichthyosaurs), plesiosaurs and flying reptiles (pterosaurs)

→ lots of niches open (no birds or mammals yet)

Dinosaurs

~450 different species of dinosaurs have been described

2006 study concluded that at least 70% of dinosaur genera remain unknown

ichthyosaurs, plesiosaurs and pterosaurs are technically NOT dinosaurs but other extinct groups of reptiles

dinosaurs generally lived in warmer even tropical parts of the world but fossils are also found much closer to poles

Cretaceous dinosaur fossils are being found further and further north and south.

eg. north slope,

eg. southern argentina and australia

→ cold winter nights would have lasted several months

→how? (1988)

dinosaurs share a group of unique features that set them apart from all other vertebrate groups:

- many dinosaurs were bipedal
- considerably stronger hinge joints at knee and ankle

same as in birds

much less flexibility than in mammals

- most with upright stance

→ legs positioned directly beneath body

similar to mammals and birds

not like amphibians and most living reptiles

- dinosaurs walked on their toes

like horses

- many or most dinosaurs were endothermic (warm blooded)

like birds and mammals

- some had feathers &/or fur in addition to epidermal scales

- many showed considerable maternal care

most reptiles today have no care of young

were apparently competitively superior to mammals at the time since mammals remained small and inconspicuous until ALL dinosaurs disappeared

→ then mammal diversity exploded

all dinosaurs and most of the diversity of reptiles disappeared ~65 MY ago

→ probably meteorite impact

cretaceous extinction may have been caused by a pulse of asteroids not just one, eg. Manson, Iowa crater 66MY old

today only 4 groups of reptiles (3 major, 1 minor)

1. **Turtles** (~300 species)

ancient group (only surviving anapsids)

appeared in U Triassic (200 MY ago)

very little change in body form over past 200 M years

enclosed within a shell

dorsal **carapace** and ventral **plastron**

outer layer of **keratin**, inner layer of **bone**

→formed from fused vertebrae and covered with dermal bone=carapace & plastron of fused scales

ribcage can't be used for breathing

turtles must pump air into lungs like amphibians do

aquatic forms can breath some through skin

no teeth, instead rough horny plates

good sense of smell & color vision, poor hearing

low metabolism → live long >100 yrs

many turtles require 6-12 years to attain maturity; some take 20 or more

internal fertilization

all turtles bury eggs in ground

nest temperature determines gender of hatchlings

no sex chromosomes

three kinds of turtles:

tortoises – terrestrial

terrapins – freshwater

turtles – marine

eg. sea turtles

have webbed feet

up to 6' long

migrate 1000's of miles

live, feed and grow in sargasso sea

may take 50 years to reach sexual maturity
(low metabolism – some live to 150 yrs old)

they then return to beach where they hatched
to lay eggs

(reverse of amphibians)

as soon as they hatch sea turtle swim across 100's of miles
of ocean

→ can detect earth's magnetic fields for navigation

eg. box turtle

shell has 2 hinges to close up from predators
omnivorous: fruits and berries
may live up to 100 years

25,000 box turtles/yr are exported to Europe
as pets
90% die in transit

eg. snapping turtle

common in ponds in eastern US
grow to 1 ft long
ferocious and short tempered
entirely carnivorous (fish, frogs, birds)
come ashore only to lay eggs

2. Lizards & Snakes (6000sp)

appeared in fossil record in Jurassic

evolutionarily are very similar
→ placed in same order

most successful group
→95% of all living reptiles

very effective jaws to capture prey
very flexible
eg. snake can swallow prey several times
its own diameter

the order is about evenly divided between lizard

and snake species

2a. Lizards

terrestrial, burrowing, aquatic, arboreal or aerial

many lizards show reduction or loss of limbs

some legless forms

eg. glass lizard

eg. worm lizard

very effective jaws to capture prey

cold blooded but can regulate temperature by behavior to maintain a fairly constant body temperature

→ early morning basking in sun to absorb heat

→ hot → turn face to sun to expose less area

→ lift legs on hot substrate

→ hottest part of day may retreat to burrows

the desert iguana prefers higher body temperatures and can tolerate 117° F

→ lethal to all birds, mammals, most lizards

eg. Geckos

small, nocturnal

adhesive pads on feet → can walk upside down

common around houses in Austin

eg. Chameleons

catch insects with sticky tongue

eg. Iguanas

include skinks, monitors and komodo dragons
often brightly colored

some marine

→have salt glands to get rid of excess salt

2b. Snakes

most are terrestrial, some are aquatic, some
marine

most lizards have moveable eyelids;

snakes eyes are permanently covered with
transparent layer; no moveable eyelids

body very similar to lizards except for legs

most snakes have lost all traces of
appendages

some retain vestiges of pelvic girdle

locomotion is radically altered, very adaptable

scales grip the ground as they make eel-like
movements

essentially walk on their ribs:

→ up to 300 ribs

each rib has separate muscles that control its movement

snakes can climb, leap, swim, stand erect and “run”

→ probably most unusual is side winding of some desert species

sidewinders have only 2 parts of body touching ground at any one time

→ essentially *walking* without legs

no external ears or tympanic membrane

do have internal ears and can detect low sound vibrations and soil vibrations

most snakes use chemical senses to detect prey

use tongue as “smell” receptor

picks up chemicals with tongue

transfers tongue to Jakobson’s organ in mouth

snakes generally have only 1 functional lung that extends almost the whole length of the body

the other lung is greatly reduced

most rely on chemical senses to hunt

flexible jaws allow snakes to swallow prey several times their own diameter

subdues prey by suffocation (constriction) or venom

eg. boas and pythons → wrap and suffocate

venom = saliva with a mixture of digestive enzymes

→ kills and starts the digestive process

some of these enzymes work on nervous system to cause paralysis

while only 2 lizard species are venomous (include Gila Monster)

→ many snakes are venomous

a. coral snakes (ELAPHIDAE)

most dangerous

Indian cobra kills 10,000/yr

spitting cobra can blind by spitting in eyes

Tx Coral Snake

small mouth, short fangs

b. sea snakes (HYDROPHIIDAE)

are similar to cobras

effective venom

c. pit vipers

in US include rattlesnakes,

water moccasins, copperheads

fangs fold back when not in use

use pits to track warm blooded prey

→ as effective in dark as daylight

most snakes lay eggs

pit vipers bear live young

other snakes

inland taipans, fierce snakes up to 10 ft long, can get darker in winter
and lighter in summer

australian copperhead can also change color

3. Crocodiles & Alligators

21 species

mostly unchanged for 200 MY

largest of the living reptiles

→ up to 6M (18')

large robust skull with massive jaws with powerful
closing muscles

distant cousins of dinosaurs (diapsid like dinosaurs)

more closely related to birds than other living reptiles

- have diaphragm for breathing
- have 4 chambered heart

two groups:

crocodiles → long slender snout; more aggressive

alligators → shorter, broad snouts; much less aggressive

crocodilians have scent glands and produce a strong musk during mating season

glands in mouth and throat with slit like opening to outside of neck

another pair within cloacal slit

the only living reptiles that can make vocal sounds

- vocal sacs on each side of throat
- bellowing mating calls

one of only a few reptile groups that show parental care

lays 20-50 eggs per nest

tends to and protects eggs & hatchlings

gender temperature dependent

low nest temp → females

higher nest temp → males

4. Tuataras (O. Sphenodonta)

2 living species (endangered)

found in New Zealand

lizardlike

features similar to fossils 200MY old

retain the most primitive reptilian traits

well developed parietal eye with cornea, lens & retina

but buried beneath layer of skin

→ can only detect light intensity

complete palate

teeth fused to jaw (not in sockets)

to 60 cm

live in burrows

live long lives; to 77 yrs

Humans Impacts

1. Poisonous Snakes

snakebites kill 50-60,000 people worldwide each year

esp India, Pakistan & Mideast

most are mistrustful of reptiles in general because a *few* are dangerous

Travis county has 5 venomous snakes:

Texas Coral Snake

- small mouth short fangs; coral snakes are nocturnal; only bite under unusual circumstances; have up to 12 hours to get antivenom

Western Cottonmouth

- can bite underwater

Western Diamondback Rattlesnake

- responsible for more human deaths than any other N. Am. snake

Blacktail Rattlesnake

- rare

Brown Banded Copperhead

but in US the average American is more likely to be killed by another person than to be bitten by a venomous snake

8000 bitten/yr in US

99.8% chance of survival (~80 die/yr)

reptiles are much more of a benefit than a threat

eg. keep rodent populations in check

2. Invasive Species

eg. brown tree snake

bioinvader of islands (eg Hawaii)

→has wiped out numerous species of birds and mammals

3. Reptiles as Food

humans are much more of a threat to reptiles than they are to us

eg. sea turtles

such as Kemps Ridley sea turtle

eg. Kemps Ridley sea turtle

1947: 40,000

1985: ~200

1994: 580

they like the same beaches we do

hunted for eggs and meat

→in Mexico armed troops must guard beaches during nesting season

also affected by pollution & fishing

→US now requires exclusion devices on shrimp nets

eg. Alligator meat comprises about 1/3rd of

commercial harvests in US

4. World Trade in Live Reptiles/ Pet Trade

Because reptiles are traded for such a wide variety of reasons, there are many hundreds of species in trade.

millions of live reptiles are sold each year for the pet trade.

eg. In 2001 the United States imported just under **2 million live reptiles.**

eg. The United States annually exports more than 8 million **red-eared slider turtles** (*Trachemys scripta elegans*), the world's most commonly traded live reptile.

eg. over 500,000 were **green iguanas** (*Iguana iguana*) from Central and South America.

eg. Other species commonly found in the pet trade include:

boa constrictor (*Boa constrictor*)

ball python (*Python regius*)

panther chameleon (*Chameleo pardalis*)

red-footed tortoises (*Geochelone carbonaria*)

reptiles are among the most inhumanely treated animals in the pet trade.

90% of wild-caught reptiles die in their first year of captivity because of physical trauma prior to purchase or because their owners cannot meet their complex dietary and habitat needs.

Because they are cheap and easily replaceable, dealers, captive breeders, and retailers factor huge mortality into their operating costs.

5. World Trade in Reptile Products

eg. In many parts of the world, "tortoise shell" curios and jewelry, which are actually made from the shells of hawksbill sea turtles, remain popular, as do leather items made from snakes, lizards, and crocodilians.

eg. Tortoises and turtles fetch high prices in Asian markets - especially in China - where their meat is eaten and their shells are used to make traditional medicines.

eg. American Alligator; brought back from near extinction
\$30M hide business now