CHAPTER 26
Reptiles
Amniotic “Pond”

- Development of a shelled egg freed the reptilian groups to exploit land

- Extraembryonic membranes are maintained and used as a respiratory surface and storage of nitrogenous wastes.
Origin of Amniotes

Characters of Amniotes (reptiles, birds, mammals)

**Amniotic egg**
- Consists of *four extraembryonic membranes*
- **Amnion**
  - Encloses the embryo in fluid-filled space
  - Cushions the embryo and provides an aqueous medium for growth
- **Allantois**
  - Stores metabolic wastes
Origin of Amniotes

- **Chorion**
  - Surrounds embryo and all other extraembryonic membranes
  - Lies just beneath shell
  - Highly vascularized
  - Respiratory surface

- **Yolk sac**
  - Nutrient storage
Origin of Amniotes

- Amniotic egg permitted development of a *larger, faster-growing embryo*
- Provides better support and movement of oxygen
- Shell can also be broken down to provide calcium for growing skeletal structures
- **All amniotes**
  - Lack gilled larvae and have internal fertilization
    - Eliminated the need for aquatic environments
- **Penis is the most common copulatory organ**
**Origin of Amniotes**

*Rib ventilation of the lungs*

- Amniotes draw air into lungs by expanding the thoracic cavity using costal muscles or pulling the liver posterior
- Amniotes use a negative pressure gradient to draw air in
Thicker and more waterproof skin

- **Amniote skin** is thick and tends to be more keratinized and less permeable to water.
- Variety of structures composed of keratin such as scales, hair, feathers, and claws project from the skin.
- Keratin protects the skin from physical trauma, and lipids prevent water loss.
- Few amniotes use skin as a primary respiratory organ because *keratin and lipids limit exchange of gases.*
Members of the class **Reptilia** includes nearly 8000 species

- The term "**reptiles**" refers to a group that includes the living turtles, lizards, snakes, tuataras, and crocodilians.

- **Reptiles have better developed lungs than amphibians**
  - Reptile lungs have more surface area than amphibians’ lungs
  - Respiration is supplemented by respiration in the cloaca or pharynx in many aquatic turtles and by cutaneous respiration in sea snakes and turtles
Nonavian reptiles have tough, dry scaly skin that offers protection against desiccation and physical injury.

- Dermis contains chromatophores
- Color-bearing cells that give many lizards and snakes their colorful hues
Characteristics of Reptiles

- **Scales of nonavian reptiles**
  - *In crocodilians*, scales remain throughout life.
  - In other nonavian reptiles such as *lizards and snakes*, new keratinized epidermis replaces old epidermis which is shed.
  - Turtles have *scutes*:
    - Platelike modified scales.
  - Crocodiles and many lizards possess *osteoderms*:
    - Bony plates located in the dermis beneath the scales.
Characteristics of Reptiles

- **Amniotic egg** of nonavian reptiles
  - All egg shells of nonavian reptiles are impregnated with **calcium**
    - Turtles have eggs with **rigid shells**
    - All others are **leathery**
  - In some species of nonavian reptiles
    - Embryo develops in reproductive tract of female
Characteristics of Reptiles

- **Jaws of nonavian reptile**
  - Efficiently designed for applying *crushing or gripping force to prey*
  - Larger jaw muscles have mechanical advantage over the jaws of fishes which are designed for suction feeding or for quick closure

- **Tongue is muscular and mobile**
  - Functions to move food in mouth for mastication and swallowing
Nonavian reptiles circulatory system

- Right atrium receives deoxygenated blood and is partitioned from the left atrium which receives oxygenated blood.
- Crocodilians have separated ventricles.
  - In other nonavian reptiles, ventricle is incompletely partitioned.

Characteristics of Reptiles (Image from Norman, 1985)
Characteristics of Reptiles

- **Nonavian reptiles have efficient strategies for water conservation**
  - *Amphibians* secrete metabolic waste primarily as *ammonia*
  - *All amniotes* have metanephric kidneys
    - *Nonavian reptiles* cannot concentrate urine in the kidneys
    - Urinary bladder receives undiluted urine
    - Water and most salts
      - Resorbed in the bladder
      - “urine” voided as a *semisolid mass* of uric acid
    - Salt is removed by *salt glands* near the nose, eyes, or tongue

Nasal salt glands
The nervous system of nonavian reptiles is more complex than that of amphibians

Brain of nonavian reptiles small compared to brain of other amniotes

However, cerebrum of all amniotes is relatively enlarged

Enlargement of cerebrum correlated with integration of sensory information and muscle control during locomotion

Nonavian reptiles have good vision

Snakes and many lizards use a highly sensitive sense of smell to find prey and mates

Olfaction assisted by a Jacobson’s organ, a specialized olfactory chamber in the roof of the mouth

Characteristics of Reptiles

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Characteristics and Natural History of Reptilian Orders

Order Testudines

- Shells consist of a dorsal carapace and a ventral plastron
  - Outer horny layer of keratin and an inner layer of bone
  - Bony layer is a fusion of ribs, vertebrae, and dermally-ossified elements
  - Lack teeth and use tough, horny plates for gripping food
Breathing

- Consequence of having a **rigid shell**
  - Turtle cannot expand chest to breathe
- Solve problem by using abdominal and pectoral muscles as a “diaphragm”
- Air is drawn in by contraction of the limb flank muscles, *increasing abdominal cavity volume*
- **Exhalation** accomplished by drawing back the shoulder girdle to compress the viscera
- Movement of limbs while *walking* also helps ventilate the lungs
- Some **aquatic turtles** gain sufficient oxygen by pumping water in and out of the mouth cavity
**Nervous System and Senses**

- *Brain* is small, less than 1% percent of body weight
- *Cerebrum* is larger than that of amphibians
- Have a middle and an inner ear but *sound perception is poor*
  - Make few sounds aside from those made during mating
- Good sense of smell, acute vision, and color perception about equal to humans
Characteristics and Natural History of Reptilian Orders

- **Reproduction and Development**
  - Oviparous
  - Fertilization is internal
  - Bury their eggs in the ground
  - Female lays her eggs in a nest and deserts them
  - In some turtle families nest temperature determines sex of hatchlings
    - Low temperatures produce *males*
    - High temperatures produce *females*
Marine Turtles
- Buoyed by water, marine turtles may reach two meters long and 725 kilograms in weight
- Giant land tortoises, such as those on the Galápagos Islands, weigh several hundred kilograms
- Low metabolic activity may explain their longevity, believed to exceed 150 years

Box Turtles
- Shell is an effective coat of armor
- Plastron is hinged
- Pulls the plastron up to fully enclose body
Snapping Turtles

- Have a reduced shell that does not permit full withdrawal of the body
- Jaws are adequate defense
- Entirely carnivorous and can eat fish, frogs, waterfowl, etc.
**Order Squamata: Lizards & Snakes**

**Suborder Sauria: Lizards**

- Diverse group with terrestrial, burrowing, aquatic, arboreal, and some aerial members
- **Geckos**
  - Small, agile, nocturnal forms
  - Adhesive toe pads allow them to walk on ceilings
- **Iguanids**
  - Include many New World lizards as well as the marine iguana of the Galápagos
- **Chameleons**
  - Arboreal lizards of Africa and Madagascar
  - Many have an extendible tongue
Some have degenerate limbs
- **Glass lizards** are nearly limbless

*Moveable eyelids* whereas snakes have a transparent covering

Have an external ear that snakes lack

Geckos use vocal signals to announce territory and drive away males

Some lizards survive well in hot and dry regions
Conserve water by producing **semisolid urine** with a high content of crystalline uric acid

Some can **store fat in tails** to provide energy and metabolic water during drought

Gila monster and beaded lizard are the only lizards capable of a **venomous bite**

Lizards keep body temperature relatively constant by behavioral thermoregulation, although they are **ectotherms**
Suborder Serpentes: Snakes

- Limbless and have lost pectoral and pelvic girdles
- The many vertebrae are shorter and wider than in other tetrapods, allowing undulation
- **Feeding apparatus** allows them to eat prey several times their own diameter
  - Two halves of lower jaw are loosely joined, allowing them to spread apart
  - Skull bones also loosely articulated so mouth can accommodate large prey
  - To allow breathing during the slow process of swallowing, the *tracheal opening is extended*
Eyeballs have reduced mobility and a permanent corneal membrane for protection.

Most have poor vision.

Lack external ears and do not respond to most aerial sounds.

Can feel vibrations at low frequencies, especially vibrations carried in the ground.

Chemical senses rather than vision or hearing are main senses used to hunt prey.


Jacobson’s organs

- Pair of pits in the roof of the mouth
- Lined with olfactory epithelium
- Forked tongue picks up scent particles and conveys them to this organ

Skin is infolded between scales

- When stretched by a large meal, the skin is unfolded
Characteristics and Natural History of Reptilian Orders

- Pit vipers, such as rattlesnakes
  - Have “pits” with nerve endings sensitive to heat emitted by warm-bodied birds and mammals
  - Viper fangs are hollow and hinged to inject venom when snake strikes
  - Of an average of 8,000 snake bites each year in the U.S., only about 12 result in death

- Nonvenomous snakes
  - Kill prey by constriction or by biting and swallowing
Reproduction

- Most are oviparous and lay shelled eggs
- Others, including pit vipers, are ovoviviparous
- A few snakes are viviparous, having a primitive placenta to exchange nutrients with the young
- Female snakes can store sperm and lay several clutches of fertile eggs long after a single mating
Order Sphenodonta: The Tuatara

- **Only 2 living species** in New Zealand represent this ancient lineage
- Once widespread across New Zealand, the 2 species are now restricted to small islands
- Loss of the tuatara populations caused by human introduction of nonnative species which preyed upon the tuatara
  - Tuatara are vulnerable because they have **slow growth and reproductive rates**
- Lizard-like and live in burrows often shared with petrels
- **Slow growing** and may live to 77 years of age
- Well-developed median parietal eye buried beneath skin
Order Crocodilia: Crocodiles and Alligators

- **Alligators and caimans** are found primarily in the New World and have a broader snout
- **Crocodiles** are widely distributed
- One species of *gavial* occurs in India and Burma and has a very narrow snout
All have long, well-reinforced skull and jaw musculature for a powerful bite

Teeth are set in sockets

*Four-chambered heart*

Alligators and crocodiles are *oviparous*

- Usually 20–50 eggs are laid in mass of vegetation
- Unguarded nests are easily discovered and raided by predators
- *High nest temperatures* produce males
- *Low temperatures* produce females
- Can result in females outnumbering males *5 to 1*