Class Mammalia
Subclass Prototheria
Order Monotremata: The Monotremes

A. Introduction and Taxonomy.
   1. The ordinal name "Monotremata" means "1 opening" and refers to the cloaca, a common opening for the fecal, urinary, and reproductive tracts.
   2. Monotremes are endothermic, but they have unusually low metabolic rates and maintain a body temperature that is lower than that of most other mammals their size.
   3. Extant monotremes are represented by 2 families: Ornithorhynchidae (1 genus) and Tachyglossidae (2 genera).

B. Morphology.
   1. The skull.
      a. The skulls of monotremes are almost birdlike in appearance, with a long rostrum and smooth external appearance.
      b. Modern monotremes lack teeth as adults; sutures are hard to see; the rostrum is elongate, beak-like, and covered by a leathery sheath; and lacrimal bones are absent.
      c. Dentary bone is reduced and adults are edentate.
      d. The jugals are reduced or absent, the dentary is a slender bone with only a vestige of a coronoid process, the angle of the dentary is not inflected medially (unlike that of marsupials), auditory bullae are missing (part of the middle ear is enclosed by tympanic rings), and much of the wall of the braincase is made up by the petrosal rather than the alisphenoid (unlike all other modern mammals).
      e. Monotremes have no corpus callosum, a bundle of nerve fibers that integrate the 2 hemispheres of the brain.
   2. Postcranial skeleton.
      a. Postcranially, the skeleton of monotremes is unique among mammals. It is a fascinating mosaic of primitive characteristics inherited from therapsids but found in no other living mammals, and modifications probably related to the burrowing habits of modern monotremes.
      b. Their shoulder girdles are complex, including the standard components of modern mammals (scapula and clavicle), but also additional elements including coracoid, epicoracoid, and interclavicle.
      c. The scapula, however, is simplified, lacking a supraspinous fossa. The shoulder girdle is much more rigidly attached to the axillary skeleton than in other mammals.

d. Femur and humerus are held roughly parallel to the ground when the animal walks, more in the fashion of therapsids and most modern reptiles than like modern mammals.
e. Ribs are found on the neck (cervical) vertebrae as well as the chest (thoracic) vertebrae; in all other modern mammals, they are restricted to the thoracic region.
f. Another interesting skeletal characteristic of monotremes is the large epipubic bones in the pelvic region.
    1) Epipubic bones were originally thought to be related to having a pouch, but they are found in both males and females.
    2) They also occur in all species of marsupials, whether a pouch is present or not (not all marsupials have a pouch).
    3) It is now thought that epipubic bones are a vestige of the skeleton of therapsids, providing members of that group with extra attachments for abdominal muscles to support the weight of the hindquarters.
g. All male monotremes have spurs on their ankles that are presumed to be used in fighting and in defense. In the Ornithorhynchidae, a groove along the spur carries poison secreted by adjacent glands.

C. Reproduction.
1. The eggs layed by monotremes are small (13-15 mm diameter) and covered by a leathery shell.
2. The number of eggs laid is small, usually 1-3, and they are placed in the mother's pouch, except in the platypus, which does not have a pouch.
3. They contain a large yolk, which is concentrated at 1 end of the egg very much like the yolk of a bird's egg.
4. Only the left ovary is functional in the platypus, but both varies produce eggs in the echidnas.
5. After an egg is shed into the infundibulum, it passes to the Fallopian tube, where fertilization occurs. The shell is deposited in the oviduct over a period of about 2 weeks. Nutrients are absorbed through the shell; thus, the eggs are permeable (not cleidoic, or impermeable, as is the case for birds).
6. Like the eggs of birds, monotreme eggs are incubated and hatched outside the body of the mother. Incubation lasts about 12 days.
7. The young, which are tiny and at a very early stage of development when they hatch, break out of the eggs using a "milk tooth.
8. They are fed milk produced by mammary glands; the milk is secreted onto the skin within the pouch and sucked or lapped up by the babies.
9. Weaning takes place when the young are 16-20 weeks old.
10. After the eggs hatch the young are nursed via mammary glands without teats. Milk is secreted from pores on the belly of the platypus and from paired glandular lobes in the pouch of echidnas.
11. Males have a baculum, permanently abdominal testicles, and no scrotum.

D. Fossil history and Zoogeography.
   1. Their fossil record is very poor; the earliest fossil attributed to this group is from the early Cretaceous. A fossil from Argentina suggests that the monotremes were more widely distributed early in their history. Monotremes may have split from the lineage leading to other mammals sometime in the Mesozoic.
   2. Based on amino acid sequence analyses, Messer et al. (1998) concluded that monotremes diverged from therian mammals during the Jurassic period.
   3. They retain many characters of their therapsid ancestors (for example, a complex pectoral girdle, laying of eggs rather than bearing live young, limbs oriented with humerus and femur held lateral to body, and a cloaca).
   4. Monotremes are restricted to Australia and New Guinea.

E. Families.
   1. Ornithorhynchidae—the duck-billed platypus.
      a. This family consists of a single genus and species, the duck-billed platypus.
      b. It occurs near freshwater lakes and rivers at both high and low elevations along the east coast of Australia and throughout Tasmania, where it feeds on a variety of invertebrates, small fish, and amphibians.
      c. Often considered the most unique and bizarre of mammals; the physical appearance is so remarkable among mammals that the first specimen brought to London in 1798 was believed to be a hoax.
      d. Adult males average 50 cm total length and weigh approximately 1,700 g; females are smaller.
      e. Mean litter size is 2. As with birds, only the left ovary is functional.
      f. The bill is distinctive; it is soft, pliable, very sensitive, has nostrils at the tip, and is highly innervated both for tactile reception and to sense electric fields generated by the muscle contractions of prey.
      g. The feet are pentadactyl and the manus is webbed.
      h. This species is highly aquatic. It has webbed feet; dense woolly, water-repellant fur; and furrows along the sides of its head to protect the eyes and ears when it swims under water; the ears lack pinnae.
      i. While young platypuses have molars, adults are toothless. They grind their food between horny (keratinous) plates located over the gums.
      j. Male platypuses have a sharp spur attached to each ankle. The spurs are grooved and connected to venom glands; these weapons may be used in combat between males for mates.
      k. A platypus feeds primarily on aquatic crustaceans, insect larvae, and some plants.
      l. Duck-billed platypuses live in burrows along the banks of water, including lakes, rivers, and even mountain streams.
   2. Tachyglossidae—the short and long-beaked echidnas (also called spiny anteaters).

a. This family includes only 2 genera, each with 1 species. *Zaglossus*, the long-nosed echidna, is found in New Guinea, and *Tachyglossus*, the short nosed echidna, is native to Australia.
b. Guard hairs on the back and sides of the body are modified to form barb-less spines up to 6 cm long.
c. Maximum body mass for short-billed echidnas is 6 kg; for the long-billed echidna it is about 10 kg.
d. Echidnas have spines covering their stout bodies. They curl up into a spine-covered ball in a rather effective method of defense.
e. Echidnas are powerful diggers and can wedge themselves into a burrow or crevice with their spines so that they are difficult to remove.
f. In general, echidnas dig for food, which consists of termites, ants, and assorted invertebrates. Food is located with the help of special electroreceptors located in the rostrum.
g. Echidnas have long, protrusible, mucous-covered tongues that aid in the capture of prey. The sticky mucous coating is produced by enlarged submaxillary salivary glands. Spines at the base of the tongue grind against spiny ridges on the palate to masticate food.
h. Echidnas are moderately large animals (up to 16 kg for *Zaglossus*).
i. Their skeletons are heavily built, perhaps to accomodate the powerful muscles used for digging.
j. Unlike platypuses, echidnas lack webbing and instead have large, shovel-like claws are present on all feet.
k. Spurs, the function of which is unclear, are located on the ankles of all males and some females.
l. Echidnas lay a single leathery egg that is kept in the pouch 7-10 days, until the young hatches. The young remains in the pouch another 6-8 weeks, until its spines begin to harden.