

Mammalogy Lecture 1 - Introduction to Mammals

I. In terms of the number of living species, mammals are not a particularly diverse group - there are only 4,629 described species listed in the most recent taxonomic checklist (although more have been discovered since). For perspective, this is just over half the number of bird species. However, if we look at morphological diversity, mammalian diversity is really quite remarkable.

For example if we just look at size, the smallest mammal is *Craseonycteris thonglongyai*, the Bumble-bee bat. It weighs just under 2 grams: basically, the weight of a couple of paper clips. The largest, *Balaenoptera musculus*, the blue whale can weigh up to 200,000 Kg, that is 200 Million g. This represent a size range spanning 8 orders of magnitude.

In addition, these two species represent both flying and marine forms;

There are also gliding forms, saltatorial (hopping) forms, fossorial (burrowing) forms, arboreal forms, and forms that specialize on a diet of ants. Each of these lifestyles has a suite of traits that are usually associated, and we'll learn about these throughout the semester.

This diversity is especially remarkable when we recognize that all mammals originated from a single common ancestor, that is, a single ancestral species that live ca. 170 million years ago.

II. So, we'll spend the semester exploring both the nature and the origin of this diversity, but before we move on. I think it's a good idea to try to come up with a definition for mammals.

Short definition: hairy, milk producing, endotherm that gives birth to live young.

Like most short answers, **this one has some problems**; there are exceptions to each of the terms in the definition. Furthermore, it's useless for fossils.

We'll list mammalian characteristics, and contrast each either with other tetrapods or, where we can, with the condition seen in the earliest ancestors of all mammals.

A. Soft Anatomy Characters – Eleven characters

1. *Lactogenic - nourish young by producing milk with **mammary glands**.
2. Viviparous - exception are monotremes, which we'll discuss later.
3. *Hair - Hair is a uniquely derived feature of mammals not found in any other group.
Structure is well-suited to serve as an insulator. Cuticular scales, cortex, medulla.
4. *Sweat and *Sebaceous glands - sweat glands - evaporative cooling
sebaceous glands - associated with hair.
5. Endothermic - That is, mammals produce their own heat through metabolic processes.
6. Four-chambered heart, with complete separation of pulmonary and systemic circulation.
7. *Annucleate Red Blood Cells – This provides more space for hemoglobin and greater capacity for carrying oxygen.
8. *Separate renal artery and vein rather than a renal portal system.
9. *Muscular Diaphragm - used in respiration.
10. *Facial muscles. This allows for facial expression and is important in communication.
These facial muscles are derived from ancestral constrictor coli, which itself evolved from interhyoideus.
11. Expanded cerebral portion of brain - particular portion called *dorsal pallium

B. Hard Anatomy (Skeletal) Characters.

— Cranial — Eight cranial characters

1. Double occipital condyle, the point of articulation between skull and vertebral column. The ancestral condition is a single condyle, similar to that seen in a modern alligator skull.

2. *Atlas/Axis Complex - modifications of the first two cervical or neck vertebrae

When mammals rotate head, atlas rotates on shaft of axis.

3. ***Tympanic bone** is present that supports the tympanum or eardrum. This is derived from an ancestral lower jaw bone called the **angular**. In many species, this forms an auditory bulla.

4. *Three ear ossicles – transmit sound waves from the ear drum, or tympanum, to inner ear.

malleus --- articular -- ancestral jaw joint

incus --- quadrate -- ancestral jaw joint

stapes --- stapes or columella

5. *Single pair of bones in lower jaw or mandible, the **dentary**. Since it's the only bone, it **participates in the jaw joint**. This is a key paleontological character, as we'll see later.

6. Single opening into nasal cavity (we have two nostrils, but one bony opening). **External Nares** (ancestrally, there were two).

7. Secondary Palate – A solid shield of bone separating nasal and oral cavities.

- Ancestrally, external nares opened into oral cavity.

Ventral and medial extensions of palatine bones, maxillae, and premaxillae separate the nasal cavity from oral cavity.

This allows mammals to breathe while processing food.

8. Respiratory turbinates – These convoluted bones in the nasal cavity are thought to be critical for endothermy, and we'll talk about their role in mitigating respiratory water loss.

— Teeth — Five dental characters.

1. Lack palatal teeth; teeth are restricted to jaw margins.

2. *Diphyodont - At most, there are two generations of teeth. This contrasts with monophyodont and polyphyodont.

3. Thecodont – Teeth are rooted in a socket, as opposed to acrodont or pleurodont.
4. Heterodont - Different teeth have different shapes and different functions, as opposed to homodont (seen in alligator)
5. Multicuspate – Teeth have lots of cusps or bumps; contrast with unicuspate.

— Axial Skeleton — 2 axial characters

1. *Extreme regionalization of vertebral column

cervical region- neck vertebrae - almost always 7; some groups with 9

thoracic region - chest region - 12 or 13

lumbar region - lower back - variable number

sacral region - associated with the pelvis

caudal region - associated with the tail

2. Ribs are restricted to thoracic vertebrae

— Appendicular Skeleton — Four characters associated with the limbs

1. *Limb bones have epiphyses - Bony caps at either end that are separated from the shaft by cartilage that ossifies during ontogeny. This permits a great deal of stress at joints.

- 2.* Calcaneum – There is a heel bone where Achilles tendon inserts. This provides a great deal of leverage for extension of the foot.

3. Reduction in the # of bones in limb girdles, the point of attachment of limbs to axial skeleton
 - pectoral girdle - scapula plus clavicle - lack anterior and posterior coracoids as well as an interclavicle. The exception is monotremes.
 - pelvic girdle - ileum, ischium, pubis fused into the pelvic bone.

4. Limbs rotate under body; contrast with lizards for example which exhibit a condition similar to the ancestral condition.

C. The presence of these characters in mammals represents really a sweeping set of changes relative to those present in ancestors. We'll go through that a bit later.