A. Introduction.
1. The Insectivora includes such groups as shrews, moles, hedgehogs, and tenrecs; these groups include approximately 375 species arranged in 6 families.
2. What traits characterize members of the Insectivora?
   a. Most insectivores are small; shrews, for example, are among the smallest mammals.
   b. Most rely more on their senses of hearing, smell, and touch than on vision (some shrews can echolocate).
   c. The part of the brain that houses the sense of smell is especially well developed.
   d. The ear region of insectivores lacks an ossified bulla.
   e. The tympanic membrane is attached to a bony tympanic ring, and the middle ear may be partially enclosed by processes from adjacent bones.
   f. The jugal is reduced or may be absent, and the zygomatic arch is sometimes incomplete.
   g. The cheek teeth of many are dilambdodont, and even those with more derived molariform teeth tend to have cusps that can easily be identified according to the tribosphenic pattern.
   h. The incisors of some Insectivora are enlarged (but they are reduced in others), and the canines also vary considerably in morphology.
   i. The eyes are usually very small, the feet are plantigrade and have 5 digits, and neither the hallux nor the pollex is opposable.
   j. Many of the traits used to define Insectivora are probably primitive for mammals.
B. Family Chrysochlorida (golden moles).
1. Golden moles are fairly common throughout southern Africa, where 7 genera and approximately 18 species are known.
2. They thrive in habitats ranging from deserts to swamps, where they are generally solitary and territorial.
3. Golden moles dig and live in burrows, eating mainly invertebrates that they find underground.
4. They appear similar to both the Talpidae (“true” moles) and the Notoryctidae (marsupial “moles”) in that they have small ears that are hidden by their fur, short tails, and eyes are totally covered by skin.
5. Large leathery pads on their noses probably help them to burrow through the ground, as do their short, powerful forearms and claws.
6. Golden moles are also unusual in that both males and females have a single opening (a cloaca) for the urogenital system.
7. The skull is conical in outline.
8. They have a pair of bones, called tabulars, in the occipital area of the skull, which are not found in other mammals.
9. The zygomatic arches are formed by elongations of the maxillae.
10. The malleus is tremendously enlarged, and it has been suggested that this actually aids hearing under ground (that is, the detection of ground-born vibrations).
11. Golden moles have no 5th finger on their front paws, and most species have a huge claw on the 3rd (and sometimes also the 2nd) digit.
12. Their fur has a beautiful iridescent sheen.
14. The 1st incisor is enlarged; the 2 lateral incisors and 1st premolars are canine-like; and the molars are zalambodont.
15. Golden moles burrow mainly using their leathery snout combined with thrusts of the forepaws, which are held under the body (rather than at the sides, as in the talpids). They are powerful and adept burrowers.
16. Chrysochlorids are known from Miocene deposits, but because these fossils resemble modern members of the family, they tell us little about the origins of the group.

C. Family Erinaceidae (hedgehogs and gymnures)
1. Members of this family, the hedgehogs and gymnures, are perhaps the most similar of all extant mammals to the very earliest mammals.
2. Erinaceid fossils, however, date back only to the Eocene, while their extinct ancestors, the Adapisoricidae, are known from the Cretaceous.
3. The family is made up of 17 species grouped in 7 genera, and can be found in Africa, Eurasia, southeastern Asia and Borneo.
4. Hedgehogs and gymnures range in size from that of a mouse to a small rabbit.
5. Dentition.
   a. Erinaceids can be identified by their dental formula (2-3/3, 1/1, 3-4/2-4, 3/3 = 36-44), complete zygomatic arches (the jugal is present), eyes and ears of moderate size, and plantigrade foot posture.
   b. The anterior incisors in some species are enlarged, but not to the degree seen in their smaller cousins, the shrews.
   c. The upper molars are quadritubercular and appear bunodont; the lowers include well developed trigonids and talonid basins.
6. Hedgehogs (but not gymnures) are covered with sharp spines. Many species of hedgehogs can roll up into a ball, hiding all vulnerable areas of the body under the protective spines.
7. Gymnures lack spines but when threatened, produce a foul smell.
8. Erinaceids live under logs or in burrows that they dig.
9. They eat a wide variety of foods, including invertebrates, reptiles (hedgehogs are curiously resistant to snake venom and other environmental toxins), carrion, roots, and fruits.

10. Hedgehogs are active only at night, and some species hibernate in the winter. They appear to be facultatively heterothermic.

11. Gymnures may be active during the day.

12. Even though they are mainly terrestrial, erinaceids tend to be good climbers and swimmers.

13. Most have 1 or 2 breeding seasons per year.

14. In most species this is the only time adults associate; at other times they are solitary.

15. The young are born with soft spines that quickly harden.

D. Family Solenodontidae.

1. The single surviving genus, Solenodon, contains 2 species.

2. Solenodons live in Haiti and Cuba where their populations are declining rapidly and are in danger of extinction. Expanding human populations, the clearing of land for agriculture, and the introduction of dogs, cats, rats, and mongooses are all responsible for the decline of this group.

3. Solenodons look like large, stout shrews. They have long snouts, small eyes, large, clawed feet and long nearly naked tails.

4. Coat color varies from blackish to deep reddish brown.

5. They have an incomplete zygomatic arch (maxillary and squamosal roots are present but the jugal is absent), no auditory bulla, and a nearly flat skull.

6. Solenodons also have an extra bone, the os proboscis, which helps support the tip of the rostrum.

7. The dental formula of the 2 existing members of this family is 3/3, 1/1, 3/3, 3/3 = 40.

8. The anterior upper incisor is large.

9. The 2nd lower incisor has a deep groove. Solenodons produce toxic saliva, which is carried through this groove into the flesh of their victims.

10. The molars are V-shaped, and the primary cusp is the paracone (zalambdodont).

11. The main prey of solenodons is animals (including insects), but they sometimes eat plant material as well.

12. Solenodons live in forests or brush, and are active at night.

13. They are apparently social, with young sometimes remaining with the parents while subsequent litters are born and raised.

14. Solenodons walk with an awkward gait and are incapable of jumping, but can run surprisingly fast and can climb.

E. Family Soricidae (shrews)

1. With over 300 species in 23 genera, Soricidae is by far the most specious family in the order Insectivora.

2. Members can be found throughout the world, with the exceptions of the polar regions, Australia, and southern South America.
3. Skull characteristics.
   a. The skulls of shrews are long and narrow, usually with a flat profile.
   b. They lack zygomatic arches, auditory bullae, and postorbital processes.
   c. The tympanic bone is distinctively annular (ring-shaped).
   d. The mandibles have distinctive doubled condyloid processes, forming a double articulation.
4. Dentition.
   a. The dental formula of this family is 3/1-2, 1/0-1, 1-3/1, 3/3 = 26-32.
   b. The first incisor is large and made up of an elongate, projecting main cusp and smaller, posterior secondary cusp. The second cusp is sometimes mistaken for an additional tooth.
   c. The first lower incisors are long and forward-projecting. The rest of the incisors, canines, and premolars 1-3 (if present) are small and peglike.
   d. These unicuspid teeth are useful for identifying some kinds of shrews.
   e. The upper molars are dilambdodont, with a strongly developed W-shaped ectoloph.
   f. Shrews lose their milk teeth before birth.
   g. Tooth wear can therefore become a problem, and older adults may starve to death when their teeth become too worn to function.
5. Most shrews are very small, with the smallest only 2-3 grams adult weight.
6. Their eyes are tiny and their main senses are probably touch, hearing, and smell (some species are believed to use echolocation).
7. Shrews have a high metabolic rate and consequently a voracious appetite. Shrews must eat very frequently, and so are active throughout the day and night, feeding primarily on invertebrates.
8. The pointed shape of their snout probably helps them burrow into the ground as they look for prey items such as grubs.
9. Some shrews are poisonous, allowing them to hunt and kill larger prey (including small vertebrates).
10. Most shrews seem to prefer moist microhabitats, although a few species are found in deserts.
11. A few kinds of shrews are aquatic, well adapted to swimming and catching aquatic invertebrates and small fish.
12. Many of these have long, bristly hairs between their toes and along the sides of their feet, which aid them in swimming by increasing the surface area of the feet. These hairs also can hold air bubbles, allowing the shrew to actually run across the surface of the water.
13. Shrews do not fossilize well because their bones are small and delicate, but some European fossils are known from as early as the late Eocene.
F. Family Talpidae (moles and desmans).
1. The family Talpidae consists of moles and desmans; currently, its approximately 42 species are grouped into 17 genera.
2. Talpids can be found throughout most of North America and Eurasia.
3. Around 2/3 of the members of this family are at least partially fossorial, digging underground tunnels in which they live and forage on subterranean invertebrates (some also eat plant parts).
4. Others are aquatic (desmans) or forage on the surface (Asian shrew-moles, *Uropsilus*).
5. Fossorial moles have evolved notable specializations for their underground lifestyle.
   a. Their bodies are fusiform, the eyes are tiny (and sometimes covered by skin), the legs are short, and external ears are lacking.
   b. The forelimbs are rotated such that the elbows point dorsally and the palms of the front feet face posteriorly. This orientation lends power to their digging strokes.
   c. In addition, the forelimbs are short and strong and terminate in formidable claws.
   d. The fur of moles is velvety and can lie equally well in any direction, which allows easy movement in the burrows backward as well as forwards.
6. Most talpids have a flattened skull with a long and narrow rostrum.
7. Sutures between cranial bones fuse early.
8. The zygomatic arches are complete, and auditory bullae are present.
9. The modifications of the pectoral girdle and forearm to achieve the orientation and power described above are extreme in some species of moles; the humerus, for example, is broader than long and almost unrecognizable due to the elaboration of surfaces for the attachment of muscles.
10. A short and broad clavicle is present.
11. The dental formula of talpids is $2-3/1-3$, $1/0--1$, $3-4/3-4$, $3/3 = 33-44$.
12. The molars are dilambdodont.
13. Desmans and some moles are aquatic; that is, they are skilled swimmers that live near the water and eat aquatic invertebrates and small fish that they catch underwater.
14. Desmans have webbed feet and a very unusual flexible snout that is used to probe for food at the bottoms of lakes, streams, or ponds.
15. There are only 2 species of desmans, 1 lives in Asia and the other in Europe, and both are endangered.
16. Like shrews, moles have relatively high metabolic rates and insatiable appetites.
17. They are active at all times of the day and night.
18. While they can be found in a wide variety of habitats, they seem to prefer moist soils that are easy to burrow in.
19. Fossil talpids are known from as early as the Eocene.

G. Family Tenrecidae (tenrecs).
1. Members of this remarkable family do not have a wide geographic distribution. They are most numerous and diverse on the island of Madagascar, but a few species are also found in western central Africa.

2. Tenrecs have radiated such that they include species that resemble, both morphologically and ecologically, widely diverse mammals including hedgehogs, shrews, opossums, mice and even otters; and members of the family occupy a diverse collection of habitats, including aquatic, arboreal, terrestrial and fossorial.

3. Currently, we recognize 10 genera and 24 species. These are divided into 3 subfamilies, the Tenrecinae and Oryzoryctinae (both confined to Madagascar) and the Potamogalinae (west-central Africa).

4. Tenrecs lack jugals, and their zygomatic arches are incomplete.

5. Their tympanic bones are annular, and the squamosal contributes to the roof of the tympanic cavity.


7. The upper molars are zalambdodont, except in the African otter shrews (Potamogalinae), in which they are dilambdodont.

8. The urogenital and anal apertures are included in a cloaca, and the eyes are small. Many tenrecs do not maintain a constant body temperature, but rather let their bodies cool down while they are at rest. At least 1 species hibernates.

9. Curiously, male tenrecids lack a scrotum and the testes remain within the body cavity.

10. **Subfamily Tenrecinae**
   a. Relatively large (up to the size of a cat) and highly variable in body form.
   b. All have spines, which are barbed and detachable in some forms and controlled by a well-developed muscle called the panniculus carnosus.
   c. Tenrecines are mostly nocturnal and mostly omnivorous.
   d. One genus, *Hemicentetes*, uses its quills to produce sounds that are important in communication.

11. **Subfamily Oryzoryctinae**.
   a. Like the Tenrecinae, this subfamily contains a number of genera and species.
   b. They lack spines.
   c. Most are shrew-like or mole-like, but 1 species, in the genus *Limnogale*, is aquatic.
   d. Some are highly fossorial.

12. **Subfamily Potamogalinae**.
   a. Made up of 3 species, all aquatic forms called otter-shrews.
   b. *Potamogale* is large, around 600 mm in length and 1 kg in weight, and much modified for aquatic life.
   c. Potamogalines probably represent an early branch of the family.

13. The fossil record of tenrecids is relatively poor.

14. The oldest known fossils are from the Miocene in East Africa and the Pleistocene in Madagascar, but the group is certainly considerably older.