ADAPTIVE RADIATION: MAMMALIAN FORELIMBS

The variety of forelimbs - the bat's wing, the sea lion's flipper, the elephant's supportive column, the human's arm and hand - further illustrates the similar anatomical plan of all mammals due to a shared ancestry. Despite the obvious differences in shape, mammalian forelimbs share a similar arrangement and arise from the same embryonic, homologous structures.

The mammalian forelimb includes the shoulder, elbow, and wrist joints. The scapula or shoulder blade connects the forelimb to the trunk and forms part of the shoulder joint. The humerus or upper arm bone forms part of the shoulder joint above, and elbow joint below. The radius and ulna comprise the lower arm bones or forearm, and contribute to the elbow and wrist joints. Finally, the carpal or wrist bones, the metacarpals, and phalanges form the bat wing, the sea lion flipper, the tree shrew, mole, and wolf paws, the elephant foot, and the human hand and fingers.

Using light colors, begin with the tree shrew scapula in the center of the plate. Next, color the scapula on each of the other animals: the mole, bat, wolf, sea lion, elephant, and human.

Continue coloring the other bones in this manner: humerus, radius, ulna, carpal bones, metacarpals, and phalanges.

After you have colored all the structures in each animal, notice the variation in the overall shape of the forelimb. Notice, too, how the form of the bones contributes to the function of the forelimb in each species.

The tree shrew skeleton closely resembles that of early mammals and represents the ancestral forelimb skeleton. The tree shrew is small bodied, moves easily on the ground or in the trees, and has a flexible forelimb for these functions.

The mole's forelimb is relatively short and lies close to the body, giving it a somewhat streamlined shape. The shovellike paw comprises almost half the length of the limb. The slender rodlike scapula and the short, peculiarly shaped humerus help anchor the forelimb against the trunk and draw the paws very near to the head. The elbow joint is rotated so that the paws face backward. Powerful muscles attach on the long bony olecranon process; they straighten the elbow joint and help the paws dig and push the soil out to the side. The robust metacarpals and phalanges give strength to the paw and an extra bone (the falciform) adds breadth. Thus, the forelimb is well suited for the mole to dig its way through moist soil as it searches for insects.

The bat's forelimb is adapted for flight. The humerus is short relative to the longer, slender radius; the ulna is reduced and not part of the wrist joint. The metacarpals and phalanges provide a light but strong frame over which the skin is stretched, much as the silk of a kite covers its frame.

The wolf is a swift runner, the better to pursue prey. Its humerus, radius, and ulna are relatively long and make possible a long stride. In marked contrast to those of the bat, the metacarpals are closely packed together for bearing weight. The wolf walks somewhat up on its toes, on bent phalanges.

For its life in the water and on land, the sea lion has a broad scapula, short and robust humerus, radius, and ulna. The scapula and humerus lie within the body cavity and so help streamline the ani-

mal. The relatively long metacarpals and phalanges form a broad paddle. The robust bones support the sea lion's weight on land; this gives the animal mobility when it hauls out on land to mate and give birth.

To support its five ton bulk, the elephant's shoulder, elbow and wrist joints are stacked one above the other, giving an arrangement like an architectural column; the scapula is oriented downward, so it too is in line with the robust humerus and ulna. The radius is reduced so that the ulna carries most of the weight. The metacarpals and phalanges are short and robust, and a pad of fat and skin cushions the foot.

The human forelimb is long, slender and mobile and, unlike that of other mammals, does not bear weight in locomotion. The ball and socket shoulder joint enables a 360˚ range of motion, and slender finger bones and a prominent thumb enable the hand to carry out fine manipulations.

The similarity of a bat's wing, an elephant's leg, and a human's arm may not be readily apparent without a closer look at the underlying bony structures. The basic design of the mammalian forelimb demonstrates the evolutionary phenomenon of adaptive radiation. Through natural selection, the form of mammalian forelimbs has been modified during the last 65 million years into many shapes to perform a variety of functions. By adapting to forest, plains, air, water, and underground, mammals have been able to radiate (like the sun's rays) into a diversity of habitats. Studies of comparative anatomy and embryology well illustrate the "descent with modification" of Darwin and the branching out of species from a common ancestor.

– adapted from *The Human Evolution Coloring Book*, 2d ed., by Adrienne L. Zihlman.
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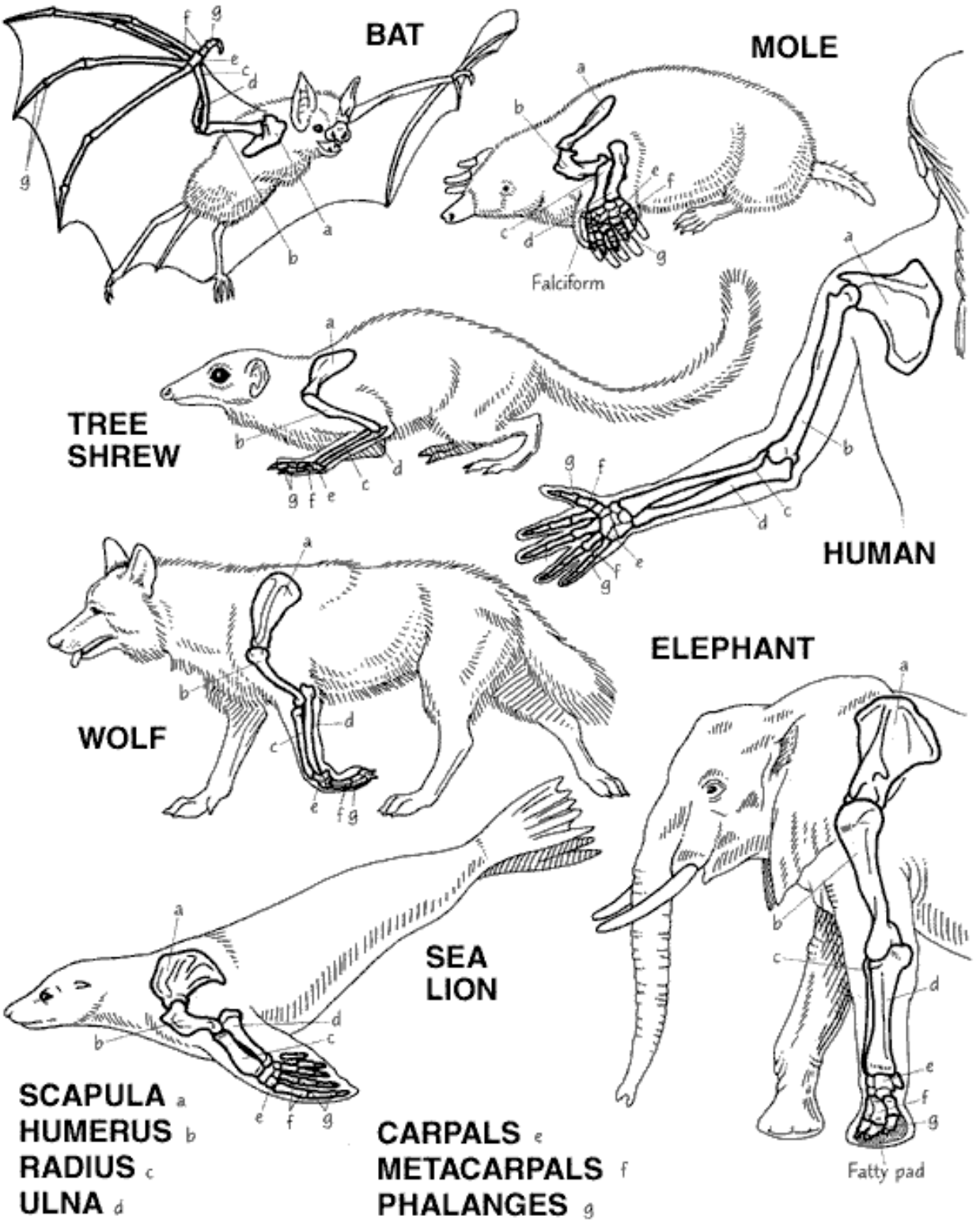

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