

Kangaroo circulatory system



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What are the differences and similarities between the anatomy and physiology of a cat and dog, (a placental mammal) and the anatomy and physiology of a kangaroo? Well, you are about to find out. Introductory information such as outer appearance and behavior will be discussed, such as height, hair coat, speed, and more. Also, all eight body systems: skeletal system, muscular system, nervous system, circulatory system and respiratory system, digestive system and urinary system, and reproductive system will be covered. The reproductive system is the most interesting system because the embryo does not mature in the mother's womb but in her pouch.

In Australia, the only place on earth where kangaroos are found, there are no native hoofed animals. Kangaroos are tall, standing 5 to 6 feet, and alert, with long necks, and large ears that swivel, their eyes are also located on the side of their head to allow a full range of vision, and these are all characteristics of herbivores. Overall weight of kangaroos can vary from 50 to 120 pounds. The average lifespan is four to six years, however in captivity they can live for more than twenty years under the right conditions. (Infoqis Publishing Co., 2009) They are also night dwelling animals. Kangaroos live in groups, called mobs that help alert others of predators. Their heads are small with short and soft muzzles, large nostrils, and a divided upper lip. The kangaroo has a narrow but deep chest with pronounced collarbones. They are unable to move their back legs separately. (Infoqis Publishing Co., 2009) Their tail is at least as long as their body. Kangaroos have a course coat that is very thick; it has a wooly like texture. (Infoqis Publishing Co., 2009) Male kangaroos are much larger than females (up to four times) and their fur coat

is more reddish-brown, while the female's coat is bluish-gray. As males age their chest becomes broader and their forelimbs become increasingly muscular. The red kangaroo can jump up to 30 feet long and reach speeds of 30 miles per hour. The smaller gray kangaroo can jump 44 feet. They cannot move backwards but their tail can act as a fifth limb. The tail supports the back end while it leans on its forelimbs, and their hind limbs are swung forward. The hind feet can be up to 14 inches in length with hairless soles, covered instead by hard calloused skin. (Marshall Cavendish Corporation, 2010) The three most abundant species are the eastern gray, the western gray and red kangaroo together number in the tens of millions. Every year millions of these species and thousands of other species are harvested. The skins are made into rugs and clothing and their meat (formerly used as pet food) is now sold for human consumption. (Encyclopedia Britannica, 2012) They are also very good swimmers and will get in the water in order to get away from predators when they need to. (Infoqis Publishing Co., 2009) When chased by hunters with dogs they will make for water and turn on the dog and hold it under water in order to drown it. (Encyclopedia Britannica, 2012)

Kangaroos are oddly shaped animals. This is due to their skeleton. A kangaroo's backbone is comprised of 49-53 vertebrae: 7 in the neck, 21-25 in the tail, and 13 dorsal. The dorsal vertebrae have long projections which allow for the large muscles of the limbs to attach. (Marshall Cavendish Corporation, 2010)

The clavicle is very pronounced. The humerus is about half the length of the radius and ulna. The lumbar vertebrae are extremely large to allow support for the jumping movement of the kangaroo. The pelvis has two processes

called the epipubic bones, which is present in both sexes. These bones help support the pouch in females, but have no purpose in males. These bones evolved from reptiles and were lost in placental mammals during evolution. The hind limbs have very pronounced Achilles tendons that store energy for when the animal hops. The femur is much shorter than the tibia, fibula, and metatarsals. This creates the great length of the legs and allows for the long distance jumps. The fourth and fifth toes on the kangaroo's hind limbs bear the animal's weight. The third and second toes are fused by skin and have a double claw at the tip and the first toe is absent. The hind limbs are very large to allow stabilization when standing upright and acts as a spring when it bounds, while the forelimbs are very small and similar to a humans arm with five digits. They use the forelimbs to manipulate food. Kangaroos have no kneecaps because the ankles prevent the foot from rotating sideways. (Marshall Cavendish Corporation, 2010)

The kangaroo's skull is very small, delicate, and thin which, allows kangaroos to be killed easily by a blow to the head. The palate is incomplete with spaces in the bones. The articulation of the jaw allows sideways movement for grinding, and opening and shutting movements for biting and munching. Kangaroos have three pairs of incisor teeth in the upper jaw and one pair in the lower jaw. The lower and upper teeth do not line up which allows the front teeth to escape wear and tear when the animal grinds its teeth. But, if their teeth do get worn down over time, their bodies are designed to handle it. If the tooth is ground down it will fall out and new teeth that grow in the back of the mouth will move forward into the empty spaces. (Infoqis Publishing Co., 2009) Thus, an old kangaroo may only have two molars in

place after the others have been shed. (Encyclopedia Britannica, 2012) The front teeth are separated by the molars by a gap called the diastema. The canine teeth are only housed in the upper jaw. (Marshall Cavendish Corporation, 2010)

The requirement for the kangaroo to jump creates powerful hind limb muscles and very strong elastic tendons. Kangaroos have 23 muscles in the proximal hind limb. The biceps femoris is a large muscle lying in the caudo-lateral part of the thigh. The caudofemoralis is a large muscle lying in the lateral aspect of the hip. The abductor cruris caudalis is a small muscle lying in the caudal part of the thigh. The semitendinosus is a muscle lying in the caudal part of the thigh and extending from the ischium to the medial surface of the crus. The semimembranosus is a muscle lying in the caudo-medial part of the thigh between the adductor and semitendinosus muscles. The adductor is a large triangular muscle lying in the caudo-medial part of the thigh. The quadrates femoris is a deep tendinous muscle extending from the ischium to the femur. The pectineus is a small muscle in the medial part of the thigh lying between the quadriceps femoris and adductor muscles. The gracilis is a superficial muscle lying in the caudo-medial part of the thigh. The vastus lateralis is a powerful muscle lying in the cranio-lateral part of the thigh. The rectus femoris is a deep muscle lying in the cranial part of the thigh. The vastus intermedius is a deep muscle lying in the cranial part of the thigh adjacent to the femur. The vastus medialis is a superficial muscle lying in the medial part of the thigh between mm. pectineus and tensor fasciae latae. The sartorius is a muscle lying in the cranio-medial part of the thigh extending from tuber coxae to the stifle joint. The gluteus superficialis

is a muscle extending from the tuber coxae to the greater trochanter of the femur. The gluteus medius is a large muscle lying in the lateral part of the hip. The gluteus profundus is a deep muscle of the hip lying on the dorsal surface of the body of the ilium. The tensor fasciae latae is a small superficial muscle lying in the cranio-medial part of the thigh. The piriformis is a small muscle lying deep to the caudofemoralis extending from the proximal caudal vertebrae to the femur. The obturatorius externus is a deep muscle of the hip lying in the ventral surface of the pelvis. The gemelli are two small muscles lying in the space between the proximal caudal surface of the femur and the ischium. The obturatorius internus is a small thin muscle lying on the dorsal surface of the ischium just caudal to the obturator foramen. The iliopsoas is a muscle lying ventral to the caudal lumbar vertebrae and the shaft of the ilium). (Hopwood & Butterfield, 1976)

They also have a long muscular tail that acts as a counterbalance when bounding and a stabilizer when feeding. The tail can support the entire animal's body weight. The tail also is supported by numerous tendons that connect to the pelvis. The reason cats for example cannot use their muscles for jumping as efficiently as a kangaroo, is because their forelimbs touch the ground. Every time their front feet touch the ground they act as brakes. The tail acts as a counterbalance to allow the kangaroo from landing on its face. Hopping uses a lot of energy but, once they get going the movement becomes self-sustaining. The tendons of the animal's legs and tail act like springs in a pogo stick. Considering this, they can easily outrun any predator so; they are able to live in the open environment. The muscles in the thighs and tail are not only used for hopping, they are also used for fighting in males and

protection for females and their young. When males fight they will lock their forelimbs and wrestle. Each tries to unbalance the other then uses its tail to balance so its hind legs can lash forward and land a punishing double blow. (Marshall Cavendish Corporation, 2010)

Kangaroos have a small brain relative to their body size. On average the brain is 2 or 3 inches long and weighs 2 ounces, thus representing only about 0.1 percent of the animal's body weight. The two cerebral hemispheres are much smaller than those of a placental mammal of the same size. Kangaroos lack a corpus callosum. This is the brain tissue that, in placental mammals, links the two hemispheres of the brain. Instead kangaroos have a fasciculus aberrans. Considering kangaroos leave the womb and continue development in the pouch they need to develop rudimentary senses early. These senses are smell and gravity, so that it can climb into the pouch. Adult kangaroos have good eyesight and night vision. Scent is also pronounced in kangaroos and males have a scent gland on their chest that leaks into the fur. The odor is very nasty to humans; therefore, they are sometimes nicknamed stinkers. (Infoqis Publishing Co., 2009)

Kangaroos are normally silent animals, but sometime will give a short, harsh bark when angry or alarmed. Females make clucking sounds to call their joeys to their sides. Also most kangaroos will use an urgent drumming or thumping of their hind feet on the ground to signal danger. (Marshall Cavendish Corporation, 2010)

The circulatory system and respiratory system of kangaroos is very similar to placental mammal's systems. A kangaroo's heart is about the size of a human's heart. They have a closed system with arteries running away from

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the heart and veins running to the heart. The blood receives oxygen from the lungs and transports it throughout the body by red blood cells. Differences from other mammals are the absence of the interventricular sulcus, the great development of the auricles, the plentiful trabecula carneae, and the origin and distribution of the arterial irrigation and venous irrigation which have intramyocardiac localization. (Lima, Mendez, & and Perez, 2009)

Kangaroos tend to avoid sweating in the arid Australian heat because it could create problems such as dehydration. They only sweat when they are hopping because, when they are moving, the air passes over the body as an effective way to dissipate the heat generated by exercise. Therefore, when they are not hopping around they find other means to cool off such as wallowing in pools, lying in the shade, and coming out to feed in the dark.

Also, the peripheral circulatory system helps dissipate heat. The skin of the forearms is well supplied with blood vessels and the kangaroo will lick them and cover them in moist saliva which speeds up the rate of heat loss.

Kangaroos will also pant like a dog. By breathing fast they keep a flow of air moving down the moist lining of the windpipe and lungs. Air that becomes saturated with water in the throat and lungs is continuously exchanged for new dry air which maximized the rate of evaporation thus the rate of cooling.

The temperature of kangaroos is just slightly lower than that of placental mammals. This is thought to be because at running at a lower temperature they use less energy and is better able to cope with food shortages and other hardships. (Marshall Cavendish Corporation, 2010)

Kangaroos mainly eat grass, but they will also eat shrubs and even fungus. (Infoqis Publishing Co., 2009) Their ancestors were forest dwellers that

mainly ate fruit, tubers, and succulent leaves. When evolution began the forest began to be replaced by shrubs and grassland. Kangaroos were the first and only large native animals that grazed, and thus flourished. Their sharp incisors allowed them to cut grass very close to the roots. (Infoqis Publishing Co., 2009) Grass is low in energy and nutrients and because of this kangaroos need to eat a lot of it to sustain themselves. Their stomachs are very large and chambered with long intestines to create a very efficient digestive system. When the stomach is full it can account for more than one-seventh of the animal's body weight. On average though, kangaroos eat less than similar size herbivores such as cattle. A kangaroo's digestion is far more efficient and will extract every last ounce of nutrition from the food, while a sheep or cow relies on food becoming continuously available, processing large quantities rapidly and less thoroughly. In kangaroos the grass is ground enough to moisten it and then swallow it whole and then stored in the mid stomach where bacteria break down the cellulose. In cows, food is partially broken down in the rumen area of the stomach and is returned to the mouth for further chewing. Kangaroos take a very long time to chew their food to turn it into a fine pulp before swallowing because of the food staying in the mid stomach rather than being regurgitated like a cow. As stated above the stomach is multichambered or "sacculated." Food passes slowly through the different compartments which are separated by bands of muscle that pucker the lining at different intervals. The elongated middle section acts as a fermentation chamber. Their long intestines allow time for full absorption of the nutrients. Kangaroos that feed on lush green grass do not do as well as kangaroos that feed on dry, shriveled grass. This is because fresh grass contains a lot of water which does not allow as much energy and takes up

more stomach space. (Marshall Cavendish Corporation, 2010) Kangaroos do not release methane from their bodies; instead they use it for energy. (Infoqis Publishing Co., 2009)

Considering the arid climate kangaroos may go weeks without water and thus will lick the dew off of the leaves and rocks and use all of the available moisture in their food. If they desperately need water they will use their feet to dig deep into the ground until they find it. (Infoqis Publishing Co., 2009) They conserve water by producing concentrated urine and produce dry hard pellets, and they avoid the need to sweat by feeding at dawn and dusk and resting in shady areas during the day. (Marshall Cavendish Corporation, 2010)

Female kangaroos, called does, have two wombs and two vaginas for mating purposes. The male kangaroo's, called bucks; scrotum is located in front of the penis. The young, called joeys are born as an embryo through a third, central vagina which develops when giving birth. This area is similar to a vagina in placental mammals and opens adjacent to the digestive tract in the cloaca. In most marsupials the opening closes after each litter but after the first birth in kangaroos it becomes a permanent structure. (Marshall Cavendish Corporation, 2010)

While in the womb, the embryo is surrounded by a thin membrane secreted by the uterus wall similar to that of an eggshell in a reptile. Inside this membrane the embryo is nourished by its own yolk. The beginning of a placenta forms as the yolk runs out but never completely forms because the baby is born soon after, still in the embryo stage. The baby is born 30 days

after conception, and the membrane and fluids are born with it and are eaten by the mother. A newborn kangaroo is less than an inch long (about the size of a lima bean) and weighing about 0.03 ounces; it has no eyes or fur and its back legs are mere buds. The only help the mother gives is to sit back on her tail to reduce the risk of the baby falling off and licking a path in her fur for the embryo to crawl into her pouch. The journey takes about three minutes of swimming through the fur with just its forelimbs. Once inside the pouch the baby is exhausted and attaches to the teat for the next six months or more. (Marshall Cavendish Corporation, 2010)

The teat provides them with nourished milk from a mammary gland. Once the baby attaches to the teat it swells inside its mouth so it does not have to exert energy to hold on. The baby remains attached to the teat for weeks. Female kangaroos are equipped with four teats but a joey will only use one. The milk will change nutrients as the baby grows and develops. As the baby is allowed to leave the pouch and hop around the mother may already have another embryo inside the pouch that has its own supply of completely different milk. The milk for the embryo is very thin to allow easy digestion for their underdeveloped digestive systems. (Marshall Cavendish Corporation, 2010)

Kangaroos are able to breed whenever the opportunity arises but can also abandon the process if conditions get tough, therefore, mating will normally take place during the rainy season. This is unlike placental mammals which are committed once fertilization occurs. If food is scarce when the baby is born it may not survive and the mother has also reduced her chances of survival for no reason. By giving birth to such a small baby, kangaroos make

a small initial investment. Males often cannot produce sperm during the dry season if food is scarce. (Infoqis Publishing Co., 2009) The estrus cycle of a kangaroo is two days longer than its gestation period. Unlike other mammals whose estrus cycle stops when they become pregnant, kangaroos are able to mate successfully just a day or so after giving birth. The cycle then stops only if the first baby, now in the pouch, latches onto a teat and begins to suckle. At this point hormones send the second baby, only containing 90 cells, into a state of suspended animation known as embryonic diapause. The embryo resumes development only if a change in the milk production signals that the first offspring will vacate the pouch soon. Joey number two will be born two days after its older sibling leaves the pouch for the last time and the female will soon mate again. The female wastes no time between births; and if the joey in the pouch is lost the mother has a back-up baby developing and does not need to wait to go into estrus or find a mate. (Marshall Cavendish Corporation, 2010) This is thought to be an adaption for recovering population numbers quickly after a drought. (Encyclopedia Britannica, 2012) Females can also determine the sex of her offspring. In the early years of mating she will prefer female babies but, the older she gets she will prefer male babies. Kangaroos really enjoy caring for their joeys; if one gets lost they will spend all their time searching for it and not eating. Many kangaroos will become very depressed when they get older and can no longer reproduce; during this time they will start to spend more time with younger females in the mob that have their own joeys. (Infoqis Publishing Co., 2009)

Therefore, kangaroos are very unique animals. The skeletal system differences include the absence of a kneecap and first toe, the presence of epipubic bones, and their teeth fall out and can be replaced. The muscular system differences include the strong tail muscles. The nervous system differences include the lack of a corpus callosum. The circulatory and respiratory system is very similar to placental mammals such as cats and dogs. The digestive system includes a chambered stomach like a cow. The urinary system of the kangaroo conserves water by creating concentrated urine. Finally, the reproduction system differs by the baby developing in the pouch after 30 days in the womb and producing different milk concentrations for different aged joeys.