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ANATOMY

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Coping with water loss is a particular problem for animals that live in dry conditions. Some, like the camel, have developed great tolerance for dehydration. For example, under some conditions, camels can withstand the loss of one third of their body mass as water. They can also survive wide daily changes in temperature. This means they do not have to use large quantities of water in sweat to cool the body by evaporation.

Smaller animals are more able than large ones to avoid extremes of temperature or dry conditions by resting in sheltered more humid situations during the day and being active only at night.

The kangaroo rat is able to survive without access to any drinking water at all because it does not sweat and produces extremely concentrated urine. Water from its food and from chemical processes is sufficient to supply all its requirements.

Desert animals and plants need water for bodily processes and cooling, but animals lose water through breathing, excretion, panting or sweating, and milk and egg production. Adaptations help balance water income and water use, and an animal often exhibits multiple adaptations for survival.

Avoiding the Heat

A common desert adaptation in animals is to save water by not exposing themselves to hot temperatures. Insects, other invertebrates, rodents, toads, desert tortoises and kit foxes use underground burrows to shelter from surface temperatures that can reach 71 degrees Celsius (160 degrees Fahrenheit). Other refuges include rock crevices and overhangs, caves and the shade from bushes and trees.

Some animals, such as toads, frogs and desert tortoises, escape the heat for months at a time by aestivating in burrows. During aestivation, animals are dormant with reduced breathing and heartbeat, allowing them to escape high heat and conserve water. Most desert biome animals limit their above-ground activity in summer to twilight or evening hours.

Getting Rid of Heat

Some desert animals, such as antelope squirrels and camels, are active during hot summer days because they can allow their bodies to accumulate heat without harm. Body temperatures rise to 40 degrees Celsius or more (104 degrees Fahrenheit), doing away with the need to cool themselves by evaporating body water. Squirrels lose excess heat to shaded surfaces and camels to cooler night air.

A variety of adaptation examples can be seen in desert biome animals. Desert sheep, goats, camels and donkeys retain insulating fur on the tops of their bodies but have sparsely covered abdomens and legs that radiate excess heat. Jackrabbits have long legs that carry them well above the heated ground and large ears well-supplied with blood vessels. Blood flow to the ears increases to lose heat to cooler air and flow decreases when air is hotter than body temperature to avoid overheating.

Avoiding Water Loss

To save water ordinarily lost in excretion, another common desert adaptation in animals is dry feces and concentrated urine. Specialized desert dwellers, such as the kangaroo rat, have feces five times drier than that of a laboratory rat and urine twice as concentrated as the white laboratory rat. Other animals, including lizards, snakes, insects and birds, excrete uric acid, rather than liquid urine.

Small rodents and birds, such as cactus wrens, have specialized nasal passages that cool the breath before it is exhaled, condensing water for re-absorption. Many desert lizards possess nasal salt glands that excrete potassium and sodium chloride with very little water loss.

Water-Capturing Strategies

Kangaroo rats go their whole lives without drinking free water. They can capture water by oxidizing food -- recombining molecules -- to create water. One gram of the high-carbohydrate grass seeds that form the bulk of its diet produces one-half gram of oxidation water. Many small desert animals get sufficient water in the food they eat, such as rodents that eat water-storing cactus stems and cactus fruits, and birds that eat insects. The large lizards called Gila monsters store water in fatty deposits in their tails and desert tortoises store water in their urinary bladders that can be reabsorbed when needed.

THE CLINCAL ANATOMY OF GLOMERULAR

The glomerular capillaries are lined by a fenestrated endothelium that sits on the glomerular basement membrane, which in turn is covered by glomerular epithelium, or podocytes, which envelops the capillaries with cellular extensions called foot processes. In between the foot processes are the filtration slits. These three structures—the fenestrated endothelium, glomerular basement membrane, and glomerular epithelium—are the glomerular filtration barrier. The nephrotic syndrome is a set of symptoms that include the following:

* protein in the urine;
* low blood protein levels;
* swelling or edema.

It may also include elevated levels of serum lipids, anemia, and vitamin D deficiency, all because of loss of plasma proteins into the urine. This can have multiple causes, but all involve defects in the glomerular barrier to proteins so that excess proteins are filtered and thereby excreted in the final urine. The three barriers were discussed in the text: the fenestrated endothelial cell layer, the GBM, and the podocyte and slit [diaphragm](https://www.sciencedirect.com/topics/engineering/diaphragms).

Nephrotic syndrome can be primary or secondary. Primary causes are described by their histological changes: minimal change disease, focal segmented glomerulosclerosis, and membranous nephropathy. Secondary causes are described by their underlying cause, which include diabetes mellitus, sarcoidosis, hepatitis B, hepatitis C, bacterial infections, parasitic infections, and more.

All of the diseases are characterized by protein in the urine, at least 3.5 g per 24 h. The loss of protein can cause hypoalbuminemia, with resulting edema that may show as puffiness around the eyes, pitting edema in the legs, and pleural effusion. Loss of proteins stimulates liver synthesis, including lipoproteins. Because lipoprotein lipase levels fall, lipoprotein levels increase. Loss of vitamin D binding protein can lead to vitamin D deficiency diseases, with calcium malabsorption and bone disease.

Mutations of nephrin, a protein of the filtration slit, cause nephrotic syndrome. Mutations of podocin also cause nephrotic syndrome that is insensitive to steroid treatment. Podocin is an integral protein of the podocyte cell membrane that segregates into [lipid rafts](https://www.sciencedirect.com/topics/engineering/lipid-raft) and is required to recruit nephrin into those rafts. Current thought is that podocin and nephrin form a signaling complex that activates protein kinases involved in glomerular structural integrity. These mutations cause minimal change diseases in which structural changes are evident only at the [electron microscope](https://www.sciencedirect.com/topics/engineering/electron-microscope) level and not at the histological level. Until recently, these were part of the set of nephrotic syndrome called idiopathic nephrotic syndrome.

Membranous glomerulonephritis is one of the more common causes of nephrotic syndrome in adults. It is an inflammatory disease, believed to be caused by binding of antibodies to antigens in the GBM that triggers the formation of a [membrane attack complex](https://www.sciencedirect.com/topics/engineering/membrane-attack-complex) from complement .This triggers release of proteases and [oxidants](https://www.sciencedirect.com/topics/engineering/oxidant) that damage the [capillary walls](https://www.sciencedirect.com/topics/engineering/capillary-wall), causing them to become leaky. Histology reveals thickened basement membranes.