WOLLO UNIVERSITY SCHOOL OF VETERINARY MEDICINE

CHAPTER 3

ADAPTATION MECHANISMS OF CAMEL TO ITS ENVIRONMENT

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- The camel is raised in the **arid** and **semi-arid zones** where feed resources are **frequently scarce**.
- The dromedary camel (*Camelus dromedarius*) is well known for **its ability** to survive **harsh desert conditions.**

- Is this survival ability due to its **heat tolerance** / **its ability to withstand** the effects of dehydration???

Or

- Is there other adaptive strategy employed to overcome the harsh conditions???

- Adaptation of animal to its environment in general is used often for **the process of adjustment** to the environmental changes.

- Adaptations of the camel to **the desert** environment encompass **anatomical**, **behavioral** and **physiological** changes.

- It is quite **clear** that, the camel **does not** have any **special mechanism** for survival, but

relies on mechanisms known to and utilized by other animals.

- All the desert species have **fluctuating body temperature**, **decline** in **metabolism** and **utilization** of **intestinal water**.

- The **camel however** is able to utilize these mechanisms more **effectively** when exposed to the direct rays of the sun and for extremely long periods **without drinking water.**

- **Anatomical adaptations**
- **Camels' humps** are filled with **fat** and **muscle** but **no bone** or **free water**.

- Their main purpose is **to store fat** as **an energy reserve** that sustains the animal when **food** and **water isn't** available.

- By **concentrating** fat in the hump rather than the body, the camel can **expel** body heat better through **its body** (there is **no layer of fat** to

- Most animals **store their fat** throughout their bodies.
- The camels can survive **for weeks** without food, drawing on the fat from the humps for energy.

- The humps acts also like **a body cover** that protect and shade the internal organs by slowing the conduction of heat.
- Camels have **dark eyes** which are good for seeing in **glaring sunshine**.
- Their **interlocking eyelashes** also cut **glare** and keep out **sand.**

- They have **thick coarse wool** on their back which acts **as insulation** from the hot sun but have little hair on their undersides which allows them **to give off** excess heat.

- The camel's **large size** has an advantage. A large object takes **a long time** to warm up plus it can create a lot of **its own shade**.

- Excluding the hump, there is **very**

- Their **nostrils** have **small muscles** that allow the animals to close them to small slits to keep out blowing sands.
- So the camel is **the only animal** that **can close** its nostril as protection **against sand** and **winds**
- The upper lip is **split** and **hairy**, **extensible** and **slightly prehensile** and very s**ensitive**.
- This modification helps the camel **to select** its food (selective feeder) and **avoid** the thorny plants

- The camel has a long **arched neck** helping them to manipulate the **high tree plants** and **to explore** the **enemy** from long distances.

- **Skin** of camel is **attached** rather **tightly** to the **underlying tissues** and **has short fine hairs** which help in **thermoregulation.**

- **The legs** are relatively **long** and **slender**, an adaptation, perhaps to a

- More than **65%** of the camel’s total weight is supported by the **front limbs**.

- The **chest** is deep and narrow which allows the balance to be **shifted easily,** so that it is directly over the **weight bearing** foreleg **during locomotion**.

- Camels have two large **flexible toes** on each foot instead of hooves.

- The toes are connected by **skin** so that when the animal walks their toes splay out and the webs keeps them from **sinking in** the sand.

- Beneath the toes are **thick pads** that offer **protection** from the heat.

- These **soft padded** feet are better adapted for traveling on sand than hard surfaces.

- **Physiological adaptations**
- Defined as the **physiological processes** involved in **adjustments** by the individual to **climatic changes** and **changes in food** quality…… etc.
- The requirements for **survival in hot arid** areas are very important.
- Temperature must be **maintained** and water must be **conserved**.
- The camel losses body heat **by sweating** more **efficiently** than other mammals

- **Water Conservation**
- **Water is essential** to life and the camel has often to survive on limited quantities for long periods of time.

- To do this, it has developed not only a **very low rate** of **water use** but mechanism for restricting water loss as soon as its intake is reduced.

- The hump is mainly comprised of fat and thus the **metabolic water** content is **high**,

complete oxidation of fat in the hump **results water.**

- The **camel's stomach** contains a **large amount** of **fluid** secreted by the **glandular**

- Water is lost from the body by evaporative cooling, in the urine and in the feces.

- The structure and function of the kidney are of **extreme importance** in water conservation.
- The **long loops of Henle** in the medulla have the function of **urine concentration (recovery of water and NaCl)**
- Urea is reabsorbed from the intestine and transferred back to the stomach for **re-conservation to**

- The kidney **controls water loss in two ways:**

⎫ by the absolute concentration achieved or

⎭ by reduction in **flow** of urine.

- A reduction in **urine flow** is also achieved by reducing the **glomelular filtration rate** from a normal of 55-65 ml/100kg body weight / minute to 15 ml / 100kg body weight / min.

- The camel’s kidneys play a **major role** in the process of **conserving water**

- **Fecal water loss** is also small in camel. Final reabsorption of water occurs in **the colon**.

- It has been **reported that camels can survive up to** 14 days without water.

- Camels can tolerate **water losses of up to 30%** of their body weight, whereas the maximum for many mammals is approximately 1**0 to 12%.**

- Other species such as Australian **Merinos** can also lose up to **30%** of body weight but they would **not be expected** to survive for more than one to two days of exposure to **hot conditions** (**41ºC;** no shade),
- whereas the camel will survive for **15 days**

- Rehydration following a period of water deprivation is important for animal survival.
- A camel may drink more than **one third** of its body weight as it **rehydrates**.
- In terms of actual water intake it is reported to drink **200 L** in **3 days**
- In other animals rehydration at these levels would lead to **over hydration** and **possible to death.**
- The camel is able to do this **as large amounts of water** can **be stored** for up to **24 hours** in the **gut** to

- **Blood**
- The camel can dehydrate without compromising blood viscosity.
- Camels have **unusual blood**. It has **more water** than the blood of other animals and **the oval-shaped** red blood cells stay intact even when the amount of liquid in the blood is low.

- When the amount of liquid is reduced in the blood of other animals, the red blood cells **shrivel**, the **blood stops flowing** and **transferring body heat** and a **lethal heatstroke occurs.**

- By contrast, the blood of a camel that has lost its body water keep flowing and

- **Blood composition** and **volume** remains relatively **constant** and **haemoglobin** function remains **normal**.
- The **erythrocytes** of the camel are **oval shaped** and **non-nucleated** which resist **osmotic variation** without rupturing;

these cells can **swell** to **twice** their initial volume following **rehydration**

- Another **unique feature** of the **erythrocytes** is their **long life span** when the camel is dehydrated.
- The life span of the erythrocytes of **hydrated** camels is **90 to 120 days**.
- When camels were **chronically dehydrated during summer** (**40^{o}C** mean during **day**; **20^{o}C** mean at **night**) the life span of erythrocytes was **extended to 150 days.**
- Erythrocyte **turnover** is **water** and **energy expensive**.
- Therefore extending the life span of erythrocytes **reduces** energy and

- **Thermoregulation**
- When exposed to high heat load animals need to increase **evaporative heat loss** in order to keep body temperature below a **lethal level**.

- A fully **hydrated camel** has a **diurnal** body temperature range of **36 to 38ºC**.
- However when **dehydrated** and **exposed to high environmental heat,** the body temperature may **fluctuate by 6 to 7ºC**, from approximately **34 to 41ºC**.

- The increase in body temperature of camels exposed to **high heat load** is **advantageous,**
- because it allows a considerable amount of heat to be **stored during the day** and

- Furthermore, as body temperature increases the temperature **gradient(d/ce)**between the camel and the external environment is reduced, and again water use is **reduced**.

- Because of this change, the camel doesn’t sweat as much when the temperature rises.
- Sweating causes an animal to lose water, so the camel’s temperature change helps it to conserve water.

C. Behavioural Adaptation

- Under conditions of dehydration and intense heat the camel adopts **behavioural** mechanisms to **conserve energy.**
- To conserve water and **resist** the heat, camels stay in a **recumbent position** for long periods during the day,
- thus **reducing** the **heat energy** produced by **muscle activity** and **food metabolism**.
- Camels sometimes **urinate** on their legs. As the **urine evaporates**, the blood vessels on its legs are cooled.

- **Nasal secretions** that drip between the nose and mouth also act as a **coolant** but have a relatively **minor effect**.
- Groups of camels **sit close together** so they **cool** each with the **shade** created by their bodies.
- Each camel **faces** the sun in such a way that **its hump absorbs** the direct sunlight.
- Resting camels will **reorient themselves** throughout the day in

Table 9. *Some morphological and behavioural characteristics enabling the camel to survive in various environments.*

Environmental stress	Adaptive mechanism
1. Solar radiation/reflection	Long limbs (increasing height from ground)
2. High temperatures	Hair shedding in summer
3. Seasonality of feed availability	Adipose tissue reserves (hump)
4. Deserts - thorny vegetation	Thick skin, hard tissue around mouth, thick mouth lined with long papillae
- water scarcity	Increased drinking capacity, conservation of metabolic water, ability to survive dehydration (metabolism lowered)
5. Low temperatures	Low renal flow during dehydration, renal resorption of urea, can feed without water, thick coat in winter
6. Evaporative cooling	Apocrine sweating