CAMEL NUTRITION

The camel is a large, strong desert animal.

- Camels can travel great distances across hot, dry deserts with little food or water.
- They walk easily on soft sand where trucks would get stuck, and carry people and heavy loads to places that have no roads.
- Camels also serve the people of the desert in many other ways.
- The camel carries its own built-in food supply on its back in the form of a hump.
- The hump is a large lump of fat that provides energy if food is hard to find.

There are two chief kinds of camels:
(1) the Arabian camel, also called dromedary, which has one hump, and
(2) the Bactrian camel, which has two humps.

- In the past, hybrids (crossbreeds) of the two species were used widely in Asia.
- These hybrid camels had one extra-long hump and were larger and stronger than either of their parents.
- Camels have been domestic animals for thousands of years.
- Arabian camels may once have lived wild in Arabia, but none of them live in the wild today.
- There are several million Arabian camels, and most of them live with the desert people of Africa and Asia.
- The first Bactrian camels probably lived in Mongolia and in Turkestan, which was called Bactria in ancient times.

Reproductive characters

seasonal sexual activity occurs in both the males (Bulls) and females (Cows).

Increasing daylight is believed to activate the breeding urge.

Sexual activity can commence at 2-3 years, however the first calf is not normally born until the female is 5 years old.

 Breeding continues on an average every 2-3 years until the female is 20 years old.

The average female produces 8 calves. Pregnancy length depends on the season, (food availability, stress, etc.)

Varying from approximately 374 days (12.5 months) to 419 days (14 months).

 Ovulation is induced by coitus (mating) and the average cycle is 27 days.

Bulls become sexually mature at 3-4 years.

- **In Australia mature bulls commence rutting around August to October.**
- **The rutting bull will return from the bachelor herd to dominate the cowherd and any other males in the area.**
- **Alternatively he will drive off some of the cows and establish his own herd.**
- **The length of an individual Camels rut varies from 2-4 months depending on, his nutritional state and dominance.**
- **Periods of rut are nutritionally and physically demanding and severe weight loss occurs.**
- **This has the effect of ceasing the rut of that bull and consequently several dominant bulls are active throughout the breeding season.**

The birth weight of calf is between 30-40 kg. Weaning weight at 1 year is about 150-180 kg, and mature weight is 500-600 kg. on average, reached at 6-7 years.

- **The weights of mature Camels have ranged from 514-635 kg. for bulls and for cows 470-510 kg.**

- **Animals of an estimated 5 years of age had a live weight of approximately 340-430kg.**

DIGESTIVE SYSTEM

Camel is Pseudo Ruminant.

A pseudo-ruminant is an animal that eats large amounts of roughages but does not have a four-compartments stomach like ruminants.

The digestive system consists of the organs directly concerned in the reception and digestion of the food, its passage through the body, and the expulsion of the unabsorbed portion.

These organs are usually grouped under two heads 1)The alimentary canal

2) The accessory organs

✓**THE ALIMENTARY CANAL IS A TUBE WHICH EXTENDS FROM THE LIPS TO THE ANUS.**

MOUTH

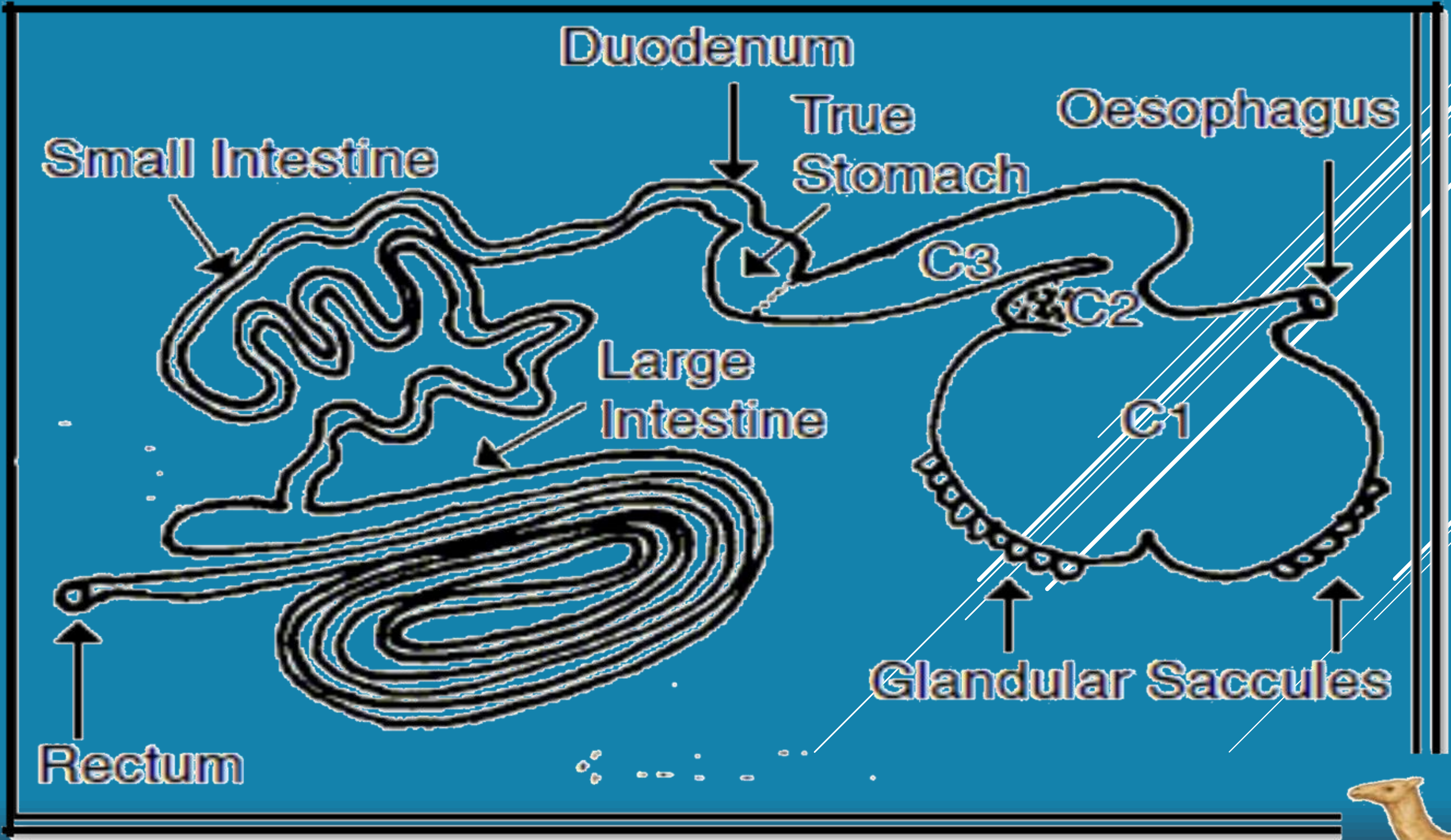
PHARYNX

ESOPHAGUS

STOMACH

SMALL INTESTINE

LARGE INTESTINE



Duodenum
True
Stomach
Oesophagus
Small Intestine
C3
C2
C1
Large
Intestine
Glandular Saccules
Rectum

MAJOR DIFFERENCE: SHEEP AND GOATS

Sheep graze.

Goats browse.

Goats require copper in the diet.

Sheep tolerate little copper in the diet.

(As a rule of thumb SHEEP NEED NO MORE THAN 4-8 PPM IN THE DIET)

Mouth:

The mouth is the first part of the alimentary canal. It is bounded laterally by the cheeks, dorsally by the hard palate, ventrally by the body of the mandible and behind by the soft palate.

Function:

Chewing (with the help of teeth) and lubrication of feed.

Pharynx:

The **pharynx** is the portion of the **digestive tract** that receives the food from mouth.

Two branches of Pharynx

- **Esophagus:** which carries food to the stomach

- **Trachea:** windpipe, which carries air to the lungs.

There are no guttural pouches in the camel.

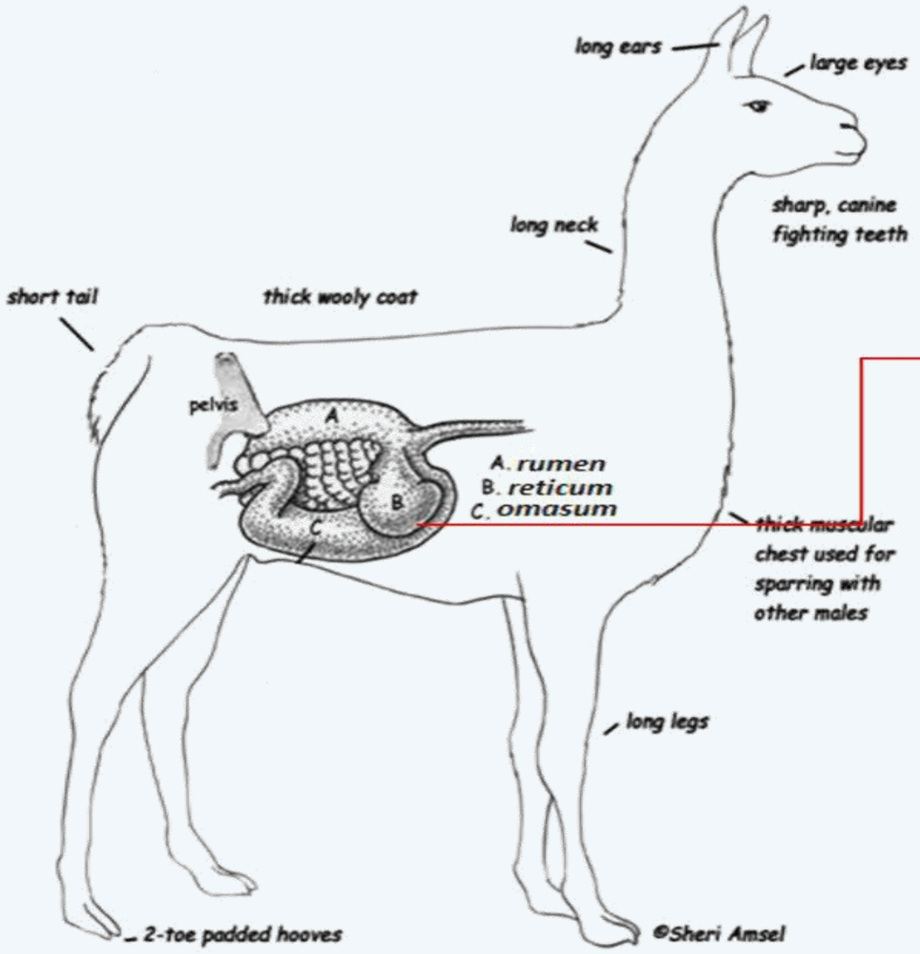
Stomach:

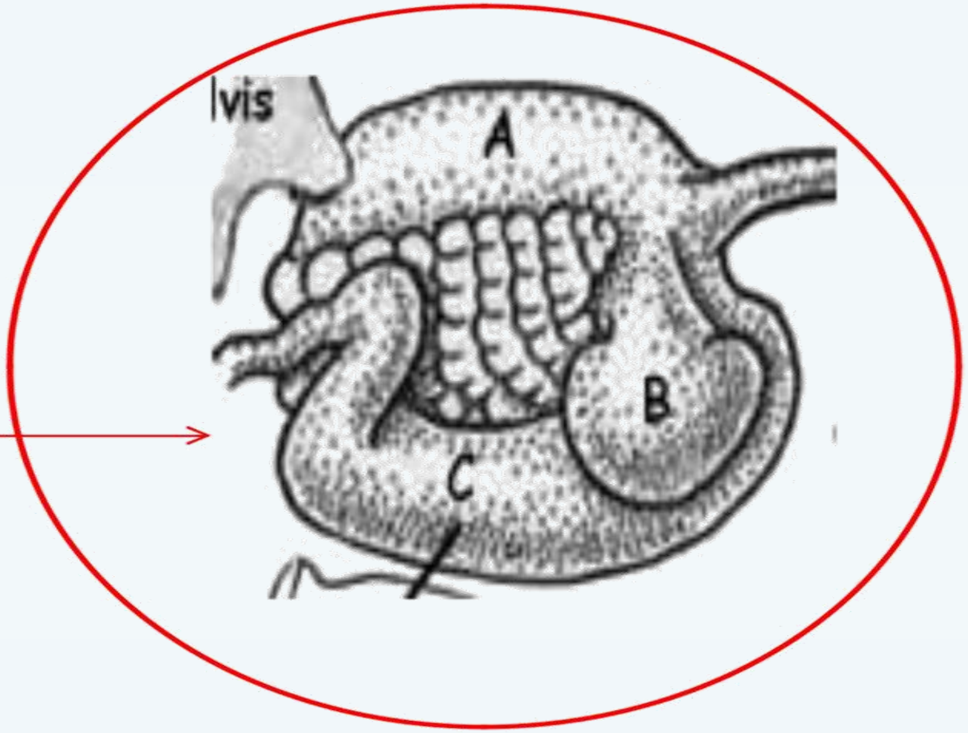
The stomach of camel consists of three different sections. The biochemical pattern of microbial fermentation is generally similar between ruminants and camelids.

C1: A large compartment that is divided by a strong transversal muscular ridge into a cranial and caudal portion.

C2: Is relatively small portion and not completely separated from C1

C3: which originates from C2, is situated at the right side of C1, C3 is a long tube, intestine-like organ.


long ears
large eyes
sharp, canine fighting teeth
long neck
short tail
thick wooly coat
pelvis
A
B
C
A. rumen
B. reticum
C. omasum
thick muscular chest used for sparring with other males
long legs
2-toe padded hooves
©Sheri Amsel


lvis
A
B
C

- **Intestine:**
- **The intestine of the camel has the usual designation of small and large intestine.**
- **<u>The small intestine</u> has a length of about 65 feet.**
- **Neutralization: Bicarbonate ions from the pancreas and bile from the liver neutralize stomach acid to form a pH environment suitable for pancreatic and intestinal enzymes.**
- **Digestion: Enzymes from the pancreas and the lining of the small intestine complete the breakdown of food molecules. Bile salts from the liver emulsify fats.**

- **Absorption: The circular folds, villi and microvilli increase surface area. Most nutrients are actively or passively absorbed.**
-
- **The large intestine has a length of about 78 feet.**
-
- **Absorption: The proximal half of the colon absorbs salts (e.g., sodium chloride), water, and vitamins produced by bacteria.**
-
- **Storage: The distal half of the colon holds feces until it is eliminated.**

- **The accessory organs:**
- **The accessory organs are**
- **1.Teeth: A. *Deciduous* B. *Permanent***
- **2.Tongue: for the movement of feed**
- **3.Salivary glands: Three pairs of glands-the parotid, the mandibular and the sublingual-situated on the sides of the face and adjacent parts of the neck. Amylase in saliva begins carbohydrate (starch) digestion. Mucin and water in saliva provides lubrication, and lysozyme kills microorganisms.**

- 4.Liver: liver *is the largest gland in the body.* Bile salts from the liver emulsify fats.
-
- 5.Pancreas: Bicarbonate ions neutralize stomach acid to form a pH environment suitable for pancreatic and intestinal enzymes.

In camels, two basic contraction sequences (A-and B-contractions) have been observed

A-sequences start with a contraction of C2 followed by a contraction of the caudal C1 about 4 sec later.

B-sequences begin with a contraction of the cranial C1 followed by C2 and caudal C1.

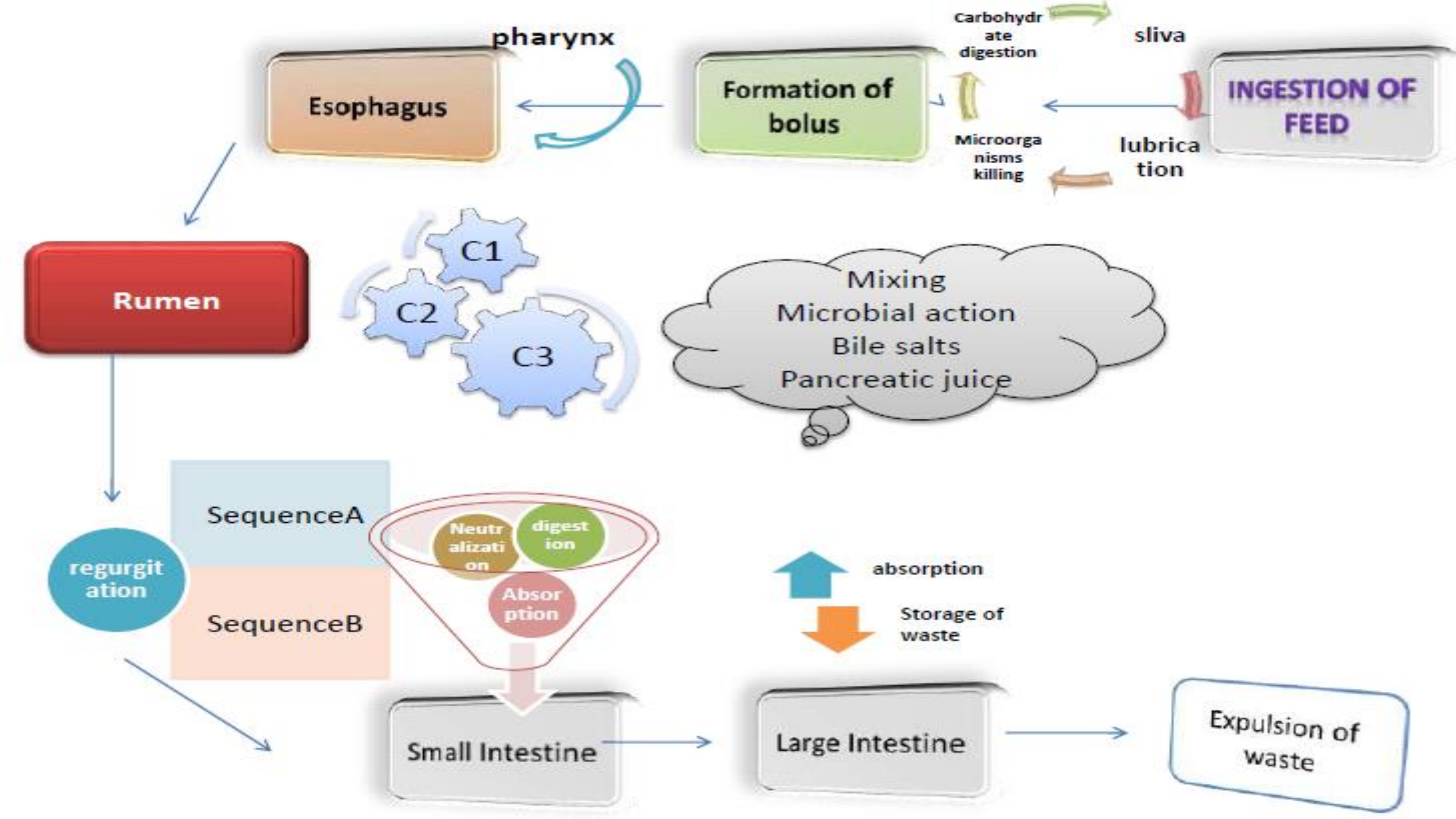
B-sequences last for about 9 sec.

The flow of digesta through the canal between C2 and C3 occurs during contraction of C2.

**After contraction of the cranial C1 contents are sucked into the esophagus. This is followed by an antiperistaltic wave toward the mouth cavity.

**Eructation of gas from the stomach of camels, occurs during a contraction of the caudal C1 .

**During eating and rumination stomach motility frequent(about 100 A- and B-sequences per hour).

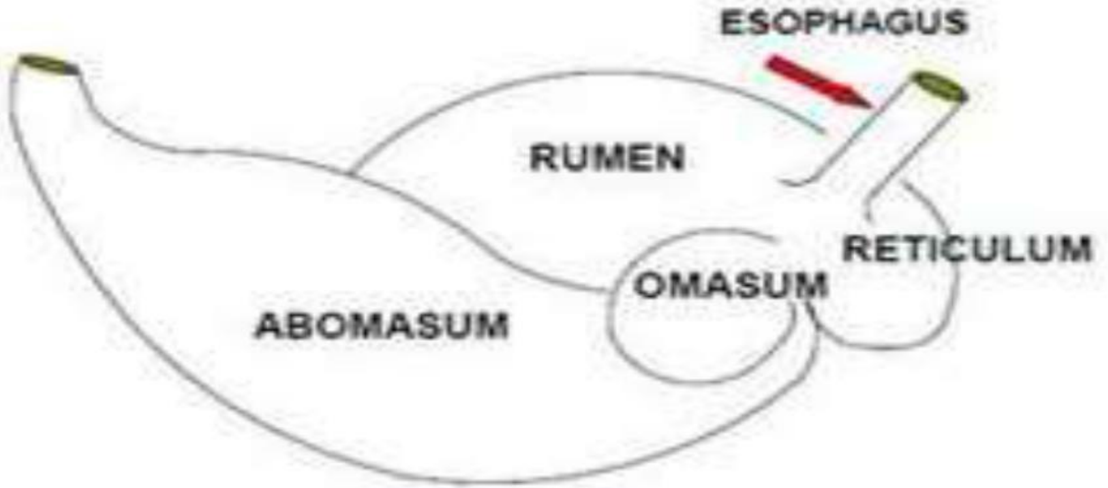


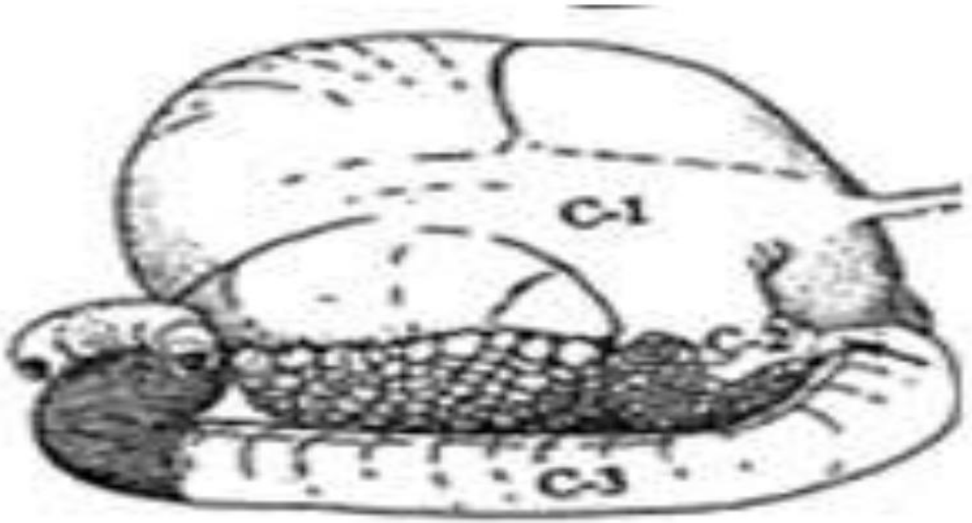
INGESTION OF FEED
sliva
lubrica tion
Carbohydr ate digestion
Microorga nisms killing
Formation of bolus
pharynx
Esophagus
Rumen
C1
C2
C3
Mixing
Microbial action
Bile salts
Pancreatic juice
regurgit ation
SequenceA
SequenceB
Neutr alizati on
digest ion
Absor ption
Small Intestine
absorption
Storage of waste
Large Intestine
Expulsion of waste

ANATOMICAL DIFFERENCE:

ØIN THE RUMINANTS 4 COMPARTMENTS OF THE STOMACH

RUMEN, RETICULUM, OMASUM AND ABOMASUM ØIN CAMELS 3 COMPARTMENTS OF THE STOMACH C1,C2,C3(RUMEN, RETICULUM, OMASUM RESPECTIVELY)





- Compartment 1 is not papillated like the rumen.
-
- Compartment 2 is not lined by the honeycomb structure of the reticulum.
-
- Compartment 3 is not globular and filled with laminae as in ruminants.

In adult camels small intestine is 65 feet length, while in case of bovines the small intestine is 20 times more in length than the length of animal.

Example:

A cattle, 2 meters in length have a small intestine of 2×20=40 meters length.

- **Histological Difference:**

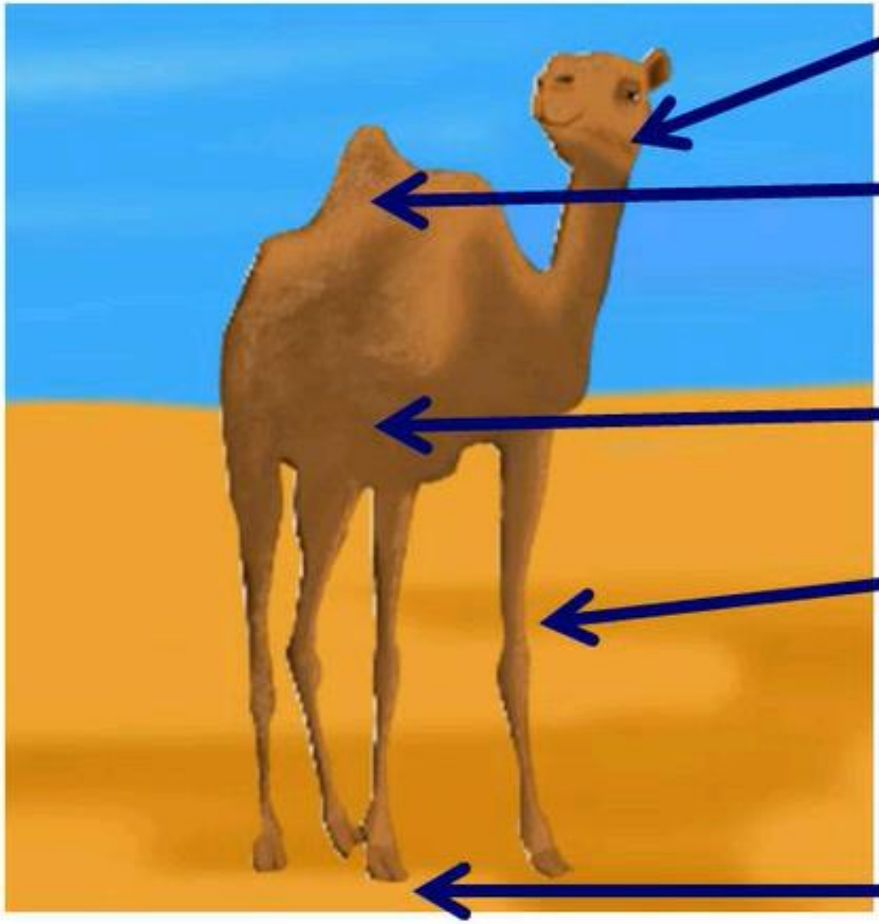
- **In camels, unlike as in ruminants, only the dorsal parts of C1 and C2 are made of a squamous keratinized epithelium.**
-
- **The ventral parts of C1 and C2 and the whole inner**
-
- **surface of C3 are, instead lined by a columnar surface epithelium.**

Curious camel facts

- Camels are amazing creatures! Did you know that…
  - …camels have three stomachs.
  - ...some camels live to over 40 years old.
  - …some Bactrian camels can transport 450 kg.
  - …archaeological finds show that they originated in North America.
  - …Somalia is home to over 6 million camels!

How are camels adapted?

- How is a camel adapted to life in a very hot, dry climate?



Brown coat for camouflage.

Fat is stored in the hump. There is no other body fat to prevent overheating.

Loses little water through sweating or urine.

Long, thin legs mean the body surface area is large compared to volume to increase heat loss.

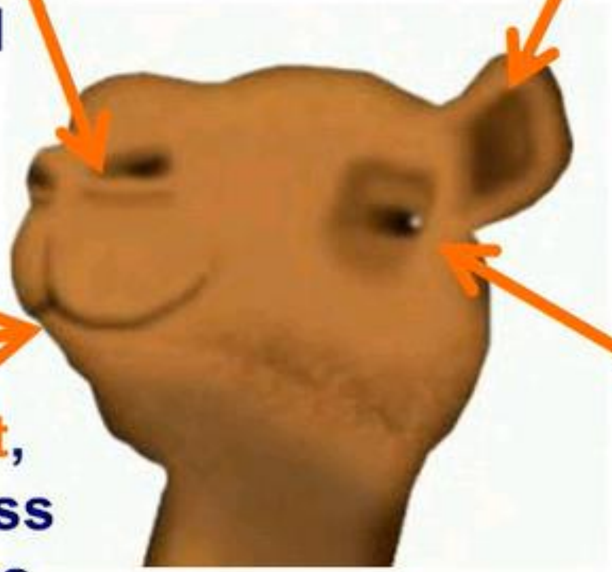
Wide feet for spreading body weight over soft shifting sand.

How is a camel adapted?

- Other adaptations that camels have evolved to cope with conditions in the harsh desert environment are:

Nostrils can close when needed to protect the camel in sandstorms.

Ears are lined with fur to prevent sand and dust from getting in.



A very varied diet, ranging from grass and bark to thorns and bones, is eaten.

Long eyelashes protect the eyes from sand and dust.

NUTRITION

- Energy
- Protein
- Fats
- Minerals
- Vitamins
- Additives

Factor affecting camel nutrition

age
weight
environment
exercise

ENERGY

- Come from grains
- increase ……acidosis
- Fat
- Increase decrease digestion mal absorption
- Fibers
- increase …….impaction &bloat

DRY MATTER

- 1.75-2.5 %
- Concentrate not more than 30%
- Forage not less than 70 %

High fiber - less protein –high digested – ideal microbial digestion – high performance

RUMEN DIGESTION COVER OVER THAN 60 % FROM REQUIRED PROTEIN 70% REQUIREED ENERGY

- Protein
- Healthy mature camel
- 10% cp
- Growing working and lactating
- 12-14 %

- Energy

- Maintenance DE = 75 X W^0.75 Kcal

- Minerals
- Ca :P
- =1.2-1.6: 1 not exceed 2:1
- Se
- =1-1.5 mg daily

- Salt 6-8 times than other animals 140g /day
- Less than that cause contagious necrosis of skin and lameness

- Pregnancy
- First 8 month ……maintenance cover requirements
- Covered from good quality forage (not barseem or others cultivated with chemical fertilizers)
- Last 4 month add 12-16 % conc. Mixture by 0.25-0.5 kg /day/head
- Slowly gradually

- Lactating
- After parturition
- Loss in BCs
- Need supplementation with conc.
- as before parturition
- NEB

FEED INTAKE AND DIGESTIBILITY

- Camels have a lower dry matter intake than cattle or horses. Camels typically consume only 1.7% of bodyweight as dry matter, compared with 3-4% bodyweight for horses and cattle. Camels require 70% of dry matter intake as roughage. Camels typically have higher digestibility coefficients compared with ruminants.
- Camels can efficiently digest low quality roughage's because of the wide range of ruminal microflora which can adapt to a range of forages, active rumination, and high levels of urea recycling.

FERMENTATION

- Camels produce the volatile fatty acids acetate, propionate and butyrate from fermentation in their forestomach, in similar molar proportions to ruminants given roughage based diets. Compared with ruminants, camels can extract more energy from the food they consume. This has been attributed to their specialised metabolism of glucose and urea recycling .

ENERGY

- The ME requirement for maintenance in camels is lower than for cattle. A 450kg camel requires only 37 MJ ME for maintenance compared with 52 MJ ME for cattle. The DE requirement for a 450kg horse is 48 MJ DE/day, which approximates 40 MJ ME/day. Camels therefore have an energy requirement similar to horses for maintenance.

OIL

- Camels can store fat efficiently in their hump, and in the adequately fed camel, the hump can represent 20% of the camel's total body weight (Mirgani 1981). The oxidation of fat in adipose tissue yields more energy (1g fat=9.3 kcal) than the oxidation of carbohydrates (1g=4.2 kcal).

- Research suggests that the maximum oil inclusion in camel diets is 3%, because of the effects of oil on reducing fermentation. There is no information available on feeding different types of oils to camels.

- In cattle, it is the free fatty acid concentrations that impact on rumen fermentation, and not the total fat concentration. In ruminants, rumen function is impaired at free fatty acids (FFA) at levels greater than 3-4% in the diet. For example, polyunsaturated oils such as canola and soybean contain approximately 80% FFA, and so can only be fed at 3-4% of the diet. By comparison, saturated oils such as coconut oil contain only 30-35% FFA, and so can be fed up to 9-10% of the diet.
- In horses, polyunsaturated oils which are long chain (C18) are slowly absorbed into the lymphatics and then slowly metabolised in the liver. By comparison, medium chain fatty acids (C12-C14) such as in coconut oil are readily absorbed into the portal blood and metabolised in the liver.
- Saturated oils such as coconut oils have been shown to be beneficial energy sources to both cattle and horses, and may well be beneficial to racing camels as an energy substrate. Coconut oils can be fed at higher levels, and are more readily digested and absorbed compared to polyunsaturated oils.

PROTEIN

- Basal protein requirements in camels (450 kg bodyweight) have been estimated at 300g DCP / day for adult working and racing camels.
- Nitrogen retention in camels is greater than sheep given a diet of 4% crude protein. During a state of dehydration the camel's nitrogen retention is increased by 150%, whereas in sheep it is only increased by an increment of 34%. Supplementation of urea has found to have a variable effect on the VFA producing microbes in the camel.
- Camels recycle greater quantities of urea to the rumen, which in turn would support higher levels of digestion. It is reported that young camels given low protein diets respond well to supplements of bypass protein, as shown with weaner sheep and cattle. Proteins with a high biological value give the best results.

GRAIN FEEDING

- The main source of roughage for the racing camel is fresh cut alfalfa. Typically, much of the camel's energy is derived from barley. A normal diet for the racing camel consists of "10kg of alfalfa tops, 3-4kg of soaked whole barley, 1kg dates, 2L of fresh milk, occasional hay, and some electrolyte, vitamin and mineral supplements" .
- Although camels perform well on these diets, they often suffer digestive upsets including colic and rumen dysfunction, similar to grain poisoning in cattle.

- Urea in camel nutrition

- Should be avoided
- Found after protein metabolism
- Found in blood as 8-28 mg/dl
- Standard values in racing camels are 10-16

- Urea cycle
- Re-absorption of urea In kidney
- Return in blood stream
- Excreted with saliva
- Return to rumen
- Formed into microbial protein

- Reuses of urea increased from 47% to 86 % when protein content decreased in diet (13 to 6%)
- Recycling decreased with increased protein to less than 10%
- Protein quality and digestibility affect urea cycle effeciency

- High quality forage decrease recycling

- **High urea in blood**
- **Causes :**
- **Less water intake**
- **Heavy work and More exercise**
- **Diuretic drugs and Anti-inflamatory drugs**
- **Stress**
- **Less protein diets (less than 6%)**
- **Low quality forage (bad quality roughage)**
- **Low energy diets**
- **Liver and kidney disturbance**

- **Treatment**
- **Increase water intake**
- **Herbal plants**
- **Soaked Barely**
- **Fenugreek soaked**
- **treatment of liver and kidney**

- Prevention
- High quality diets in protein and amount
- High quality Forage
- Avoid forage raised with fertilizers
- Increase water intake
- Avoid over use of diuretics and anti-inflamatory
- Good nutrition concept
- Add probiotics and prebiotics

NUTRITION OF ATHLETIC CAMELS

- Camels are remarkable animals that have evolved with a ruminant like digestive system to enable them to survive on low quality, fibrous feeds. Being browsers, camels are able to select high quality diets, which they can efficiently digest.
- Camels have lower energy requirements than ruminants, and have evolved an efficient mechanism for nutrient recycling.

- Camels have the ability to perform muscular functions such as racing at a level of intensity that exceeds the ability of horses. This unique capacity reflects the lower energy requirements for locomotion, the higher glucose supply, the lower oxygen demand, and preferential dependence on slow twitch muscle fibres which in turn rely on aerobic metabolic pathways.

- or short distance, high intensity races, camels need high energy feeds to meet the additional energy demand. As with both horses and cattle, inclusion of high levels of grain in camel diets can cause metabolic disorders. Oil supplements provide energy, however the slow rate of metabolism of traditional polyunsaturated oils makes them of limited use in short distance, anaerobic metabolism races.
- By comparison, tropical oils such as coconut oil are rich in medium chain fatty acids which are readily absorbed and metabolised providing an available source of cool energy

- Camel racing is a major sport in the Middle East, with camel races over distances from over 5 to 40 km. Even though camels are pseudoruminants, the expectation is that they perform like a horse. Horses can sustain high levels of muscular exercise, because of the power to weight ratio, the balance of muscle fibre types (fast twitch and slow twitch fibres) and the forms of energy provided by digestion. Horses rely on energy sources which provide an immediate supply of ATP for explosive/intense muscular function. These energy sources include carbohydrates, oils, and muscle glycogen.

- by comparison, ruminants rely primarily on volatile fatty acids from rumen fermentation to provide energy. These energy sources generally do not provide an immediate supply of ATP to support explosive muscular function for racing.
- In practical terms, ruminants are unable to sustain intense muscular exercise and fatigue quickly. By comparison, horses can sustain both high levels of intense muscular exercise, and long term endurance exercise.
- The challenge therefore is to feed camels (a pseudo-ruminant) to produce energy sources which support intense muscular exercise to enable them to perform like a horse.

- With racing camels, the aim is to feed a pseudo-ruminant to perform like a horse. That is, to provide digestible energy (DE) to supplement the energy from roughage to meet the energy demands for high intensity exercise. In horses, the additional DE is traditionally provided by feeding grains together with digestible fibre. It is now known that feeding high levels of starch to both ruminants and horses is the main cause of temperament changes (fizzy or hot behaviour), and metabolic disorders including colic, laminitis and tying up. The effects of starch have been alleviated in most cases by replacement of dietary starch with digestible fibre and non starch, energy feeds such as oil. Anecdotal evidence suggests that camels also suffer from temperament changes and metabolic disorders on high grain diets.

- The energy cost of locomotion in camels is considerably lower than horses at moderate to high speeds. At 15km per hour, the horse requires 25% higher energy, and at 30km/hour, the horse requires 50% more energy than camels. The energy cost of locomotion (ml O2/kg at 22 km/hour) was 85 in camels compared with 160 in horses.

THE LOWER ENERGY COST FOR LOCOMOTION IN CAMELS RELATES TO THE COMBINED EFFECTS OF

- musculoskeletal function. Unlike cattle, camels have less fusion in the bones of the lower leg which allows them to move faster and more efficiently
- camels pace rather than gallop,
- low oxygen requirement. The maximal capacity of an animal to exercise aerobically is determined by oxygen consumption. VO2max is a measure of aerobic capacity, and is the volume of oxygen consumed during a minute of exercise. The aerobic capacity of camels (VO2max) was 53ml/kg/min at 30km/hour, which is significantly lower than that in thoroughbreds (100-160 ml/kg/min). The VO2max in cattle was 55-60 ml/kg/min. This reflects the very low oxygen requirement of camels for rest and exercise in comparison with horses

- higher lactate threshold. Camels can perform at high levels of intensity before lactate accumulates in the blood. It is considered that 4mM/L of serum lactate represents the anaerobic threshold in many species, ie the level of exercise above which aerobic exercise is supplemented by anaerobic exercise. The Lactate Threshold is the level of exercise beyond which the rate of lactate production from pyruvate exceeds the rate that pyruvate is used in aerobic energy metabolism in the mitochondria. The accumulation of lactate causes a block to energy production, and rapid muscle fatigue.

Camels will perform at up to 95% of VO2max before plasma lactate levels reach 4 mM/L, whereas this occurs in other species at 50-60% VO2max.. Elite horses, have lactate thresholds at or above 80% of VO2max. Camels can achieve this normally.

- At rest, the racing camel depends on lipid combustion to provide energy substrates. At low, submaximal speeds, carbohydrates are the dominant fuels, and there is a good balance between lactate metabolism and accumulation, because lactate does not accumulate until close to VO2max. Camel has extraordinarily high Krebbs cycle activity.

ENERGY METABOLISM

- Energy systems to provide energy for exercise
- Camels have a continual energy demand for maintenance and muscular performance. The form of energy in the muscle cell is adenosine triphosphate (ATP), and is the only energy source that can be used for muscular contraction. ATP is stored only to a limited extent in cells, and so ATP must be produced from other sources by chemical reactions . These sources of ATP include creatinine phosphate (which is converted directly to ATP) or feed sources (glucose, fats and proteins). ATP is supplied from the feed sources either by aerobic or anaerobic chemical pathways

- **Aerobic metabolism**
- **Aerobic metabolism is the use of oxygen to burn fuels (carbohydrate/fat) to supply ATP. This energy source yields high levels of ATP, but more slowly than the anaerobic system. This is the main energy source for endurance and low intensity exercise.**

- **Anaerobic metabolism**
- Anaerobic metabolism produces ATP very rapidly from glucose/ glycogen without the use of oxygen, and produces lactic acid. Lactic acid production of the muscle causes muscle fatigue. The rate of energy production is very high, and is the main energy source for explosive or sprint energy. The total contribution of the anaerobic system even under intense exercise is only 30%.
- Camels have an inherent capacity for anaerobic activity, and can clear lactate efficiently. The challenge is to increase glucose supply to the racing camel, without causing starch overload, and metabolic disorders. ATP sources such gluconeogenic amino acids, and medium chain fatty acids provide an alternate to starch based diets.

- Racing camels have an energy requirement of 2 MJ ME/ km travelled, ie an additional 20 MJ ME for an average 10km race. For feeds with an energy density of less than 10, this represents an additional feed intake of over 2 kg/day, which is a 25% increase in feed intake. The challenge therefore is to increase energy intake without increasing the amount of bulky feed, and without causing rumen dysfunction by feeding excess grain.
- Camels, like horses have an increased energy demand for muscular function for racing, which requires supplementation of the basal diet with an additional energy source from hay or grain.

GLUCOSE METABOLISM

- The blood glucose concentrations (130 mg/100ml) in camels are much higher than in ruminants (63 mg/100ml) and horses (90 mg/100ml) (Table 1), despite having a ruminant pattern of digestion which does not yield glucose for absorption.
- Although the glucose turnover rate is similar between camels and sheep (1.7 mg/min/kg bodyweight), when corrected for metabolic body size, camels have a glucose entry rate at least 60% greater than in sheep (4.3 and 2.6 mg/min/kg Bwt0.75).
- Camels have higher concentrations of the hormone glucagon compared with other mammals. The role of glucagon is to increase glucose output from the liver by increasing glycogenolysis (glucose from glycogen) and gluconeogenesis (glucose from amino acids) (Abdel Fattah, 1999).
- Camels therefore produce greater quantities of glucose compared with true ruminants, presumably as a survival mechanism. This also allows camels to produce higher levels of ATP from glucose for muscular function, and highlights the importance of feeds that can provide glucose or glucose forming substrates (gluconeogenic amino acids).

OIL

- Racing camels require an additional 2.0 MJ ME /km travelled, and therefore require an additional energy dense feed in addition to roughage. It has been suggested that inclusion of energy dense oils in racing camel diets may be beneficial. Up to 200g/day of protected fat has been fed without causing metabolic and nutritional disorders. Little research has been conducted however into the type and nature of dietary oil.
- Oils are useful feed supplements to provide slow release energy for endurance exercise, or long distance races. It is believed that camels don't begin to metabolise fat stores until after a period of 1.5 hrs of submaximal exercise (20km) suggesting that energy provided by fats is only of importance for endurance races. It is further suggested that oils are of no value for short races (8-10km) because of the slow metabolism of oils.

ENERGY USED BY CAMELS

1. STORED
2. DEMANDED
3. PRODUCED

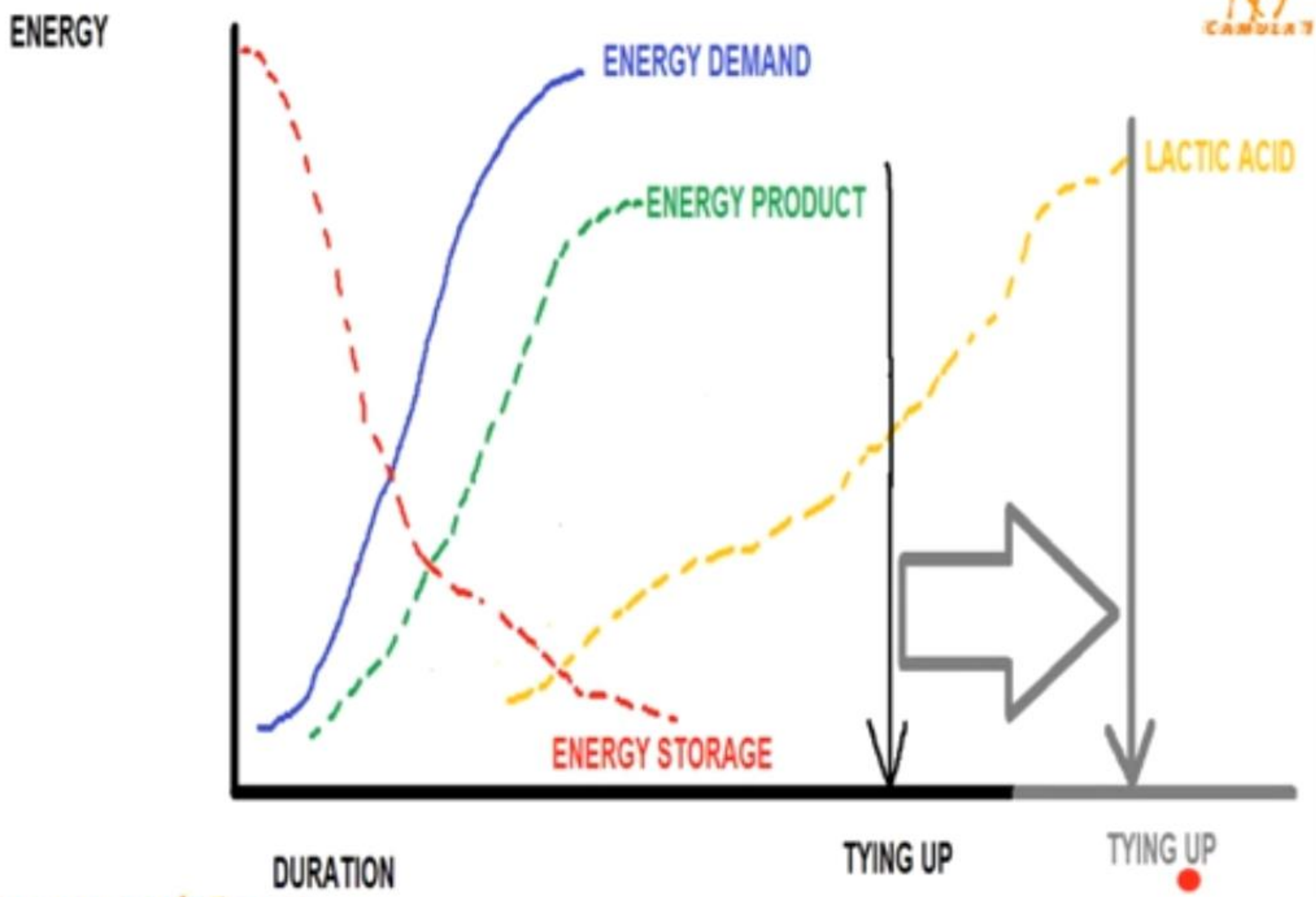
AEROBIC AND ANAEROBIC PATHWAY OF GLUCOSE METABOLISM IN MUSCLE

1- INCREASE STORAGE

INCREASE GLYCOGEN + FATTY ACIDS IN MUSCLE

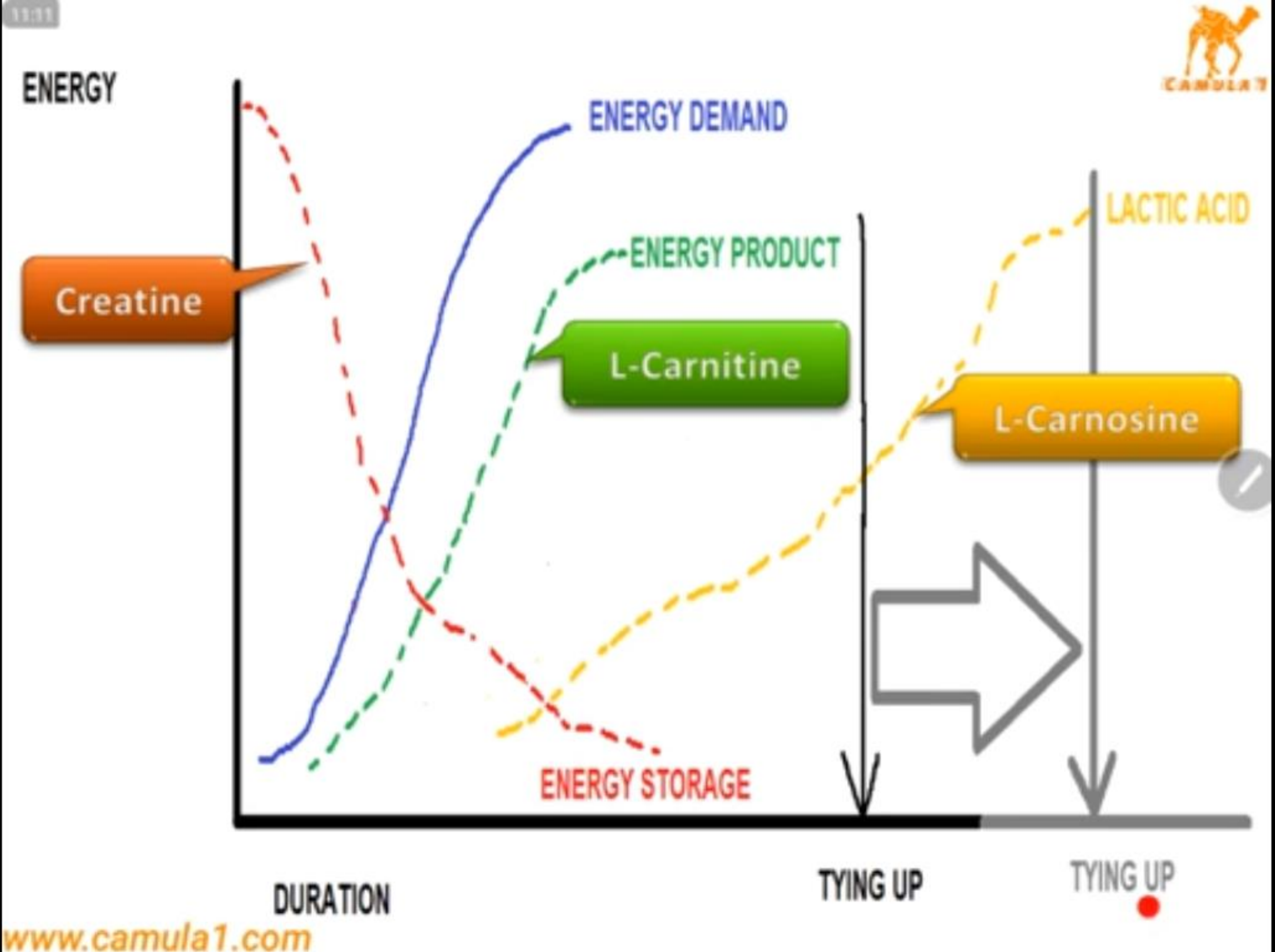
2- INCREASE PRODUCED

INCREASE AMOUNT AND DECREASE TIME



ENERGY
ENERGY DEMAND
ENERGY PRODUCT
LACTIC ACID
ENERGY STORAGE
DURATION
TYING UP
TYING UP

- Additives used
- 1- creatine and DMG TMG (trimethyle glycine)
- L carnitine
- L carnosine (histidine +B-alanine)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- Nutritional deficiency diseases

VITAMIN A

- three forms (congenital, postnatal and subclinical) of hypovitaminosis A were observed clinically in camels.
- **Congenital form: Calves suffering from congenital deficiency of vitamin A are born blind or showing multiple congenital deformities likes hydrocephalus or anophthalmos.**
- **Postnatal form: The symptoms are characterized clinically by loss of appetite, reduction in the growth rate, true xerophthalmia, (with thickening and clouding of the cornea) and discharge of thin serous mucoid from the eyes.**
- **Subclinical form: Mainly in adult camels, characterized by night blindness and loss of reproductive function in both males and females.**

VITAMIN D

- The appearance of one of the osteodystrophic diseases (Rickets and Osteomalacia) as well as loss of appetite and weakness

VITAMIN E

- Two forms of the deficiency were observed.
- **Acute form: The clinical form usually occurred in calves' is characterized by sudden death without showing any obvious symptoms.**
- **Subclinical form: Mainly in adult camels. This form is characterized by impaired fertility and a gradual reduction in muscular activity, especially in race camels.**

VITAMIN B1

The clinical findings showed variable signs including disorientation, aimless walking with a high stepping gait due to blindness, anorexia, opisthotonus or head retraction (star gazing), muscle tremor and convulsion followed by recumbency with paddling movement and death.

During the present study, it was noticed that thiamine deficiency in camels usually occurs in sporadic cases.

Vitamin B1 (Thiamine deficiency) is the disease of racing camels and higher rate of incidence occurred in camels with age range of 2-4 years.

SELENIUM

Poor racing performance, stiff gait, lethargy, anorexia, heart and respiratory disturbances and reduced fertility in adult camels are the main clinical findings selenium deficiency.

CALCIUM & PHOSPHORUS

the clinical symptoms of both deficiencies are usually appeared gradually, in the early stage of the disease, calves (one month-one year) shows stiff gait, difficult to move, increase in the size of the joints especially the fore limbs, lameness and sometimes arched back.

Later on and as the condition become more progress, calves shows abnormal curvature of the shift of the long bones with an abnormal increase in the depth and width of the epiphyseal plates of particularly the long bones. General weakness, emaciation and appearance of abnormal appetite are the main signs that are observed in adult camels.

COPPER

Clinical form: is usually a progress gradually and is mostly noticed in young calves (4-6 months) as characterized by ataxia and incoordination of the legs, particularly fore legs, during movement of the animal and softening of the bones specially the bones of the foot, followed by leg deformities and poor growth.

Subclinical: While in adult camels, they are often infected with subclinical form. The higher incidence of subclinical form showed no clinical signs with blood copper levels below 60 ug/dl. However, some cases showed variable signs including general weakness, low milk production, anaemia, temporary infertility, the hair coat is rough and depigmentation.

IODINE

In camels, both forms (clinical and subclinical) were diagnosed.

Young camels are usually prone to the clinical form more than adult camels. In this form, calves are either born with goitre or the disease appears in calves 1-2 months old. The characteristic findings are birth of stillborn or weakness in newborn calves with gross palpable enlargement of the thyroid gland.

Adult camels are usually showed subclinical form which manifested clinically by loss of libido in the male, failure to express estrus in the female, and high incidence of aborted, stillborn or weak calves.

IRON

During the present study, low serum iron (40 ug/100ml) was observed in association with ruminal lactic acidosis, hemorrhagic disease, sever mange, heavy tick infestation, diseases accompanied by fever and trypanosomiasis.

- **The proper attention to camel nutrition by following a systematic regular program to use balanced food supplements containing all the vitamins and minerals is expected to prevent nutritional deficiencies.**
- ** Provide green or dry ration rich in beta carotene and selenium, especially in the later stage of pregnancy.**
- ** Regular oral doses of copper oxide (4 grams) should be providing pregnant camels between the fifth and eight month of pregnancy. Also, 4 grams of copper oxide should be given to Hiran after birth and repeated every two months.**
- ** Dosing racing camels with Vitamin E and selenium supplement at least once per week.**
- ** Provide balanced diets of phosphorus and calcium in the late stage of pregnancy and after delivery.**

- Regular supplement of camel farms with mineral blocks.
- Carbohydrate rich feed, imbalanced ration, use of illegal medications or supplements and violent exercise and/or training are the most common risk factors for diseases associated with nutritional deficiency in camels.
- Early intravenous treatment with supplement of thiamine is considered as the most important method for the early diagnosis of the disease.
- Tincture of iodine should be applied on the flank skin of pregnant camels at least once every two weeks, especially during the last three months of pregnancy.

QUESTIONS?