

DISORDERS OF ENERGY METABOLISM

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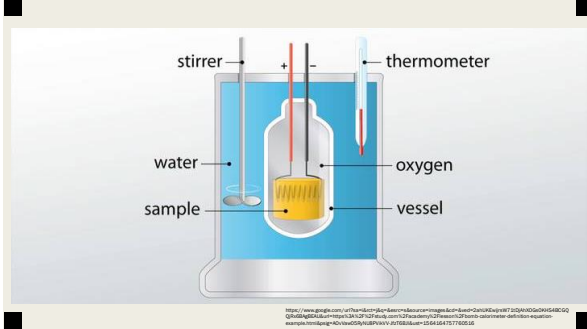
Review of:

- Ketosis
- Diabetes
- Metabolic Syndrome
- Calories and Longevity





Feed Energy

- Expressed as **calories** or **joules**
 - 1 calorie = amount of heat required to raise the temperature of 1g of water by 1°C
 - 1 kcal (kilocalorie) = 1000 calories
 - 1 calorie = 4,184 joules (J)
 - 1 kcal = 4,184 kilojoules (kJ)
- Bomb Calorimetry
 - Method by which caloric content of biological materials is determined
 - **Gross energy**

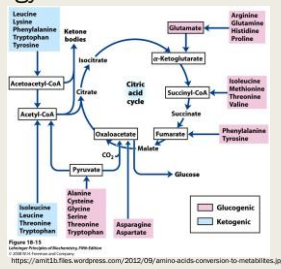


Utilizable Energy

- Metabolism trial must be conducted to account for various losses
- Digestible Energy (DE) = GE - fecal energy 
- Metabolizable Energy (ME) = DE - (Urinary + rumen gas losses) 
- Net energy (NE) = ME - Heat loss

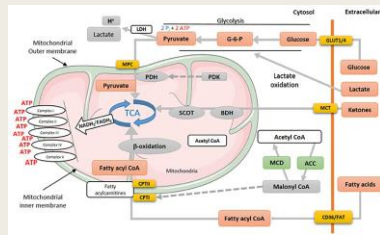
Substrates for Energy

- Amino acids
- Lipids
- Carbohydrates



Substrates for Energy

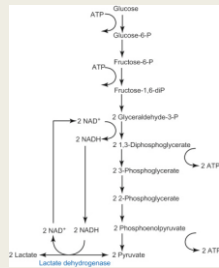
- Amino acids
- **Lipids**
- Carbohydrates



https://www.frontiersin.org/articles/180236/full/05-00068-HTML/image_m/10m-05-00068-g003.jpg

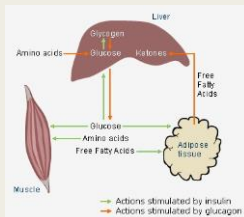
Substrates for Energy

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https://en.wikipedia.org/wiki/Glycolysis#/media/File:Glycolysis_Overview.png

Energy Storage



- TAG - 9kcal/g
- Glycogen - 4kcal/g
 - Stored in liver and muscle tissue
- Role of insulin and glucagon

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1565151/figure/F1.jpg>

Ketosis

- Excessive ketone bodies produced
- Occurs during starvation when body lipid is mobilized
- Species
 - Sheep: *twin lamb disease* or *pregnancy paralysis*
 - Cows: *ketosis*, *downer cow syndrome*
- Critical factor: insufficient glucose for brain metabolism



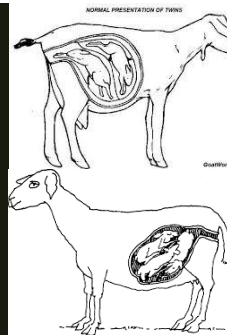
Ketosis

- In cows, occurs early lactation when in negative energy balance
- Inciting factors
 - *Inadequate post-parturient feed intake*
 - *High milk production*
 - *Mobilization of body lipid to sustain energy needs*
- Rarely fatal in cows
- Secondary ketosis



Ketosis

- Pregnancy disease in sheep
- Multiple fetuses decrease feed intake of ewe by reducing rumen volume





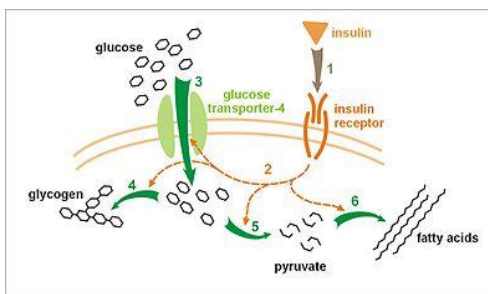
- Provide supply of energy
- Energy dense feeds – grains
- Deliver lambs



Diabetes

- Metabolic disorder characterized by elevated concentrations of blood glucose
- 4 major categories
 - Type 1 ★
 - Type 2
 - Gestational
 - Secondary



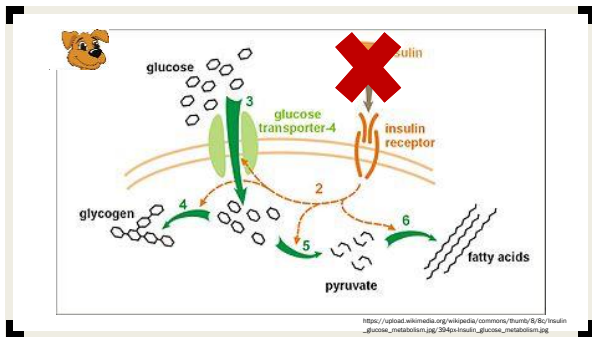


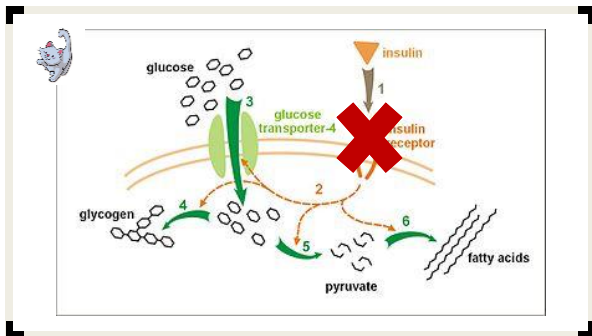
https://upload.wikimedia.org/wikipedia/commons/thumb/5/5b/Insulin-glucose_mechanism.jpg/250px-Insulin-glucose_mechanism.jpg

Diabetes



Type 1	Type 2
Autoimmune disorder	Insulin resistance
Antibodies	Cell receptors do not recognize
Lack of insulin production	Normal or above normal concentrations of insulin
Childhood	Middle aged and older adults
Dogs	Cats



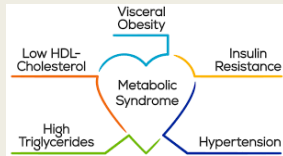


Diabetes - Treatment

- Insulin therapy
- Dietary management – avoid simple sugars
- Feeding management
- Weight loss



Metabolic Syndrome



- Impaired insulin sensitivity
- Hyperglycemia
- Elevated blood triacylglycerol (TAG)
- Abdominal obesity
- Hypertension

Equine Metabolic syndrome

- Obese
- Insulin resistance
- Chronic laminitis



Equine Metabolic Syndrome - Causes

- Increased cortisol secretion
- Association between obesity, insulin sensitivity and inflammatory cytokines (Vick et al., 2007)
 - *TNF alpha*
 - *Interleukins*
- Growing horses chronically adapted to high glycemic load diets – decreased insulin mediated glucose metabolism

Frank, 2011; Morgan et al., 2015

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Glycemic Index – Other species?



Rankovic et al., 2018; Rodiek et al., 2007; Harris and Geor, 2009

Calories and Longevity

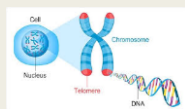
- Growing rats fed a severely restricted allotment of food had elongated lifespans (McCay et al., 1935)
- Calorie restriction extends median and maximal lifespan
- Purina life-time study



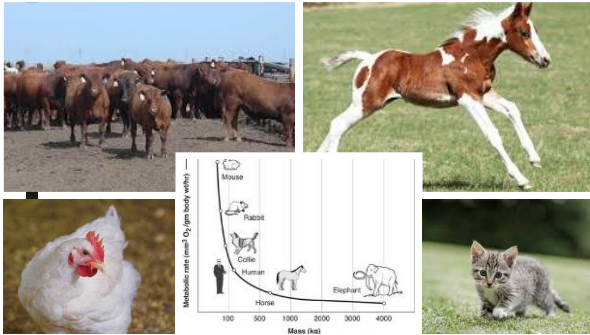
Kealy et al., 2002; McCay et al., 1935

Calories and Longevity

- Cellular metabolism
- Genetic control of the ageing process – “biological clock”
 - Tissue cells capable of a finite number of cell divisions
 - Critical length of telomere
- Ageing process slowed because of slower rate of cell division



O'Sullivan et al., 2010



References

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