How a Horse Uses Energy

Managing non-ruminant herbivores, i.e. horses:

- Will graze up to 18 hours a day, consuming 2.0-2.5% of body weight in dry forage/day. (20-25 lbs/1,000 lbs of body weight/day.)
- Whether turned out on pasture or fed free choice hay for 24 hours/day, horses will produce 25-30 gallons of saliva, which is one of the best buffers for the horse's digestive system and the most effective way to reduce the chance of ulcers and impaction colic.
- The horse's stomach continually produces acid, whether they are eating or not. While they only produce saliva when they chew, unlike a dog who merely thinks about food and salivates. Saliva is crucial to protect the upper part of the stomach and the pH of the remainder of their digestive tract.
- Best to always keep the digestive tract full of ingesta, mixed with saliva (that contains a high percentage of sodium bicarbonate), to protect stomach and like a sausage casing, will not twist when full.
- Eating time - hay vs grain…horses spend 4X longer chewing hay & producing more saliva…ex. 1 lb. grain mixture takes 5 min to eat, while 1 lb. of hay would take about 20 to 30 minutes)
- Select the right horse for your desired sport… i.e. genetics
    - Select nutrients to complement your horse's 'muscle fiber type' i.e genetics.
        I. **Type I uses fat and fiber**; **Type II-B uses starch**; **Type II-A can be 'trained' to use Fat, Fiber or Starch**, but it takes a 'minimum' of 3 weeks for the muscles to begin making this change.

Breed or Type **Type I** (*slow twitch high oxidative*) (%) **Type II A** (*fast twitch high oxidative*) (%) **Type II B** (*fast twitch low oxidative*) (%)		
Type I	**Type II A**	**Type II B**
Endurance horse		
40	**55**	**5**
Sprinter		
6	**54**	**40**
Pony		
20	**40**	**40**
Heavy foxhunter		
30	**35**	**35**
Standardbred racehorse		
20	**50**	**30**
Arabian		
20	**50**	**30**
Thoroughbred racehorse		
12	**53**	**35**
Quarter Horse		
8	**50**	**42**
Human middle-distance runner		
60	**35**	**5**

Equine Muscle Fiber Types and Their Concentrations In Various Types Of Equine Athletes taken from Lon Lewis's *Feeding and Care of the Horse*, 2nd ed. 1996.

- **Let's look at how a performance horse changes ingredients into fuel:**
    1) **Aerobic Metabolism:** (more fuel efficient) 15 x more efficient…30 ATP per glucose molecule. Example: fat and fiber sources like flax oil, beet pulp, forages with a Relative Feed Value above 103, etc.
        a) Uses fat (triglycerides/glucose) to create ATP energy
           Uses fiber (VFA to glucose) to create ATP energy
            a. Both Fat and Fiber can spare muscle glycogen until it is needed with intense work. O2 is limiting factor here (keep your horses hydrated)
            b. For long work of low intensity…endurance, trail riding, as well as beginning training to Low Level training in: dressage, eventing and driving, needs fat and fiber (long, lean 'slow twitch' muscles)
    2) **Anaerobic Metabolism:** (less fuel efficient) 2 ATP per glucose molecule QUICK energy, but inefficient. Example: Cereal Grains (Higher amounts of NSC's found in oats, barley, wheat, corn, rice, etc.)
        a) Uses muscle glycogen as fuel for 'Intense Work'.
        b) Necessary when the HR is over 170 bpm, timber horses, racing (barrel and flat), Upper Level and FEI horses in: dressage, eventing, jumping, driving and combined training (short, bulky, fast twitch muscles)
            a. This is when extreme activity has taken place and the muscles can only use 'starch/glycogen' as the energy/calorie source.
            b. Muscle glycogen is generated from NSC's (starches/ESC's in cereal grains) and a smaller amount from fermentation of high quality fibers in their hind-gut (VFA's).
            c. Lactic acid is one of the 'by-products' of the muscles working and can be a limiting factor in performance. When the muscles are 'not in adequate physical condition', the lactic acid will build up in the muscle, causing the horse to slow down. When the muscles are 'in good physical condition', the lactic acid is used as a source of fuel in their energy cycle.

- Why do we need Starch and ESC's (NSC)? During short bursts of strenuous activity, muscle cells use 'soluble' carbohydrates to supplement the ATP production from the SLOWER aerobic respiration (Fat & Fiber). In these situations, anaerobic metabolism may occur in the cells even before the O2 levels are depleted, i.e. sprinting and intense workouts…not in even paced events.
- Usually, the aerobic metabolism takes place and then when cellular oxygen is depleted, it switches to muscle glycogen using 'cereal grains' for fuel, i.e. glycogen.
- The better hydrated the horse, the longer they can stay in aerobic work before switching to anaerobic. They will use fat and fiber to make ATP efficiently and then kick it into overdrive when oxygen runs out. The muscles will use glycogen to produce ATP energy quickly. If too much lactic acid builds up in the muscle, the feedback will inhibit further intense work. When a horse gets into this state, the muscles will tier and become sore the next day!!

- The following 2 charts are excellent examples of how fat and fiber can be 'glycogen sparing' in the diets of 'intensely' trained and conditioned race horses.

    I. If the horses diet consists of fat and fiber and not enough NSC's (Starch plus ESC), the horse will 'run out of gas' and not be able to finish their performance at the same high level. At this level of competition, we recommend a minimum of 25% of the total 'energy/calories' come from non-structure carbohydrates (NSC). This formula is completed in the 'excel worksheet' titled 'Managing Horses with Metabolic Issues'. We use the formula recommended by Dr. Stephanie Valberg, for horses with 'special needs', but add at least 25% of the total calories to come from Starch and ESC's for intensely trained horses, i.e. when their heart rates exceed 170 beats per minute.

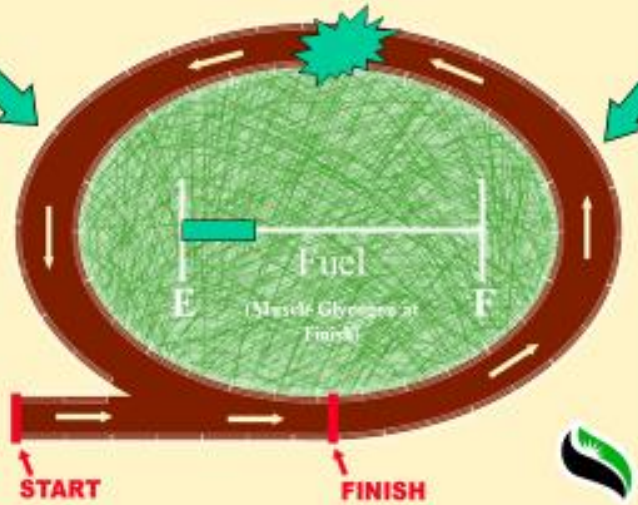
OXYGEN DEBT - Aerobic metabolism ends. Horse begins metabolizing muscle glycogen.

NO FAT

WITHOUT ADDED FAT

Stage 2

- Metabolism is mostly anaerobic.
- Muscle glycogen is main energy source..
- Rapid buildup of lactate.
- Muscles low in glycogen lose power.



Stage 1

- Metabolism is both aerobic & anaerobic.
- Glycogen, sugars, starches, and fatty acids are metabolized.
- Slow buildup of lactate.

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OXYGEN DEBT - Aerobic metabolism ends. Horse begins metabolizing muscle glycogen.

FAT

WITH ADDED FAT

Stage 2

- Metabolism is mostly anaerobic.
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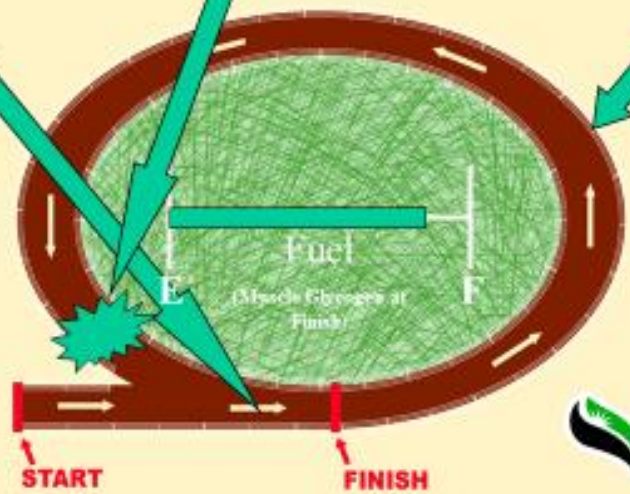
- Muscles low in glycogen lose power.



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