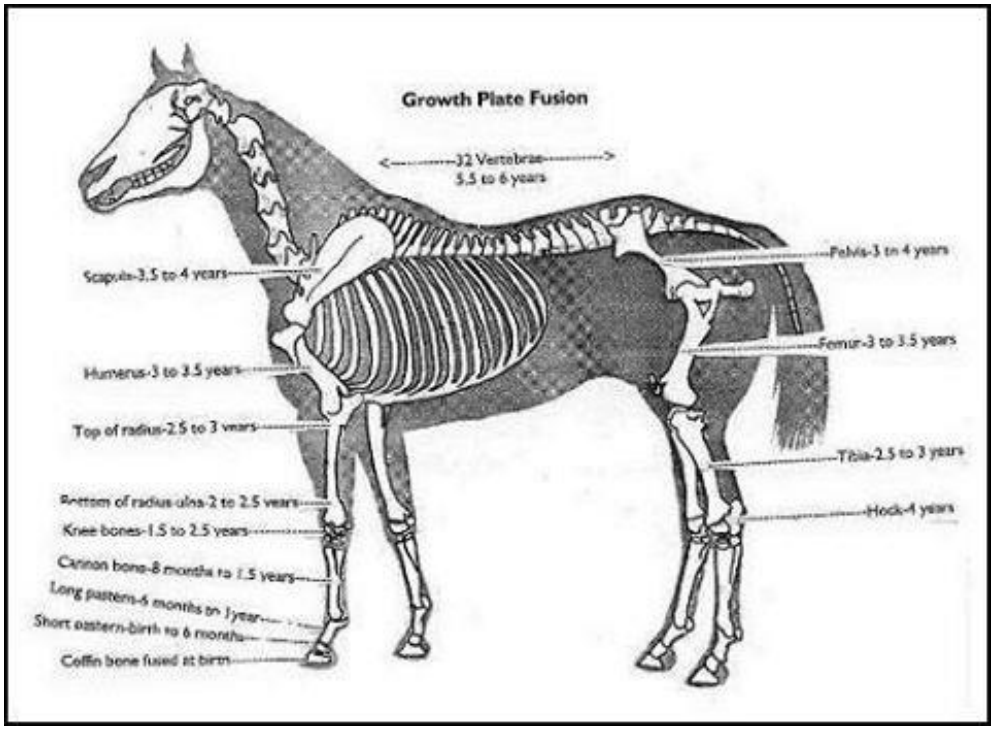
Performance Nutrition: Providing the Management Tools to Support the Performance Horse

Helping You Make the Best Management and Nutrition Decisions

Don Kapper: Retired, Director of Equine Nutrition of: Progressive Nutrition and Buckeye Nutrition
Board Member: The American Hanoverian Society



About Maturity and Growth Plates

By Dr. Deb Bennett

Owners and trainers need to realize there's a definite, easy-to-remember schedule of bone fusion. Make a decision when to ride the horse based on that rather than on the external appearance of the horse.

For there are some breeds of horse--the Quarter Horse is the premier among these--which have been bred in such a manner as to LOOK mature LONG before they actually ARE. This puts these horses in jeopardy from people who are either ignorant of the closure schedule, or more interested in their own schedule (racing, jumping, futurities or other competitions) than they are in the welfare of the animal.

The process of fusion goes from the bottom up. In other words, the lower down toward

the hooves, the earlier the growth plates will fuse--the higher up toward the animal's back you look, the later. The growth plate at the top of the coffin bone, in the hoof, is fused at birth. What this means is that the coffin bones get no TALLER after birth (they get much larger around, though, by another mechanism). That's the first one. In order after that:
2. Short pastern - top & bottom between birth and 6 mos.
3. Long pastern - top & bottom between 6 mos. and 1 yr.
4. Cannon bone - top & bottom between 8 mos. and 1.5 yrs.
5. Small bones of knee - top & bottom on each, between 1.5 and 2.5 yrs.
6. Bottom of radius-ulna - between 2 and 2.5 yrs.
7. Weight-bearing portion of glenoid notch at top of radius - between 2.5 and 3 yrs.
8. Humerus - top & bottom, between 3 and 3.5 yrs.
9. Scapula - glenoid or bottom (weight-bearing) portion - between 3.5 and 4 yrs.
10. Hindlimb - lower portions same as forelimb
11. HOCK - this joint is "late" for as low down as it is; growth plates on the tibial & fibular tarsals don't fuse until the animal is 4 yrs old! So
the hocks are a known a "weak point". Even the 18th-century literature warns against driving young horses in plow or other deep or sticky footing, or jumping them up into a heavy load, for danger of spraining their hocks.
12. Tibia - top & bottom, between 2.5 and 3 yrs.
13. Femur - bottom, between 3 and 3.5 yrs.; neck, between 3.5 and 4 yrs.; major and 3rd trochanters, between 3 and 3.5 yrs.
14. Pelvis - growth plates on the points of hip, peak of croup (tubera sacrale), and points of buttock (tuber ischii), between 3 and 4 yrs.
And what do you think is last? The vertebral column (spine) of course. A normal horse has 32 vertebrae between the back of the skull and the root of the dock, and there are several growth plates on each one, the most important of which is the one capping the centrum.

The spine does not fuse until the horse is at least 5-1/2 years old. This figure applies to all horses, small scrubby, range raised horses to huge Warm Bloods. The taller your horse and the longer its neck, the later full fusion occurs. For a male (is this a surprise?) you add six months. So, for example, a 17-hand TB or Saddlebred or WB gelding may not be fully mature until his 8th year. Something that owners of such individuals have often told me that they "suspected."

The lateness of vertebral "closure" is most significant for two reasons.
One: in no limb are there 32 growth plates!
Two: The growth plates in the limbs are (more or less) oriented perpendicular (up and down) to the stress of the load passing through them, while those of the vertebral chain are oriented parallel (horizontal) to weight placed upon the horse's back.
Bottom line: you can sprain a horse's back (i.e., displace the vertebral growth plates) a lot more easily than you can sprain those located in the limbs.

And here's another little fact: within the chain of vertebrae, the last to fully "close" are

those at the base of the animal's neck--that's why the long-necked individual may go past 6 yrs. to achieve full maturity. So you also have to be careful--very careful--not to yank the neck around on your young horse, or get him in any situation where he strains his neck."

ABOUT DR. DEB: Deb Bennett, Ph.D., is a 1984 graduate of the University of Kansas, and until 1992 was with the Smithsonian Institution. Internationally known for her scientific conformation analysis, "Dr. Deb" has made a career out of conveying a kind of "X-ray vision" for bone structure to breeders and buyers. Her background in biomechanics helps her explain how conformation relates to performance ability. You can Google her to learn more.

Changing Carbohydrate Evaluations in Horse Diets*

Forage Recommendations for Horses Based on its 'Structured' and 'Non-Structured' Carbohydrates

I.) Structured Carbohydrates (SC) in Forages

The Hay Marketing Task Force of the American Forage and Grassland Council has endorsed the use of **RELATIVE FEED VALUE (RFV)** as a measure of forage quality and its fiber digestibility/fermentability:

What is forage RFV? All forage laboratories can provide you with a RFV number for each forage analyzed. There is a direct relationship of the RFV, to the digestibility and fermentability of the forage. The higher the number, the higher the fiber digestibility and the availability of the nutrients found inside the plant cells, and vice-versa. These fibers are 'broken down by microbes' in the large intestine of the horses and absorbed.

a) **ADF (Acid Detergent Fiber)** The less digestible carbohydrates (fibers) are found with-in the plant cell walls, and include: Cellulose and Lignin.

a. The lower the ADF, the more palatable the forage and its the digestibility, and visa-versa.

1) **NDF (Neutral Detergent Fiber)** The total plant cell wall carbohydrates, includes the: ADF plus Hemi-cellulose. Often considered an indicator of forage quality and intake potential per day.

a. The lower the NDF, the easier it is to digest and the greater the potential intake/day, and vise-versa. Also, the softer the hay when squeezed, is the best indicator of plant maturity and the easier it is to digest.

Table 1: Lists the different quality standards for horses: Forage Grade and Description, along with their corresponding percentages of ADF & NDF and their resulting Relative Feed Values (RFV)

Forage Grade	(Description)	If the ADF is:	If the NDF: =	Then the RFV is:
Prime	(Excellent)	Under 30	Under 40	Over 151
1	(Premium)	31-35	41-46	150-125
2	(Good)	36-40	47-53	124-103
3	(Utility)	41-42	54-60	102- 87
4		43-45	61-65	86- 75
5	(Reject)	Over 46	Over 66	Under 74

This table is from the veterinary textbook, *Equine Internal Medicine*, 2nd Edition, 'Applied Nutrition' Chapter, Donald R Kapper, PAS, guest author and Stephen M Reed, DVM, editor.

'Good Quality' has a Forage Grade of 2, or has a RFV between 124 & 103. If the **RFV is below 102**, additional nutrients may need to be fed per day, due to the lower nutrient percentages and availability in that forage. If the **NDF is over 66** **or** the **RFV is below 74**, we do not recommend feeding, due to the increased risk of impaction colic.

2.) Non-Structured Carbohydrates (NSC) in Forages

All horse owners/managers/trainers need to understand the different carbohydrate components and how to optimally utilize them, when setting up their feeding programs. Why? Because all carbohydrates are not created equal!

NSC (Non-Structural Carbohydrates): use to be describe as easily digestible carbohydrate components of feed ingredients. Originally explained as: starch + sugar + fructans, but recently divided into: ESC + starch and WSC + starch. They are 'broken down by enzymes' in the foregut of the horse and absorbed. Therefore, it is important to switch forages slower than grain mixtures.

- **ESC (Ethanol-Soluble Carbohydrates):** are carbohydrates that dissolve in ethanol solution; these carbohydrates are primarily digested in the small intestine. High ESC generally means this feed will generate a high glycemic (blood sugar) response. Beneficial to hard-working horses that need more 'short term' energy, but not for horses that are sensitive to blood sugar changes (i.e. insulin-resistant horses, etc.).
- **WSC (Water-Soluble Carbohydrates):** are soluble carbohydrates that can be extracted with water, including: simple sugars and fructans (large sugars). High WSC might

indicate high fructan levels in 'cool season' grasses, or high simple sugars in 'warm season' grasses and 'legumes'. This could be beneficial to horses needing extra endurance, but not for horses with, or predisposed to, laminitis.

- **Fructans:** are carbohydrates made up of many large molecules (complex sugars); and are only digested by fermentation, in the hind gut. They are found in 'cool season' grasses (Ky Bluegrass, Timothy, Orchardgrass, etc), and are not found in Legumes (Alfalfa, Clover, Peanut Hays, etc.), or in 'Warm Season' Grasses (Coastal Bermuda, Tifton, etc.)
- **Starch:** Large amounts are found in cereal grains (oats, corn, barley, rice, wheat, etc.) and are digested by enzymes in the small intestine, where they are broken down and absorbed as glucose (simple sugar). **Low starch content means** a small amount of glucose will be absorbed in the small intestine (low glycemic response). This is good for horses that can't handle large blood sugar changes (i.e., insulin-resistant horses). **High starch content means** a potential high glycemic response. Good for horses needing 'quick' energy (fuel for fast twitch muscles). **This is beneficial to all horses whose heart beat exceeds 170 bpm while training or competing.**

RECOMMEND: Feed Forage plus a Balancer, for horses with Insulin Resistance, Cushings, Equine Metabolic Syndrome, PSSM, or Laminitis, to keep the nonstructural carbohydrates below 15% in the total diet. Severely affected **Insulin Resistant (IR)** horses need to be kept **below 10% ESC + starch** in the total diet, while all **Laminitic, or horses prone to Laminitis,** should to be kept **below 12% WSC + starch**. If the hay NSC's are unknown or higher than recommended, 'soak' it in 'cold' water for 20 minutes, then let it drain for 10 minutes before feeding. This will remove about 30% of the nonstructural carbohydrates. Discard the water.

NOTE: Because all cereal grains and molasses are high (45% to 75%) in NSC or ESC + Starch, we do not recommend feeding any horse feed that contains cereal grains or molasses in its ingredient list to horses diagnosed with: IR, Laminitic, PSSM, Cushings or Equine Metabolic Syndrome. If extra calories are needed, use vegetable oil and a fermentable fiber as their calorie sources, not cereal grain or molassses. The three 'best' sources of fermentable fibers are: beet pulp, soybean hulls and alfalfa.

BE AWARE – All Fibers are NOT created equal!!

There are 'indigestible' sources of fiber available today that are very inexpensive and are being used in feeds to keep the price per bag down. They include: Oats Hulls (Oat mill feed), Rice Hulls and Peanut Hulls. They all contain a high percentage of lignin, which is not digestible by the horse. Read the ingredient lists to see if they are in it. They can also be called 'Plant By-Products' or 'Processed Grain By-Products', if 'group terminology' is used in the ingredient list.

How Much to Feed Horses per Day?

1) **Hay:** Every mature horse with a BCS <6, should be fed a minimum of 2% of their body weight per day in hay. That would equal 20 lbs. of hay per 1,000 lbs of body weight.

1) The amount of protein, minerals and vitamins needed per day will depend on the individual horses' size, and: a) age, b) reproductive status, or c) training level. These nutrients are included in all 'Balancers' and 'Horse Feeds'. To help you determine how much to feed per day, read the 'Feeding Directions' found on each bag. The 'minimum' amounts to be fed per day are listed there, according to their individual body weight.

2) The number of calories that need to be fed per day to maintain desired body weight, will depend on each horses: a) metabolic rate (metabolism), b) the calories per pound (the digestibility/fermentability, i.e. RFV) in their forage (hay and pasture), c) their exercise level per day, and d) their current Body Condition Score (BCS). Extra calories can be added, when needed, with: a) 'vegetable oil', or b) Oats, Beet Pulp or Hay Cubes, when feeding Balancers, or c) a Premium line of feed, formulated to meet your horses' physiological needs, i.e. be sure to follow their Feeding Directions listed on each bag/tag.

* Information from Richard Ten Eyck is the Oregon Department of Agriculture Feed Specialist and chair of the Carbohydrate Working Group of the Feed Labeling Committee for the Association of Animal Feed Control Officials (AAFCO) contributed to this article.

KEY:

- **All Forages (grasses and legumes):** including Hay (dried), Pasture (fresh) and Haylage (Preserved).
- **'Cool Season' grasses**: Timothy, Bluegrass, Orchard-grass, Fescue, Brome, Prairie Hay, etc.
- **'Warm Season' grasses**: Bahia, Tiftin-44, Coastal Bermuda, etc.
- **Legumes**: Alfalfa, Clover, Lespedeza, Peanut Hay, etc.
- ****SC (Structured Carbohydrates)**: are the 'fibrous portions' of the plants (forage) cell walls. The different 'types' of fiber will be listed in ADF and NDF percentages.
- *****NSC (Non-Structured Carbohydrates):** Currently listed as: Starch + Sugar for all grains and forages. When laboratories become uniform the forage analysis will differentiate between the 'types' of sugars and be listed as: Starch + WSC, **and** Starch + ESC. The cereal grains can be listed as 'Starch + Sugar' or 'Starch + ESC'.
- **Cereal Grains:** Oat, Corn, Wheat, Barley, Rice, etc.
- **Protein Grains:** Soybean, Cottonseed, Distillers Grains, Linseed, etc.

- **Glycemic Response:** will vary according to the individual horses: size, pounds of feed fed at one time, daily activity level, etc. One horses 'glycemic response' may not be the same as another horses' response, due to these variables.

- **New 'Horse Hay' names for horse owners to learn & buy on, based on quality:**

  Description = Grade = RFV

  Premium .....1 ..... > 125

  Good ..... 2 ..... 103 to 124

  Utility ..... 3 & 4 ... 75 to 102

  Reject ..... 5 ..... < 74

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.
        - **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.

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.

    - 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'.

   a) 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!!

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). *Article provided by Cargill Animal Nutrition

Equine Electrolyte Use and Gastric Emptying (AAEP 2011)

by: **Nancy S. Loving, DVM**

A horse's prolonged sweating during athletic activity or travel means a need for fluid and electrolyte replacement, and horse owners commonly turn to electrolyte products for this purpose. A team of equine researchers examined one electrolyte supplement's (ES) effect on fluid replacement and performance, and Michael Lindinger, PhD, associate professor at the University of Guelph, presented the results at the 2011 American Association of Equine Practitioners convention, held Nov. 18-22 in San Antonio, Texas,

Dehydration significantly impacts the cardiovascular system, exercise performance, and recovery, as well as affecting thermoregulation (the horse's ability to cool its body during exercise). Dehydration also affects mental acuity. Thus, effectively replacing fluids lost through sweating is of utmost importance in maintaining peak levels of health and performance. Lindinger pointed out that horse sweat contains significant concentrations of ions, such as sodium, potassium, chloride, calcium, and magnesium and these are sustained during exercise.

Keeping this information in mind, he and colleagues tested an oral electrolyte supplement specifically designed with proportions of electrolyte content to replace ion and fluid losses in sweat ("Most supplements have seemingly random proportions of electrolytes; when this one was developed it was the first to have 'appropriate' proportions," Lindinger noted). Electrolytes marked with radioactive labels were administered through a nasogastric tube. In the first phase of the study, Lindinger examined how quickly electrolyte-supplemented resting horses cleared the supplement from the stomach (gastric emptying rate) by measuring disappearance of radioactivity from the abdominal regions using a gamma camera. Radioactivity from the electrolytes gradually diminished such that by the end of two hours, 82% of ES had emptied from the stomach.

The second phase of the study involved analyzing intestinal electrolyte absorption in horses at rest, and then exercising the horse to see if they performed better after receiving 3 litres of ES. They measured how fast sodium and potassium in the supplement appeared in blood plasma when the horses were resting. Lindinger reported that there was a more rapid uptake of potassium and sodium from the blood in ES-treated horses and that the electrolytes appeared in blood within 10 minutes of being orally administered, with sodium levels maintained during exercise and into the post-exercise period.

When investigators administered 3 liters of ES 60 minutes prior to exercise, those horses were able to exercise (at a moderate trot, about 6 mph) for 17 minutes longer than the control horses (treated with only 1 liter of plain water or 1 liter of ES), who became fatigued sooner. Providing more fluid volume to the ES-treated horses also seemed to enable better thermoregulation; these horses sweated more than the control horses. To support this, Lindinger explained that radioactive sodium given with the ES one hour before exercise appeared in sweat within the first 10 minutes of exercise and sodium levels were maintained throughout the exercise period.

He explained that dextrose in the ES enhances the small intestine's uptake of water and sodium; while the dextrose elicits a glycemic response (glucose surges in the bloodstream), it is of a similar magnitude but shorter duration than what occurs with feeding. Most commercially available ES do not have dextrose, and this may slow absorption rate and impair recovery.

In summary, Lindinger noted, "An effective electrolyte supplement given prior to exercise serves to replace losses of ions and water and contributes to the ability of the supplemented horses to exercise for a longer duration."

"This is the first ES supplement to be tested for effectiveness (functionality) in horses," Lindinger concluded. "It is the first study to have measured gastric emptying of an ES in horses, and to measure electrolyte absorption in horses. It demonstrates that electrolyte supplementation provides water and electrolytes from the gastrointestinal tract to the rest of the body during the exercise period, and that this is helpful for improving performance (increased exercise duration)."

Comparison of the 'Recommended Allowance' of Nutrients in the Total Diet of Dressage Horses*

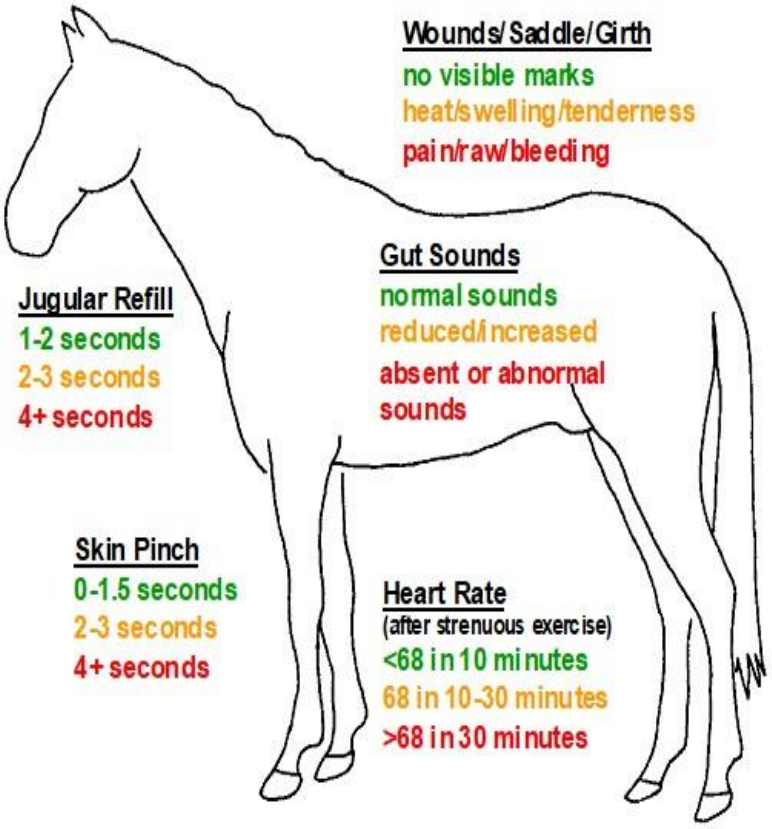
	Beginning Training		Low Level		Upper Level	
Nutrient	Until Mature / Mature		Until Mature / Mature		Until Mature / Mature	
Dry Matter	1.75-2.25	2.0-2.5	2.0-2.5	2.5-3.0	2.5-3.0	3.0-3.5
(% of Body Weight eaten/day)**						
Crude Protein, %	12.00	10.50	12.50	11.00	13.00	12.00
Calcium, %	.55	.40	.56	.42	.57	.44
Phosphorus, %	.36	.27	.37	.28	.38	.30
Potassium, %	.70	.70	.80	.80	.90	.90
Magnesium, %	.19	.18	.21	.20	.23	.22
Sodium, %	.16	.16	.18	.18	.20	.20
Iron, ppm	80	80	80	80	80	80
Copper, ppm	20	15	20	15	20	15
Zinc, ppm	60	55	60	55	60	55
Iodine, ppm	.30	.30	.30	.30	.30	.30
Selenium, ppm	.20	.20	.25	.25	.30	.30
Vitamin A, IU/lb	1,136	1,136	1,250	1,250	1,364	1,364
Vitamin E, IU/lb	36	36	36	36	36	36

- **Feed intake is determined by body capacity, physiological status, training level, relative feed value (RFV) of their forage and environmental temperature.
- Needed digestible energy (Mcal/day) is determined by body size, metabolic rate, growth rate, dry matter consumption and body condition score.
- Under average conditions, Salt (NaCl) is recommended between .35% to .50% in the total diet.

*This chart is derived from the Veterinary textbook, *Equine Internal Medicine,* 2nd Edition, Saunders & Co., 2004, Dr. Stephen Reed, editor, and the nutrients are listed on a dry matter basis.

The Horse Health Check

Go!
Caution!
Stop!



Eyes
bright, clear
glassy
fixed stare, sunken eye

Capillary Refill
0-1 seconds
2-3 seconds
4+ seconds

Mucous Membranes
pink, moist
pale, tacky
dry, purple, blue

Jugular Refill
1-2 seconds
2-3 seconds
4+ seconds

Skin Pinch
0-1.5 seconds
2-3 seconds
4+ seconds

Wounds/Saddle/Girth
no visible marks
heat/swelling/tenderness
pain/raw/bleeding

Gut Sounds
normal sounds
reduced/increased
absent or abnormal sounds

Heart Rate
(after strenuous exercise)
<68 in 10 minutes
68 in 10-30 minutes
>68 in 30 minutes

Muscles/Back
relaxed
tight or tender
very tight and tender

Rectal Temperature
<38.6°C pre-ride
<39.6°C during ride
39.5-40.4°C during ride
>40.5°C

Anal Tone
tight
slight loose
anus/penis relaxed

Respiratory Rate
relaxed/regular
panting/inversion
laboured/abnormal

Gait
no abnormal gait
slight gait change
consistent gait change or non-weight bearing

Attitude
bright/eating/drinking
depressed/lethargic
dull, not interested, absence of thirst, appetite, urination or defecation

Impulsion
free, willing, eager
stumble/short stride
stiffness/limping

Joints/Legs
no heat or swelling
heat/swelling
pain/raw/bleeding

Developed by Art King, DVM and Gayle Ecker for the www.equinescienceertificate.com

Both 'Horse Health Check' charts provided by Equine Guelph

The Horse Health Check

Directions: As you perform the Horse Health Check, record your observations on the following table by placing them in the appropriate category (green, yellow, red). Then record your results and important comments into your permanent stable records.

Parameter	Green	Yellow	Red	Comments
Eyes				
Capillary Refill				
Mucous Membranes				
Jugular Refill				
Skin Pinch				
Heart Rate				
Respiratory Rate				
Gut Sounds				
Wounds/Saddle/Girth				
Muscles/Back				
Rectal Temperature				
Anal Tone				
Joints/Legs				
Gait/Attitude/Impulsion				

These parameters can recorded on a resting horse to determine basic health and during or after exercise/competition The heart rate recovery refers to the heart rate after exercise. If any of the parameters are in the yellow zone, you should stop exercising your horse and check out the horse carefully and medical assistance may be necessary. If a parameter is in the red zone, you should consult with your veterinarian as soon as possible, as medical treatment may be necessary.

Nutrient Replacement for Optimum Performance*

Feeding a balanced diet then taking care of nutrient replacement after exercise is imperative to keep horses performing well at an upper level of performance. Don Kapper, shared his wealth of knowledge in equine nutrition and management in a recent visit to Canada. His talk at the University of Guelph discussed the importance of understanding gut function and nutrient absorption in order to understand the importance of nutrient replacement. Assessing body condition and topline evaluation scores were addressed as was the importance of providing good quality protein as a source of amino acids to avoid deficiencies that can negatively affect topline muscles, tendons, hooves and overall health. Last but not least, the role of electrolytes were discussed to avoid dehydration and keep athletes bouncing back into top form for the next day of competition.

GUT FUNCTION

"Horses are designed to be continuous grazers," explains Kapper. An 1100 pound horse will eat up to 18 hours a day consuming 2.0% to 2.5 % of their body weight per day in dry forage (22 to 28 lbs). While doing this, they will produce between 25 to 30 gallons of saliva, significantly reducing the chances of acid gut syndrome and improving nutrient absorption and over-all gut health. Horses only produce saliva when they chew, therefore, feeding forage ad-lib will increase the production of saliva – one of the best buffers for the horses' digestive system and the most effective way to reduce the chance of ulcers and impaction colic. Kapper brought home another benefit of continuous grazing by comparing the small intestine to sausage casing, "When it is full it is almost impossible to twist." Going without eating for several hours at a time can be a factor in colic resulting from a twisted intestine.

The stomach of the horse is relatively small and food only stays there for around 15 minutes, where acids begin to break it down. Moving through the next 90 foot of small intestine, it takes between 30 – 90 minutes, therefore, it moves at a rate of one to three feet per minute. Now you can understand why horses seem to be hungry all the time. The small intestine is the primary absorption sight of amino acids, fatty acids, major and trace minerals and vitamins. Therefore, the quality of the forage and feeds fed to a horse is more important than the quality of the forage and feeds fed to ruminants (cattle, goats and sheep, etc.). Ruminants will break down the crude proteins and form needed amino acids in their rumen, then it travels into the small intestine for absorption to occur. In horses, all food goes into their stomach, then small intestine, and then into their fermentation vat (cecum) to be broken down. Unfortunately, their fermentation vat is AFTER it passes through the small intestine, the primary absorption sight for many nutrients. That is why ruminants will get more nutrients out of the same forage than a horse. The quality of ingredients, or the availability of the nutrients fed to horses, are far more important than the quality fed to all ruminants.

The hind gut of the horse makes up 62% of their digestive system, which functions with a microbial population breaking down the fibre in forages by fermentation. Forage should make up 50% to 90% of a mature horses total diet. Therefore, knowledge of the nutrients in your forage is important so you can factor in what your horse may need in the way of concentrates and/or supplements to meet their needs every day. Kapper says, "If you don't know what nutrients are in your forage, you are guessing at what needs to be added. If you don't know what nutrients your horse needs every day – you are guessing at everything." He stressed, be an educated consumer, because economics come into play when you feed more than you need, but even more so, if your horse breaks down or becomes ill due to deficiencies in their diet. Kapper also reminded us that concentrates are never to exceed 50%, by weight, of the mature horse's total diet/day or exceed five pounds in one feeding/1,000 lbs of body weight. This is to avoid digestive upsets. Emphasis was put on good forage to meet the nutritional needs, optimize digestive health and improve the overall well-being of your horse. Ad-lib forage will also facilitate the best mental state.

VISUAL ASSESSMENT

Performance loss will occur before you see visual changes in your horse that may indicate an unbalanced diet. Visual changes that put up red flags include: loss of muscle over the topline, then a decline in hoof and hair quality and finally a loss of appetite and general unthrifty condition.

Checking the horses **Body Condition Score** on a monthly basis provides a good visual indicator for achieving optimal calorie intake with the ideal being between five and six on a scale of one to nine (Body Condition Scoring link http://www.equineguelph.ca/news/index.php?content=408). However, it is possible to have a horse in ideal body weight and still be deficient in nutrients required to build and support the muscles necessary to perform athletic tasks. Muscle soreness and changes in saddle fit are early indicators of a diminishing topline.

Topline Evaluation Scoring (TES) is graded from A to D, looking at the muscles on the horses back, loin and croup areas. Loss of muscle (muscle atrophy) is a solid indicator of an amino acid deficiency. Amino Acids are the building blocks that make up crude protein. Muscles contain 73% protein and the first limiting amino acid will determine how much 'all' of the other amino acids in their diet can be utilized. The easiest and first place to visualize a horse losing muscle mass, when a deficient amino acid diet is fed, is in their back area; the second is their loin; and third is their croup area.

TOPLINE GRADES with DEFINITIONS:

Grade A- The horse has 'ideal muscle development''. The back, loin and croup are full and well rounded. The topline muscles are well developed and blend smoothly into his ribs. The horse should be able to perform work requiring the use of all of these muscles.

Grade B- The 'back area is concave' (sunken) between the vertebrae and the top of the ribs:

1. You may have trouble fitting this horse with a saddle.

2. The muscle atrophy in this area may cause back soreness when worked.

3. Soreness can negatively impact their attitude and performance.

4. The loin muscles are well developed and are the same height as the spinal processes, i.e. you cannot see or palpate the spinal processes.

Grade C-The 'back and loin areas are both concave' (sunken) between the vertebrae and the ribs:

1. The 'spinal processes' in the loin area are higher than the muscles beside them and can easily be seen and palpated.

2. The atrophied muscles in the back and loin areas weaken the horse.

3. The length of time they are able to work and perform will be compromised, causing them to tire easily.

4. Muscling over the croup and hindquarters are well developed and rounded.

Grade D- All three areas of the topline, including the back, loin and croup areas are concave (sunken):

1. The croup appears pointed at the top since the vertebrae and hip bones are higher than the muscles in-between them.

2. In severely affected horses, the width of their stifle is narrower than the width of their point of hip.

3. This horse will lack the strength and stamina to perform and the muscle atrophy will cause discomfort when worked.

ROLE OF PROTEIN/AMINO ACIDS

All 10 essential amino acids need to be provided to horses on a daily basis: arginine, histidine, isoleucine, leucine, lysine (involved in growth and development), methionine (for hoof and hair quality), phenylalanine, threonine (involved in tissue repair), tryptophan, and valine. There are also 12 non-essential amino acids that horses can create themselves in adequate amounts. In order for crude protein to be synthesized, all the 'essential' amino acids must be present in adequate amounts. If one amino acid runs out, it 'limits' protein synthesis for the rest of the amino acids.

If you are feeding a grass hay, your first limiting amino acid is going to be Lysine. For alfalfa, the first limiting amino acid could be threonine or tryptophan. Knowing what 'type of forage' you are feeding is key to knowing what supplements you need to choose to complement your horse's diet.

During the process of conditioning horses, muscles are torn down during exercise and need additional branch-chain amino acids (leucine, isoleucine and valine) replenished to repair and rebuild those muscles faster. Kapper draws the parallel of weight trainers reaching for their whey protein shake after a work-out. A horse can benefit greatly from having 4 – 10 ounces of branch-chain amino acids replaced within 45 minutes of a workout. Whey is the best quality protein (amino acid) source, followed by soybean. Research has also shown that a lack of amino acids in the diet can affect the utilization of minerals in the diet, potentially causing skeletal and soft tissue problems.

To get an idea of their importance - take a look at the amino acid content in the following structures:

Hair and hoof = 95%

Muscle = 73%

Tendon = 93%

Bone = 30%

Skin = 90%

A shortage of 'one' essential amino acid will affect the quality and strength of all of the above. The first one you will 'see' is the one with the fastest turn-over.

What the Hooves Can Tell You about the Diet

THE ORDER OF NUTRIENTS FOUND INSIDE THE HORSES HOOF:

1. Protein/Amino Acids = 95 %

2. Fat/Oils = 3 %

3. Sulfur

4. Calcium

5. Zinc

6. Copper 7. Selenium

8. Carotene (Vitamin A)

9. Alpha-Tocopherol (Vitamin E)

10. Biotin (Recommend 15 mg/day/1,000 lb of body weight, for "sand" cracks in hooves)

When 98% of the hoof is made up of the top two nutrients, begin working with those and work your way down the list for a systematic way to address hoof quality problems that may be nutrition related. Too many times we hear about individuals beginning with Number 10 and work their way up the list.

Here are a few examples to help you begin 'problem solving': Slow growth can result from inadequate amino acids, while poor expansion and contraction, with cracking of the hoof wall, can result from inadequate oils in the hoof. A poor quality lamina (white line) can result from a low 'sulfur' containing amino acid diet, i.e. Methionine & Cysteine. In a calcium deficient diet the middle of the hoof wall can break down and crumble. Sand cracks in the outer service of the hoof wall can be an indicator of a lack of Biotin.

CALORIE SOURCES TO FUEL MUSCLE FUNCTION

Choosing the right horse for the work you want to do is important right off the bat (genetics). Then you need to choose the right fuel for your horse's muscles to perform up to their genetic potential.

Carbohydrates and Fats and Oils

Soluble carbohydrates are the starches and sugars needed to provide the 'glycogen' for intense work. Kapper uses a quarter horse sprinter fueling its bulky 'fast twitch' muscles as an example. Glycogen produced from these carbohydrates are utilized when their heart rate exceeds 170 beats/minute, in **anaerobic work**. "The heart rate is the key to knowing what kind of fuel you should to be using," says Kapper. Soluble carbohydrates are highest in cereal grain: oats, corn, barley, wheat...

Fats and Oils - Kapper says the Arabian is a good example of a breed using long, lean 'slow twitch' muscles that burn fat rather than glycogen for fuel. Soybean, flax and fish oils are high in Omega 3's which have anti-inflammatory responses, as opposed to corn oil and sunflower oil which are high in Omega 6's which have pro-inflammatory responses. Vegetable oils can provide slow, long term energy needed for low to moderate intensity, **aerobic work.** Oils containing higher levels of Omega 3's are recommended for this kind of work.

Kapper then went on to explain that a portion of the muscles of the Thoroughbred and Warmblood can be trained to be 'fast or slow-twitch', depending on what 'fuel' you are feeding.

Forage Digestibility

Of course, it is important that your horse is able to get the most out of the bulk of its diet. Soft hay is more desirable for the performance horse because its nutrients will be higher and is easier to digest. Over mature hay is cut later, will have grown taller and have larger, courser stems. This hay will be higher in lignin, which makes it less palatable and lower in digestibility, i.e. quality.

ROLE OF ELECTROLYTES

Given correctly, the use of performance electrolytes can delay the onset of fatigue by over 22%. They can also reduce muscle cramping and improve the horse's ability to bounce back and perform at the same high level the next day. The amount of sweat produced in a workout will determine the amount of electrolytes which require replacing. The demands are highest during hot and humid weather. The heat stress index chart is an important calculation when determining the risk of dehydration. (link: http://www.equineguelph.ca/news/index.php?content=419)

When correctly formulated, electrolytes will replace the ions lost in sweat. For performance purposes – the electrolyte should specify it is a "performance" electrolyte on the label. The ingredient dextrose should be present because it is essential to improve the absorption rate of all the ions. The amounts of sodium, potassium and chloride levels are usually provided in the labels ingredient list. Adding the amount of sodium and potassium together should come close to equaling the amount of chloride in the formula. When you compare the amount of these three ions, you will see that not all electrolytes on the market today are created equal! The higher quality electrolytes are palatable, while lower quality ones are bitter, salty and discourage consumption when top-dressed on feed or mixed in water.

Before electrolytes can be absorbed they need to be broken down with water. Delivery of a powdered electrolyte in feed or water is acceptable as long as they can continue to drink water. If water is not available or the horse does not drink after administering dry electrolytes, the horse will take water from its body and put it into their digestive system to break the powder down. Mixing electrolytes in water will reduce the absorption time in the small intestine. All electrolytes are hydroscopic, which means if fed in powdered form and the horse does not drink water, they will dehydrate the horse. Paste electrolytes are to be avoided due to their 'short term affects'. They will lay in the gut and actually pull water from the horse's body, increasing dehydration, at the most critical time after exercise! This was proven and published by Equine Guelph's research team, led by Dr. Mike Lindinger and Gayle Ecker, a few years ago.

Depending on how hard the horses are working, a 'performance electrolyte solution' can be made by mixing one ounce of powder per litre of water. Increase the number of litre's of this 'electrolyte solution' as the horses training intensifies and/or the 'Heat Stress Index' (HSI) increases. HSI is determined by adding the temperature (F or C) and the percent Humidity, together. **'Mild' HSI** begins when the combination is <140 when using Humidity plus Temperature (F); or <90 when using Humidity plus Temperature (C); **'Moderate' HSI** is between 140 – 160 (F) or 90 – 105 (C); **'Severe' HSI** >160 (F) or >105 (C). (See chart provided on the link: http://www.equineguelph.ca/news/index.php?content=419)

This 'electrolyte solution' should be given with-in 45 minutes after the horse's workout. When the humidity and temperature increase, causing the 'heat stress index' to climb to 'Moderate' to 'Severe', the number of litre's offered should increase according to their training level. One ounce/litre of water will provide the correct osmolarity for the fastest absorption and utilization by the horse. For example: for **'Moderate' Heat Stress Index**: provide two litres for training level, four litres for moderate and six litres for intense training. In the cases of 'moderate' to 'intense' training levels, providing the 'electrolyte solution' will work much better than top dressing it on feed.

More factors effecting dehydration can include: the trailer ride to the venue if it is a hot day, a decrease in water and food intake from the stresses of being in a new location or from the water tasting different. Add the workload of the day on top of that and you can have a severely dehydrated horse on your hands.

Checking for dehydration can include the skin pinch test where the handler pinches the skin on the horses shoulder then checks that it flattens back down in one to one and a half seconds. The capillary refill test is another method, pressing on the horse's gums and seeing the colour return to pink in under one and a half seconds.

(link: http://www.equineguelph.ca/pdf/infosheets/Dehydration_Infosheet_July_2014.pdf)

SUMMARY

Kapper encourages horse owners to be pro-active in their feeding programs. Know the 'ideal' body weight of your horse and what nutrients are in your forage. These nutrients will vary with the 'type' of forage (grass vs. legume) and its level of maturity (when it was cut). Knowledge of this will allow you to make informed decisions when choosing feed and/or balancers to make up the difference between what your horse is getting from its forage and what it needs. Be sure to read the 'purpose statement' on every feed tag and feed according to their 'Feeding Directions' in order to fulfill nutrient requirements. Always choose a feed that is tailored to the individual needs of the horse (size, breed, age, workload…) and feed according to the instructions. Kapper cautions, "Feeding less than recommended amounts/day, means you have chosen the wrong feed and it could result in nutritional deficiencies". Stay observant if performance declines and be quick to pick up on the visual clues that the diet may need balancing, i.e. loss of muscle over the topline, decline in hoof and hair quality, loss of appetite and loss of condition could all be indicators of amino acid deficiency and/or an unbalanced diet. For horses in moderate to intense training, giving amino acids and electrolytes with-in 45 minutes after workouts can replenish body reserves the fastest. **Nutrition is the science of prevention**. Understanding the role of nutrition and working with an equine nutritionist will put you on the road to optimal health and performance for your horse.

*Article provided by Equine Guelph