Normal Foal Nutrition

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1. Introduction
“The foal appears to make feeding the second priority after breathing.”1 Understanding the nutritional needs of the newborn foal is paramount when deciding how to feed the orphan foal. These needs change over time as the normal anatomy and physiology of the foal’s gastrointestinal tract change. Adjustments in the orphan foal’s diet should reflect these changes.

2. Anatomy and Physiology of the Gastrointestinal Tract
The transition in the foal from an in utero environment to after birth affects many body systems. We recognize this most in the cardiovascular and respiratory systems, but the gastrointestinal tract must also adapt to a new role. After birth, the intestines must assume the role of digestion and absorption of nutrients for survival of the foal.

The mean hourly gastric pH of the newborn foal stomach ranges between 3.2 and 3.7. The pH consistently decreases to <2.5 if the foal is recumbent for a period of time (>20 minutes). Presumably, this is due to the rapid gastric emptying of liquids and a decrease in the normal buffering of milk and saliva. Large increases in pH sometimes up to 6 occur immediately after nursing. The percentage of time that a foal’s gastric pH is >4 varies between 15% and 40%. There does not appear to be a diurnal variation.2 The clinical importance of this finding is that frequent feeding may help to prevent gastric ulcer disease in the normal foal by increasing the percentage of time that the pH is elevated.

Proportionally, a newborn foal’s gastrointestinal tract is very different from the adult horse. In the foal’s first month of life, the small intestine is the site of most growth, with the large colon playing a minor role. If one were to dissect the gastrointestinal tract of a newborn foal, the proportion of cecum and large colon to small intestine would be much smaller than the same proportion in the adult horse. During this first month, the small intestine grows in length and in diameter, increasing the surface area of the villous surface for the digestion and absorption of the milk meals.

Carbohydrate digestion in the horse is initiated in by salivary and pancreatic amylase. Fowden et al reported that the pancreatic β-cell function develops in late gestation in the equine fetus.3 The pancreas is not fully functional at birth because a reduced glucose clearing has been noted during the early postnatal period. This may present as a mild insulin resistance.4 Digestion continues in the small intestine by disaccharidase enzymes in the brush borders of the microvilli. These enzymes hydrolyze the various types of disaccharides in the meal converting them to glucose for absorption. Lactose is the prominent sugar in mare’s milk, and lactase is
the most prominent disaccharidase enzyme in the newborn foal. Lactase can be detected in the equine fetus but reaches peak levels soon after birth. Lactase activity is the highest in the duodenum and proximal jejunum, with decreasing amounts in the distal small intestine. This high level of lactase activity persists from birth to approximately 4 months of age, when it begins to decline. It continues to decline up to 4 years of age, when it can no longer be detected.5,6 The healthy foal can utilize almost 100% of the available energy from milk during the first weeks of life.7

Maltase can also be measured in the equine fetus at low levels. At birth, these levels represent about 15% of the adult levels. By 4 months of age, the maltase enzyme levels equal that of lactase and reach adult levels by 7 months of age. Sucrase is part of the maltase complex and follows the same time line in development.8 This time line corresponds with the foal’s ingestion of other carbohydrates such as grains. Clinically, this is important because foals will begin to nibble on the dam’s grain and hay early within the first week of life. They will not be able to utilize the disaccharides to a great extent in this type of food until they have the appropriate enzymes for digestion.

During the second month of life, the foal begins to develop the cecum and the large colon as organs of digestion. Nutritionally, the foal still depends on the mare’s milk as the primary nutrient. Over the next 3 to 5 months, the cecum and large intestine enlarge and begin to populate with microorganisms that assist in the breakdown of structural elements of fibrous feeds.8

### 3. Normal Foal Nutrition

In utero, the foal receives all of its nutrients from the uterine placental unit. The transfer rate of glucose from the placenta to the fetal foal is approximately 6.8 mg/kg per minute.9 The neonatal foal is born in a hypoglycemic condition (25 to 45 mg/dL) and remains in that state until gluconeogenesis begins. Gluconeogenesis from the liver stores of glycogen stabilizes the foal’s glucose until it receives its first enteral meal. Foals have only small reserves of glycogen; therefore the glucose levels will decrease further between 2 to 4 hours postpartum. The time table for standing and suckling in the normal neonatal foal is 90 to 120 minutes. The lowering of blood glucose may be the stimulus for the foal to seek out the mare’s udder.

Optimally, the foal’s first meal will consist of high-quality colostrum. The immunologic benefits of colostrum are important for the foal’s survival because of the complete lack of intrauterine transfer of immunoglobulins from the mare to the foal. The transfer of maternal antibodies to the foal is accomplished through the early ingestion and absorption of the first milk secretion produced by the mare colostrum. The nutritional importance of colostral ingestion is no less important. Colostrum is higher in gross energy, specific gravity, total protein, and Vitamins A and E. Colostrum provides more than 50% more energy to the foal than that provided by an equal amount of milk. One liter of high-quality colostrum delivers approximately 1350 kcal/L versus 600 kcal/L of mare’s milk.10 Depending on the quality and quantity of the colostral meal, it will help to maintain the foal’s glucose in the normal range for 10 to 20 hours. Light breed mares produce approximately 3% of their body weight in milk per day for the first months of lactation. This is approximately 15 L in a 500-kg mare. This coincides with what the average foal will ingest—approximately 25% to 30% of its body weight per day (12.5 to 15 L/d in milk).11,12 The normal foal will receive this amount of milk through frequent nursing bouts. In the first week of life the foal may nurse 6 to 8 times an hour, with each meal delivering about 80 mL of milk to the foal.13 The frequency of nursing decreases as the foal ages and it stabilizes at a rate of 1.5 to 2 bouts per hour until the foal is weaned.

Mare’s milk provides approximately 500 to 600 kcal of energy per liter of milk. At 15 L of milk a day, the healthy 50-kg foal would consume 7,500 to 9,000 kcal/d. This is in excess of their resting energy expenditure (50 kcal/kg, 2500 kcal for a 50-kg foal as measured by indirect calorimetry) by 5000 to 6500 kcal. This excess of ingested calories is utilized for activity and for growth. Thus activity and growth requirement is about 175 kcal/kg per 24 hours. The extra calories result in a daily average weight gain of 1 to 2 kg/d (2 to 3 pounds/d) during the first month of life. Healthy foals will almost double their weight in that first 30 days. Foals are about 60% of their adult height at the withers at birth. Growth in height is between 0.4 and 0.33 cm/d in first month of life, and foals reach 95% of their adult height by 18 months of age.14,15

### 4. Nutritional Assessment

Nutritional assessment of the foal is important because the signs of malnutrition can be subtle. The goals of nutritional assessment would be to identify the malnourished foal early, to identify the “at risk” foals, and to prevent any nutritional deficiency. The assessment should begin with a history. Observation of the foal’s nursing frequency and the mare’s udder may help one to evaluate the health of the foal and the adequacy of milk production by the mare. If the foal is constantly trying to nurse and the mare’s udder is flat, one may suspect that the mare is not producing enough milk to satisfy the foal. An enlarged udder with streaming of milk may indicate that the foal is not nursing adequately. This would be the first sign of a medical problem in the foal and should be investigated.

Physical examination and assessment of the foal’s size at birth is important in determining if the foal had any in utero compromise in placental delivery of nutrients. The normal newborn foal should be be-
tween 10% and 11% of its dam’s body weight. For example, a 500-kg mare should deliver a 50-kg foal. Causes for low body weight/size of the newborn foal are usually placental dysfunction or decreased placenta surface area to deliver nutrients. Examples of this could be seen in disproportionately sized twins, where one twin had the bulk of the placenta such as the body and horn of the uterus, whereas the other twin was restricted to one horn of the placenta.

Continual assessment of the foal’s growth after birth is important as well. This can be done by several methods that focus on the average daily gain of the foal. A scale for weighing the foal daily is the most sensitive method but unfortunately not every farm has access to a horse scale. Weight can be estimated by measuring the girth circumference of the foal every 3 to 4 days and using the following calculation, where Y is the circumference in cm or inches, depending on whether you are working in kilograms or pounds, and X equals the weight of the foal.

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X \text{ in kg } = \frac{Y \text{ (cm)} - 63.7}{0.38}
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X \text{ in lb } = \frac{Y \text{ (in)} - 25.1}{0.07}
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Finally, nutrition can be assessed by evaluating the foal’s body condition score. Foals are rarely born fat; therefore we usually only need the lower end of the Henneke scoring system—1 being emaciated and 5 being good body condition—using the following descriptions.12

Henneke Body Condition Scoring: modified to include only the scores used in newborn foals.

Score of 1: Extremely emaciated—spinosus processes, ribs, tuber coxae, tailhead, and tuber ischii very prominent; shoulder and neck structures evident.

Score of 2: Emaciated—slight fat covering base of spinous processes; slightly rounded feel to transverse processes and ribs; shoulder and neck structures barely noticeable.

Score of 3: Thin—fat buildup midway down transverse processes; slight fat over ribs; individual vertebrae not discernible.

Score of 4: Moderately thin; slight ridge along back; faint outline of ribs; fat can be felt over tailhead and withers; shoulder and neck are not thin. Score of 5: Moderate or normal; back flat; ribs not visible but easily felt; withers rounded; neck and shoulders blend well into body.

No matter what method is chosen to assess a foal’s nutritional status, it is important to have the owner keep a diary of the progress—daily scale weight, every 3 to 4 days estimated measurement or weekly for body condition score. These methods allow recognition of a decreasing average daily gain of weight and growth of the foal early and intervention nutritionally to correct the problem.

References