

# Blood Counts

## A Practical Guide to Common Problems

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**I**N RACING AND UPPER LEVEL SPORT HORSES, BLOOD CELL counts and analysis of biochemical parameters, such as muscle and liver enzymes, electrolytes and blood protein fractions, are often taken at regular intervals to monitor a horse's health and response as it adapts to a training program.

A healthy horse maintains a concentration of red and white blood cells, blood protein, electrolytes, muscle, liver and kidney enzymes and other blood components within an established 'normal' range relative to its age, breed, degree of fitness, health and nutritional adequacy. Deviations from the normal range, either above or below the limits of this range, in one or more blood components, can signify an underlying disease process or a lack of response to exercise by a horse in work. The degree of these changes can be used to determine the relative severity of a disease, deficiency, level of stress or lack of adaptation or response to training.

Blood counts can help establish a base line of values during training, so that any deviations which are related to less than optimum or expected performance, can be identified. Some trainers take regular samples, often at 10-14 day intervals, to monitor a horse's 'fitness' profile. However, for most trainers on a limited budget, a blood profile is only taken when a horse performs below that expected in a race.

Blood tests can also be used to determine the **dehydration state, degree of anaemia, infection and immune challenge, physical stress as well as metabolic conditions**, such as 'tying up', bone and liver stress. There are a number of factors that can influence the accuracy and diagnostic value of a blood cell count or biochemical analysis on blood plasma or serum. These include:

- The time of day relative to eating and training the sample is taken.
- The storage method, transport and interval of delay in laboratory testing of the sample.
- The degree of excitement or relative dehydration at the time of blood collection.
- The time elapsed following a trial or race, such as an elevated neutrophil to lymphocyte ratio for 24-36 hours due to the stress associated with strenuous activity, or a rise in the muscle enzymes, AST and CK.
- The method of testing and 'normal value' ranges for an individual laboratory.

Of these, the time of collection relative to exercise, feeding and fast work and/or racing has the most influence on the count of red blood cells and concentration of electrolytes and enzymes in a sample. If you collect blood yourself to pass onto your vet early in the morning, always ensure the tubes are filled to the level marked on the label.

### Did You Know That...

- **The loss of fluid and electrolytes in the large volumes of saliva secreted, up to 1 litre per 4 litres of dry food consumed (12 litres/day of saliva), when feeding can deplete blood potassium and bicarbonate levels for up to 4 hours after a meal.**
- **The loss of fluid and electrolytes in sweat during training depletes water and electrolytes from the body, concentrating blood cell parameters and lowering the concentration of circulating blood electrolytes, causing a relative dehydration for up to 4-6 hours after exercise. This effect may mask a low red cell count or anaemia and result in readings that may be falsely interpreted as an electrolyte imbalance or dietary deficiency.**
- **An excited or 'spooked up' horse will have higher numbers of circulating red cells in its blood at the time of collection, due to release of red cell reserves held in the spleen as a natural reaction to 'fear' or 'excitement'. This can elevate the red cell concentration in the blood and mask a lower than normal range red cell count due to anaemia or blood loss.**
- **Poor collection techniques, where the collection needle is not inserted expertly into the jugular vein with minimal 'jabbing' and attempts to locate the vein to draw blood, can cause a 'fear' response and splenic release ('dumping the spleen') within 20-30 seconds, which can elevate red cell numbers and be interpreted as artificially high red cell count.**
- **For transport, the blood sample should be packed next to an ice brick, but not smothered with ice as it may lower the temperature to below 4°C, causing the cells to expand and leak electrolytes and enzymes into the blood fluid. A foam container with an ice brick or cooler block is ideal. The whole blood sample should be delivered to your veterinarian, or testing laboratory, within 2 hours of collection if electrolyte analysis is to be carried out. Alternatively, the cells should be removed by centrifuging serum in a clotted blood tube, using a special 'plain' collection tube to collect and transport the blood. Ensure the tubes are correctly labeled with a permanent marking pen or pencil, rather than water soluble markers.**
- **Full details of the horse's age, sex, breed, stage and level of training, or any clinical or untoward sign, such as dehydration, poor recovery, blowing after exercise, loss of appetite, 'tying up' or loss of stamina, must be provided with the sample. It is worthwhile to advise any medications or brands of supplements that are being provided.**
- **It is preferable, but not essential, that the same laboratory is used to carry out the blood counts and biochemical tests, as the range of 'normal' values relative to their testing procedures, are likely to be standardised to enable the most accurate interpretation to help monitor a horse's improvement as it adapts to training.**

### Handy Hint

#### Keep Test Results

Always keep the readings of previous blood profiles from a horse for comparison with future tests to relate stage of training to changes in health and performance.

## Reading the Blood Test

This is a job for your vet. If the blood cell count and biochemical values are outside normal ranges, clinical information should be provided at the time the blood sample was taken. Your vet will normally carry out a full clinical examination at the time of collection to confirm or establish a diagnosis in a sick or poorly performing horse.

However, if you collect the blood yourself and forward it to your vet, or direct to the testing laboratory on your vet's behalf, ensure that your vet has a full history, and details of the training program and performance problems, especially where the horse is not performing well, or has had a recent metabolic episode such as 'tying up', viral respiratory infection, an infected wound, or a hoof or skin abscess.

There can also be variations between horses relative to their normal blood parameters and ability to perform and how they react to infection or the stress of long-term training. As an example, the red cell numbers and haemoglobin content of blood taken from a horse in early training will be 10-20% lower than the parameters in fit, well conditioned horse, which reflects the specific requirement for higher oxygen uptake at faster speeds.

**Always check the Total Protein (TP) reading when interpreting Red Cell Parameters.**

**An elevated RBC count above  $9.5 \times 10^{12}/L$  and PVC above 0.42 L/L, but with a TP between 60-66g/L, indicates excitement at time of blood collection. A similar elevation of TP above 68-70g/L indicates dehydration which artificially increases red cell parameters.**

The relative degree of horse health and physical fitness can be based on oxygen uptake capacity (referred to as  $VO_2$  max) as reflected in red cell counts and haemoglobin content of red cells in the sample of blood; lack of significant changes in white cell numbers or types; adequate serum electrolyte concentration; total protein and range of muscle enzymes, and other metabolic indicators from biochemical readings which are within 'normal' limits established for a 'fit' horse.

In racehorses, great dependency is placed on red cell numbers and associated parameters required for oxygen transport so as to maximise aerobic capacity. The 'fitness profile' may vary considerably between individual horses which are performing satisfactorily and recovering well after exercise.

### Handy Hint

#### Variation between Blood Readings

A variation of parameters between two or more successive blood tests can be used to highlight an underlying reasons for a poor performance or a medical problem which could affect a horse's health. The use of blood tests to determine dietary deficiencies or imbalances is of limited value in most horses, with the exception of electrolyte imbalances, which can be associated with lack of stamina, muscle soreness, or 'tying up' or chronic dehydration.

### Handy Hint

#### How to Ensure Repeatable Results

The most accurate and repeatable results which reflect the health status of a horse, or those used to compare changes between successive blood tests, are obtained when the blood sample is collected before exercise or daily training, prior to feeding and when the horse is relaxed and at rest. An early morning blood sample taken and stored in a refrigerator (4-8°C) is a good standard for evaluating changes in subsequent blood tests. Samples taken, say at 10am, or when a vet visits after morning training, may be influenced by the loss of fluid and electrolytes in saliva when feeding, or in sweat during feeding and exercise.

### Handy Hint

#### Monitoring Effects of Training

The differences between individual animals may also reflect the training and feeding methods used by trainers, without affecting their ability to perform at the highest level. These may need to be taken into account, for example, when interpreting changes in blood electrolyte concentration and balance, in combination with specific clinical signs, length of time in training, and a history of a poor performance.

### Handy Hint

#### Blood Collection Tips

The correct type of blood collection tube provided by your own veterinarian or laboratory must be used if you collect the blood sample yourself. The blood sample should be rotated slowly a few times to mix it with the ingredients that prevent clotting or preserve the blood contained within the tube. **Do not squirt blood through the needle into the collection tube, as cells will be damaged and may cause haemolysis.** The blood sample should be refrigerated or cooled to between 4-8°C (refrigerated) within minutes. Blood samples containing cells must not be frozen as freezing expands the water within the red cells, which may then leak electrolytes or rupture to release their contents (haemolyse), and make the blood unsuitable for laboratory analysis.

Typical Clinical Signs	Blood Changes may include	Treatment/Management that may be advised
Normal respiratory function and stamina.	Red cell count and parameters within upper 'normal' limits, usually above $8.5 \times 10^{12}/L$ RBCs. Haemoglobin above 14 g/L (Gallopers) or 12 g/L and above (Harness horses). MCV between 42-45 fl (Gallopers and Harness Horses)	Maintain training intensity and monitor recovery. Include a program - 3 alternate days of 2 heats of short, sharp sprints over 350-400 metres (2 furlongs) to stimulate optimum red cell numbers, with a 10mL Folic/B12 injection to ensure optimum MCV readings, if the MCV is above 47 fl.
Adequate recovery after exercise	Electrolyte and total protein reading within normal range of 60-64 g/L.	Maintain ration and supplementary nutrition. Low total protein below 57 g/L may indicate protein loss from stomach or duodenal ulcers, or severe lung 'bleeding'.
Absence of dehydration. elastic skin return	White cell counts (WBC) and white cell differentiation within normal ranges of $7-8 \times 10^9/L$ . Monocytes less than 4% of differential WBC count.	Check for clinical signs of dehydration and monitor the horse's appetite. High monocytes above 5% may indicate lower airway disease or a skin wound.
Good appetite and normal digestive function.	Muscle enzymes AST & CK return to normal range within 36-48 hours of fast work or racing.	Normal values of muscle enzymes indicates muscle fitness if horse has been worked hard, run in a trial or raced.

## Blood Profiles of Common Problems

Blood counts are often used to evaluate a horse's 'fitness' or readiness for racing, and although they are useful to monitor a horse's response to training, or help determine the underlying reason for a poor performance, they are not infallible indicators of a horse's likelihood to win on a certain day.

A blood test basically measures the concentration of red and white cells, biochemical substances such as enzymes, proteins, electrolytes and metabolic compounds in a certain volume of blood. Variations of these readings, above or below, the 'normal' range established for a healthy horse, can provide an indication of an underlying disease process, metabolic problem, deficiency or imbalance, or other conditions that can adversely affect a horse's health and performance.

Although a horse may be regarded as 'fit' because it has a high red cell count, this may be artificially elevated due to dehydration (loss of blood fluid which concentrates the red cells), or the excitement of being 'spooked up', with a splenic release of red cell reserves into the blood, by the sight or sensation of the needle jab into the vein.

A blood sample taken after feeding or exercise is likely to indicate slight dehydration by higher plasma protein, or with a lower potassium reading because of loss of potassium in saliva when chewing and sweat loss during and following exercise.

## Blood Profile of 'Training Off Syndrome'

Long term training, repeated hard racing in a carnival campaign, long term event training, severe or repeated metabolic episodes, such as 'tying up', and chronic respiratory infection, may have an individual or combined influence on an otherwise healthy horse to prevent it performing at its peak each time it races, or competes in high level equestrian competition.

This is often referred to as 'training off' although in many cases, few, if any, blood parameters are altered.

Studies in racehorses indicate that whilst oxygen carrying

The time of collection, the horse's attitude as well as the length of storage and transport duration and conditions can significantly affect the values of a number of readings in a blood sample.

A survey of common conditions which occur in racehorses during training, carried out in the late 1990s, indicated that anaemia, dehydration, lung bleeding and 'tying up' were the three most common medical type problems reported by trainers, other than lameness.

### Handy Hint

#### Blood counts and Anaemia

Many blood counts which you get back from your vet, will have readings for Mean Cell Volume (fL) (MCV), Mean Cell Haemoglobin Concentration (g/L) (MCHC), and Mean Cell Haemoglobin (pg) (MCH). These readings are calculations based on the haemoglobin, PCV and total red cell count, which give an estimation of the relative cell size and the amount of haemoglobin packed into the cells. Although a lot of emphasis is placed on these readings, in most cases, the MCH and MCHC will be within normal limits, except when a horse is extremely anaemic. This can be confirmed by the clinical signs of poor stamina during work, pale gums, and a poor response to training, as well as a low red cell count, low haemoglobin and lower Packed Cell Volume (PCV).

### Handy Hint

#### Signs of 'Training Off Syndrome'

In racehorses, physical 'tiredness' is often linked to a lowering of the red cell and white cell parameters, especially the lymphocyte count, as well as elevation of muscle enzymes. Many other clinical signs, including poor recovery rates, dehydration, loss of appetite and lack of stamina are evaluated in the diagnosis of 'training off'.

capacity as a measure of fitness increases during an extended training program, mental fatigue and loss of willingness to perform are common symptoms associated with 'training off'.

Often a paddock rest period, supplementation with a range of nutrients, such as vitamins, and a 'freshen up' may restore 'willingness' and improve a horse's physical wellbeing.

Typical Clinical Signs	Blood Changes may include	Treatment/Management that may be advised
Loss of stamina, reduced alertness and willingness during exercise. Dull coat - loss of condition and 'bloom'.	No significant changes may be present.	Rest and turn out for pasture grazing to improve appetite and willingness.
Faster onset of exhaustion and inability to maintain speed and sprint ability to finish strongly.	Concurrent elevated Total Protein readings above 68-70 g/L as an indication of clinical dehydration.	Supplementation with B group vitamins and amino acid supplements. Correction of electrolyte abnormalities by supplementation.
Loss of stamina, tucked up, dry coat, loss of appetite and slow recovery. Horse appears to be 'flat' and stressed.	Decreased total WBCs below $5 \times 10^9/L$ and a lymphocyte count below 25% of total WBCs. Elevated Total Protein above 68-70 g/L as an indication of clinical dehydration.	Program of short, sharp sprints in 2 heats over 400 metres on alternate days on 3-4 fast work mornings may help reduce stress of hard training. Check for gastric ulcers.
Dehydration, tucked-up appearance, failing to finish strongly, but not showing any signs of physical stress.	Electrolyte abnormalities, including low potassium below 3.0 mmol/L or adrenal exhaustion syndrome with low sodium (Na) below 130 mmol/L, high potassium (K) above 4.5 mmol/L, resulting in a Na:K ratio below 30.	The old practice of 'bleeding' a horse by taking 6-8 litres of blood with a large bore canula was often advocated for horses that 'train off' - in many cases it was beneficial in restoring blood cell parameters and 'bloom'. Consult your vet.

## Blood Profile of Anaemia

Anaemia is not a disease as such, but a multi-cause condition that can result from a diet inadequate in protein, iron and blood forming nutrients (not common); excessive blood loss due to heavy Small Redworm burdens (most common); severe gastric ulcers or repeated lung bleeding (EIPH) (subclinical bleeding); lack of adequate fast work/sprint-ups to stimulate blood cell synthesis (very common) and suppression of bone marrow activity due to stress of fast work (repeated acidosis and loss of RBCs), chronic pain states, infection (usually respiratory

### Handy Hint

#### Racehorse Anaemia

'Racehorse anaemia' is a term used by veterinarians to describe lower than expected red cell parameters (RBC count, haemoglobin, PCV and MCV) in a horse in training relative to its stage of training and apparent good health, appetite and well-being. Although, iron deficiency is often considered an underlying cause, most rations provide more than adequate iron on a daily basis. A common cause is inadequate sprint work to maximise oxygen uptake and bone marrow response.

virus EHV-1, 4) and long term anti-inflammatory treatment (relatively common in horses in extended race preparations [training off]).

Typical Clinical Signs	Blood Changes may include	Treatment/Management that may be advised
Lack of stamina, pale gums, dull, dry coat, poor recovery after fast work.	RBC count less than $7.5 \times 10^{12}$ /L, PCV below 0.33L/L, haemoglobin below 120g/L, MCV below 42 or above 48fl. (maybe increased eosinophils above 4% if caused by heavy worm burdens - may take 6-8 weeks for eosinophils to decrease to less than 2% after rigorous worming)	<ol style="list-style-type: none"> <li>1. Check adequacy of protein in diet.</li> <li>2. Supplement with iron and blood building nutrients if MCV below 42fl (eg 20g Cell Iron daily for 3 weeks and also 2 nights before racing).</li> <li>3. Check droppings for Strongyle eggs if above 200 eggs per gram, worm horse, repeat in 3 weeks.</li> <li>4. Sprint-ups if MCV above 48fl. Refer to attached sheet.</li> </ol>
Poor finishing ability, blowing or coughing after fast work/trial or race, dull coat.	RBC count less than $8 \times 10^{12}$ /L, low blood potassium below 3.4mmol/L, Total bilirubin above 45mmol/L, GGT above 50u/L, monocytes above 5%.	<p>Blood loss due to repeated lung bleeding - no blood at nostrils but internal lung bleeding.</p> <p>Management to minimise risk of bleeding. Refer to attached sheet</p>
Poor appetite, 'picking' at day feeds, cleans up overnight, agitated during travelling or in raceday stalls, dull coat.	RBC count less than $8 \times 10^{12}$ /L, low blood potassium below 3.4mmol/L, GGT above 50u/L, total plasma protein below 57.	<p>Blood loss due to gastric ulcer haemorrhaging.</p> <p>Management to minimise gastric ulcers:</p> <ul style="list-style-type: none"> <li>• gastric ulcer medication.</li> <li>• feeding lucerne before exercise.</li> <li>• supplementing with Gastro-Coat.</li> </ul>
Lack of appetite, poor recovery, poor finishing ability (flat), dehydration and lack of willingness.	RBC count less than $8 \times 10^{12}$ /L, PCV below 0.38L/L, haemoglobin below 13g/L, MCV 43-45fl.	If diet is adequate, training includes regular sprint-ups, worm control is carried out regularly (rotate wormer every 4 wormings) and horse has been in training for 6 months or longer and worked/raced hard - may be training off. Refer to separate section 'Training off syndrome' on page 3.
Horse fails to finish strongly, no evidence of bleeding, ulcers, good appetite, good coat.	RBC count less than $8 \times 10^{12}$ /L, PCV below 35g/L, haemoglobin below 13g/L, MCV 46-47fl.	<p>May be result of bone marrow suppression due to hard training, recent infection, or chronic injury/low grade lameness.</p> <ol style="list-style-type: none"> <li>1. Consider course of organic arsenic - 10mL IV alternate days for 10 days - withdraw 5 days before racing.</li> <li>2. Sprint-ups and folic/B12 - 10mL after sprint-ups for 10 days.</li> <li>3. Consider anabolic hormone - consult vet and ensure adequate withdrawal.</li> </ol>

## Blood Profile for Infection

There are various types of microbial infection, the most common being viral, bacterial and fungal invasion of tissues or blood, which depending on the severity, will result in a change in white cell counts and some biochemical parameters.

Most viral and bacterial infections cause an elevation in temperature for the first 24-36 hours is triggered and respond to the multiplication of viral or bacterial organisms.

The relative number and types of white blood cells circulating in the blood can determine the severity of the body defence challenge, or the overwhelming degree of a highly active and widespread infection. Lower protein and globulin levels in the blood may reflect the relative degree of antibody challenge.

Because infections can be life-threatening or result in long, slow recovery, it is important to consult your vet.

### Handy Hint

#### Blood Changes in a Bleeder

Bleeding in the lungs occurs to some degree in 90% of galloping or harness racing horses each time they are fast-worked or raced. Only 2% of horses show blood at the nostrils, with most horses being 'hidden' bleeders. Symptoms include failure to finish strongly, coughing after exercise and a dull rough coat, as well as blood at the nostrils. Blood changes which can indicate blood loss from lung haemorrhage, include lowered red cell count, low potassium and total protein due to blood loss, and elevated liver readings with bilirubin above 45-50mmol/L and GGT above 50-75u/L.

### Handy Hint

#### Common Types of Infection

Infections can range from a severe generalized infection in the blood such as septicaemia, or localised in particular tissues, such as nasal or lung tissues by Equine Herpes Virus, digestive tract by Salmonella, E coli and other pathogenic gut bacteria, as well as Rotavirus in young horses. Other common bacterial infections include hoof abscesses, wound infection and fungal like infection of 'greasy heel' in racehorses that can all result in altered white cell counts and differential "split".

# Blood Counts - A Practical Guide to Common Problems

Typical Clinical Signs	Blood Changes may include	Treatment/Management that may be advised
Elevated temperature above 38.5°C up to 40°C in active/ acute phase of general viral and bacterial infection. Elevated heart rate in very early or chronic stage.	Elevated white cell counts above 10 x10 <sup>9</sup> /L. Acute, severe infection much higher.  Elevation in Neutrophil/ Lymphocyte ratio – left shift. 70-80% neutrophils, $\approx$ 30% lymphocytes.  Elevation in monocyte cell numbers in chronic forms of airway disease above 5%.	Antibiotic or other antibacterial specific therapy as prescribed by your veterinarian. Use of dietary immune factors may be indicated, such as Activ-8.
Heat, swelling, pain over localised area. Discharge from skin or hoof abscess etc. Loss of appetite, dehydration and diarrhoea (gut infection).	Elevated fibrinogen levels above 4 g/L if caused by bacterial infection. Decreased globulin antibody levels in blood, below 20g/L.	Drainage of hoof and skin abscesses to relieve pain and remove discharges. Specific localized topical therapy for abscesses/wounds.
Nasal discharge, coughing and loss of appetite in viral or bacterial respiratory disease.	Associated finding may be dehydration. TP above 68g/L and bilirubin above 40mmol/L and GGT above 50U/L.	Mucolytic or airway active drugs to treat airway disease, as well as feeding in bins at floor level to drain airways. A follow-up blood count may be taken to monitor recovery. Consult your vet.

## Blood Profile of Lower Airway Disease

Chronic, low-grade airway disease is a common diagnosis in racehorses as a cause of poor performance. The inhalation of small dust particles from feed and bedding, which may include fungi and mould, and dust stirred up and inhaled during training on dry tracks, may increase lower airway irritation and

inflammation. This can adversely affect exercise capacity under race conditions. Inhalation of dust and moulds can increase bacterial and fungal contamination in the lower airways, resulting in low-grade airway disease. It may also prolong recovery from viral respiratory infections.

Clinical signs that may be present	Blood Changes may include	Treatment/Management that may be advised
Coughing and wheezing during exercise.  Reduced exercise tolerance.	Acute airway disease results in an elevated temperature, depression, loss of appetite and reduced exercise tolerance.	Treatment with antimicrobial and airway mucolytic preparations as prescribed by your vet for 7-10 days. Providing dampened feed at ground level, or turn out for 'head down' pasture grazing to assist lower airway drainage.
White mucoid nasal discharge (upper airway dust contamination).	Lowered lymphocytes and globulin levels may be associated with viral or bacterial airway infection.	Feed at ground level or provide pasture grazing for 1-2 days after long distance travel or racing.
Slow recovery after training or racing, with blowing after exercise. Symptoms of acute travelling or transport sickness with elevated temperature and reduced respiratory function may develop during or following long distance travelling.	Normal or slightly elevated white cell counts above 8-9 x10 <sup>9</sup> /L with higher proportion of monocyte cells (greater than 5%) in an otherwise healthy horse, can signify increased airway irritation and clearance of dust and mould debris from lower airways.	Allow 20 mins grazing or head down feeding every 5 hours during extended travel, especially on return from racing. Consult your vet for advice.

## Blood Profiles of Dehydration

Dehydration or loss of blood and body fluids is one of the most common reasons for reduced performance and other metabolic conditions associated with loss of water and resulting in electrolyte abnormalities, especially in horses in training or those travelling during hot, humid conditions.

Loss of body fluids can also occur as a result of acute or chronic diarrhoea, excessively high protein diets and diets that are low in fibre and high in grain, with lower fluid reserves in the hindgut. Tubing of concentrated (hypertonic) saline drenches (concentrated salts in a low volume of water) can lead to severe dehydration due to fluid loss from diarrhoea. Inadequate water intake or reduced opportunity to drink can lead to dehydration in horses suffering from increased sweat and respiratory losses of fluid during hot conditions. The severity of clinical dehydration is classified into mild, moderate and severe, relative to the degree of fluid loss.

### Normal Hydration

**Total Protein 60-64g/L** PCV (Hct) 0.34-0.40. Elastic skin. Not 'tucked up' in the belly.

### Mild Dehydration

Up to 4% fluid loss-light sweating, long distance exercise, hot weather. **Total Protein 65-67g/L**, PCV (Hct) 0.40 – 0.45. Slightly less elastic skin, dull coat. Provide salts and dampen hay. Ensure adequate clean fresh water.

### Moderate Dehydration

Up to 5-6% fluid loss – 25-35kg body weight loss - heavy sweating, hot weather, diarrhoea, inadequate water intake. Dry mouth, dull coat, slow skin 'pinch' return, 'tucked up' in the belly. **Plasma protein 70g – 76g/L**, PCV (Hct) 0.46-0.50. Provide salts – maybe drench by vet or fluids in vein. Dampen all feed. Ensure adequate water. Reduce sweat loss by cooling after exercise.

### Severe Dehydration

**Very serious condition** – above 7% fluid loss – 35-50kg body weight loss - usually severe diarrhoea, no water. Dry mouth, sunken eye, slow capillary refill, dark mouth membranes and gums. Severely 'tucked up' – dull and listless. Plasma protein above 76g/L, elevated PCV (Hct) above 50. Elevated electrolytes and red cell count. Emergency IV fluids by vet and monitor. Do not work – risk of muscle damage.

## Blood Profile of Tying up

'Tying Up' or 'Exercise-Induced Rhabdomyolysis' (muscle inflammation and 'melt away') is the most common combined muscular and metabolic syndrome in racing and working horses. Fillies are 4 times more likely to suffer from 'tying up' as compared to colts or geldings. The underlying causes include working an unfit horse too fast too early in training; maintaining a horse on a high grain ration, especially oats, during a lighter work or rest day, or when training is cut back due to poor weather or an injury; a nervous, immature type of filly, as well as electrolyte abnormalities with a low blood level of sodium and potassium, most commonly in heavily sweating or 'nervy' horses. In some 'nervy' horses, exposure to a stressful condition, such as a change in training routine, transport or barrier training can trigger a 'tying up' episode.

Over the past decade, studies by Dr Stephanie Valberg in the USA and Dr Patricia Harris in the UK and Prof. David Hodgson in Australia, have linked an inherited, genetic form in some bloodlines, which appears to be more common in Standardbred fillies as compared to Thoroughbreds. It is termed 'Polysaccharide Storage Myopathy' or PSSM for short, and is considered a less severe condition than Equine Polysaccharide Myopathy (EPM) which occurs in draft horses.

These studies have shown that affected horses usually have 'hard' or bulky muscles due to the excess accumulation of muscle glycogen (muscle energy sugar) in the hindlimb muscles, often when fed on a high oat based diet, especially when oats are given in the evening meal. When worked next morning, the muscles are unable to rapidly release the glycogen for contraction and relaxation processes and the horse begins to 'tie-up'.

### Handy Hint

#### Checking for Tying Up Using Blood Tests

A blood sample to carry out muscle enzyme assay to determine the severity of muscle damage associated with an episode of 'tying up' should be collected 24-36 hours after the horse has galloped or trialed. This will enable your vet to determine the severity of 'tying up', as well as evaluate any significant changes in biochemical parameters during the recovery period.

### Did You Know That...

#### Estimating the Time Scale of 'Tying Up'

Often a blood test indicates an elevated AST and/or CK enzyme reading relating to 'tying up' and muscle damage. The relative time of a mild 'tying up' episode can be pinpointed by the clearance of CK from the blood. CK due to muscle damage is released within 6 hours, and clears to normal range values within 36 hours. AST on the other hand, is released around 12 hours after muscle damage, but can take up to 3 weeks to slowly decrease and return to normal levels. Repeated subclinical episodes of 'tying up' may result in CK not being detected in routine blood tests, but the AST may remain elevated above 600-1000 U/L for a number of weeks as its clearance time is extended by each episode. A blood sample taken 36-48 hours after a disappointing performance may miss elevated CK levels, but identify an increase in AST enzyme. In cases where CK and AST are consistently elevated if blood is taken at 7-10 day intervals, a muscle amino acid supplement, such as Kohnke's Own Muscle XL containing glutamine and a full range of recovery amino acids, Vitamin E and organic zinc, can help to provide nutrients to correct low dietary levels to help maintain muscle function.

### Handy Hint

#### Diagnosis of Subclinical 'Tying Up'

Although the more severe forms of 'tying up' are obvious as a stiff, shortened stride, subclinical or mild forms are often associated with a subtle loss of finishing ability and transient muscle swelling and pain after a hard gallop, race or event. By the time the horse is walked off the track or course and back to the stalls, the muscles free up and symptoms disappear. A simple trotting test has been developed to help confirm the subclinical form of tying up.

Clinical signs that may be present	Blood Changes may include:	Treatment/Management that may be advised
Stiffness in hindleg movement, sweating in severe cases due to muscle pain, shortened shuffling gait, reluctance to move.	Blood samples taken within 24 hours will indicate serum AST (formerly SGOT) readings above 400U/L, in severe cases up to 10,000U/L. Elevated serum CK above 300-400U/L, Sodium and/or potassium levels may be decreased.	Mild cases - elevated AST and CK below 1000U/L - cut back grain for 3-4 days, eliminate oats from diet and supplement with salts, 2000IU Vitamin E (eg Cell-E Premium) and muscle amino acids (eg 60g Muscle XL) for 7-10 days. Warm-up well prior to fast exercise and work every day - no days off.
Swollen, sore muscles on rump and croup.	Higher levels of AST and CK, often with elevated total protein above 67g/L indicating dehydration. Elevated white cell count above $9 \times 10^9$ /cumm, with high neutrophils and less than 30% lymphocytes due to inflammation and stress.	Rest from training for 5-7 days, cut back on grain to one third - eliminate oats if filly is naturally 'hard' in the muscles before exercise or has 'bulky' hindquarters, indicating possible PSSM inherited syndrome. Injections of Selenium-Vitamin E and oral muscle buffers may be indicated.
Urinating dark coloured urine for 12-24 hours after a severe tying up episode.	Extremely high AST & CK levels over 10,000U/L, elevated total protein, elevated white cells, low potassium due to severe muscle cell damage.	Rest from training for at least 2-3 weeks, seek veterinary advice. Oral muscle buffers, electrolytes, Vitamin E 2000IU daily, amino acids (eg Muscle XL 60g daily) and change of diet if PSSM is suspected.

Note: Refer to Factsheet No. 2 for a more complete management protocol for 'tying up'.