CHEMISTRY PANELS

Bilirubin Panel
Bilirubin , Total
Bilirubin, Direct
Bilirubin, Indirect

Canine Chemistry Panel
See "Small Animal Chemistry Panel"

Electrolyte Panel
Sodium (NA)
Potassium (K)
Chloride (CL)

Electrolyte Panel, Urine*
Creatinine, Chloride, Sodium, Potassium

*** Concurrent measurement of serum electrolytes and creatinine is required for fractional excretion values.**

Equine Chemistry Panel
See "Large Animal Chemistry Panel"

Feline Chemistry Panel
See "Small Animal Chemistry Panel"

Iron Panel
Serum Iron
Total Iron Binding Capacity (TIBC)
% Saturation

Large Animal Chem Panel
Sodium, Potassium, Chloride, Bicarbonate, Anion gap, Urea, Creatinine, Calcium, Phosphate, Magnesium, Total Protein, Albumin, Globulin, A/G ratio, Glucose, GLDH/SDH, CK, AST, % Saturation, GGT, T. Bilirubin, D. Bilirubin, I. Bilirubin, Iron, TIBC

Large Animal Liver Panel
Total Protein, Albumin, Globulin, A/G ratio, Triglycerides, CK, SDH, AST, GLDH, GGT, T. Bilirubin, D. Bilirubin, I. Bilirubin

Large Animal Renal Panel
Sodium, Potassium, Chloride, Bicarbonate, Anion gap, Urea, Creatinine, Albumin, Calcium, Phosphate

Mineral/Lytes Panel
Sodium, Anion Gap, Potassium, Calcium, Chloride, Phosphate, Bicarbonate, Magnesium

Mineral Panel, Urine
Magnesium, Creatinine, Phosphate, Calcium

Mineral/Lytes Panel, Urine
Magnesium, Potassium, Phosphate, Chloride, Creatinine, Sodium, Calcium

Metabolic Profile Test Panel
Urea, NEFA, AST, Albumin, BHB

Non-Mammalian Chem Panel
Sodium, Phosphate, Potassium, Total Protein, Chloride, Glucose, Uric Acid, CK, Calcium, AST, GLDH, Bile Acids

Pre-Anesthesia Panel (Lrg An)
Sodium, Creatinine, Potassium, Calcium, Chloride, Glucose, Bicarbonate, SDH, Anion Gap

Pre-Anesthesia Panel (Sm An)
Sodium, Creatinine, Potassium, Calcium, Chloride, Glucose, Bicarbonate, ALT, Anion Gap

Ruminant Chem Panel
See "Large Animal Chemistry Panel"

Small Animal Chem Panel
Sodium, Potassium, Chloride, Bicarbonate, Anion Gap, Na:K, Urea, Creatinine, Calcium, Phosphate, Total Protein, Albumin, Globulin, A/G ratio, Glucose, ALT, AST, ALK PHOS, GGT, D. Bilirubin, Cholesterol, I. Bilirubin, Amylase, T. Bilirubin, TIBC, CK, % Saturation, Serum Iron, Magnesium, LDH

Small Animal Liver Panel
Albumin, AST, Glucose, ALT, Urea, ALK PHOS, GGT, T. Bilirubin, Cholesterol

Small Animal Renal Panel
Sodium, Potassium, Chloride, Bicarbonate, Anion gap, Urea, Creatinine, Albumin, Calcium, Phosphate, Cholesterol

Total Protein Panel
Total Protein, Globulin, Albumin, A/G ratio

Tot Protein Creatinine Ratio
Total Protein
Creatinine
Protein:Creatinine Ratio

Transition Cow Energy Panel
BHB
NEFA

HEMATOLOGY PANELS

Blood Smear Eval, Mammalian or Non-Mammalian
White Blood Cell Examination
Platelet Smear Examination
Red Blood Cell Examination
White Blood Cell Differential %

Hemogram, Automated
(Complete Bld Cnt Automated, or CBCA)
White Blood Cell Count (WBC)
Red Blood Cell Count (RBC)
Hemoglobin (Hb)
Hematocrit (Hct)
Mean Corpuscular Volume (MCV)
Mean Corpuscular Hemoglobin (MCH)
Mean Corpuscular Hemoglobin Concentration (MCHC)
Red Cell Distribution Width (RDW)
Automated Platelet Count
Mean Platelet Volume (MPV)
White Blood Cell Differential, Automated

Hemogram, Non-Mammalian
(Non-Mammalian Compl Bld Cnt, or CBC)
White Blood Cell Count (WBC)
Packed Cell Volume (PCV)
Red Blood Cell Examination
White Blood Cell Differential (Diff)
White Blood Cell Examination
Platelet Smear Examination
Plasma Examination
Total Protein by Refractometer (TP-Ref)

Hemogram, Partial
(Partial Blood Count, or PBC))
White Blood Cell Count (WBC)
Red Blood Cell Count (RBC)
Hemoglobin (Hb)
Hematocrit (Hct)
Mean Corpuscular Volume (MCV)
Mean Corpuscular Hemoglobin (MCH)
Mean Corpuscular Hemoglobin Concentration (MCHC)
Red Cell Distribution Width (RDW)
Automated Platelet Count
Mean Platelet Volume (MPV)

HEMATOLOGY PANELS

Hemogram, Routine*

(Complete Blood Count, or CBC)

- White Blood Cell Count (WBC)
- Red Blood Cell Count (RBC)
- Hemoglobin (Hb)
- Hematocrit (Hct)
- Mean Corpuscular Volume (MCV)
- Mean Corpuscular Hemoglobin (MCH)
- Mean Corpuscular Hemoglobin Concentration (MCHC)
- Red Cell Distribution Width (RDW)
- Automated Platelet Count
- Mean Platelet Volume (MPV)
- Red Blood Cell Examination
- White Blood Cell Differential (Diff)
- Platelet Smear Examination
- White Blood Cell Examination
- Plasma Examination
- Total Protein by Refractometer (Tp-Ref)

***A reticulocyte percentage and absolute reticulocyte count are provided in anemic dogs and cats**

White Blood Cell (WBC) Panel, Automated

- White Blood Cell Count (WBC)
- White Blood Cell Differential, Automated

White Blood Cell (WBC) Panel, Non-Mammalian

- White Blood Cell Count (WBC)
- White Blood Cell Differential (Diff)

White Blood Cell (WBC) Panel

- White Blood Cell Count (WBC)
- White Blood Cell Differential (Diff)
- Platelet Smear Examination
- White Blood Cell Examination

Serum Bile Acids Results: Guidelines for Interpretation

Dogs and Cats

Bile acid concentrations >25-30 umol/L in dogs and > 25 umol/L in cats are suggestive of hepatobiliary disease. These guidelines are valid for pre-prandial (fasting), post-prandial and random (unrelated to eating) samples. Most animals have higher post-prandial than fasting bile acid concentrations, however some animals (up to 20% of dogs) may have higher fasting than post-prandial bile acid concentrations, due to a recent meal, gall bladder contraction during fasting, or delayed gastric emptying. In this scenario, if both results are < 25 umol/L (especially < 15 umol/L), hepatobiliary disease is unlikely.

Based on studies done by Dr. Center at Cornell University, dogs with bile acid concentrations < 25 umol/L do not have evidence of hepatic pathology on biopsy, whereas dogs with values > 25 umol/L usually have hepatic pathology. Dogs with bile acid values between 15-25 umol/L are in an equivocal zone (i.e. may or may not have hepatic pathology). Most animals with congenital or acquired portosystemic shunting have markedly increased post-prandial bile acids concentration.

Prolonged fasting, intestinal malabsorption, or rapid gastrointestinal transit may lower bile acid concentrations and decrease the sensitivity of bile acid testing for hepatobiliary disease. Bile acid testing should not be done in an animal that is clinically icteric or has an increased direct (conjugated) bilirubin, since this test does not give any indication of hepatic function or portosystemic shunting in the presence of cholestasis.

Young dogs of breeds predisposed to congenital portosystemic shunts should be tested greater than 16 weeks of age, because bile acid concentrations may be falsely lower in animals younger than this. For stimulation testing, animals should be fed at their routine meal times (e.g. morning) and should be given their regular meal (amount and type).

Horses

Bile acids concentration greater than 11 umol/L can be the result of hepatobiliary disease. Slightly increased concentrations (up to approximately 20 umol/L) can result from decreased feed intake for a period of several days or longer. Most horses with hepatobiliary disease have markedly increased bile acids concentration.

Bile acid testing should not be done in an animal that has an increased direct (conjugated) bilirubin or bilirubinuria (both of which indicate cholestasis), since this test does not give any indication of hepatic function or portosystemic shunting in the presence of cholestasis.

Cows

Bile acids concentrations are extremely variable in health and therefore have not been found to be useful in diagnosis of hepatobiliary disease. For optimum diagnostic value, bile acids results should be interpreted with regard to clinical findings and other laboratory results.

Sample Index Results

You will find three test results following the results for both fasting and post-prandial bile acids results. These tests are titled LIPEMIA, HEMOLYSIS, and ICTERUS. These are actually indexes of sample quality and are assessed by the analyzer by passing light at different wavelengths through the sample. The number reported under LIPEMIA measures the turbidity of the sample, which may be due to lipid (fat). The number reported under HEMOLYSIS is a semi-quantitative measurement of the concentration of free hemoglobin in mg/dL. The number reported under ICTERUS is an estimation of the bilirubin concentration in mg/dL rounded to the nearest whole number. These indexes are more quantitative and consistent than visual assessment of these interferences in the sample. The LIPEMIA and HEMOLYSIS index results correlates with a visual assessment of the sample as follows:

LIPEMIA = 30 – 60 appears slightly turbid (hazy)
LIPEMIA = 60 – 120 appears moderately turbid (milky)
LIPEMIA > 120 appears markedly turbid (creamy)
HEMOLYSIS = 20 – 100 appears slightly hemolyzed (pink tinged)
HEMOLYSIS = 100 –300 appears moderately hemolyzed (red)
HEMOLYSIS > 300 appears markedly hemolyzed (dark red)

Lipemia (falsely increases) and hemolysis (falsely decreases) do interfere with bile acid measurement, so efforts should be undertaken to minimize these (by not feeding too large a meal and by separating serum from cells as soon as possible). Our laboratory indicates when bile acid concentrations may have been affected by these interferences. Bile acids should not be performed in an animal with icterus due to cholestasis or any biochemical evidence of cholestasis (high total and direct bilirubin with bilirubinuria), since in these cases, the test does not give any additional information about liver function or vascular abnormalities.

For more information on bile acids, please refer to the specialized chemistry test section of our Chemistry Module.

Protocol for performing a fasting and post-prandial bile acid test

For the fasting sample, blood should be collected after an overnight fast or alternatively just before a meal (when the animal is hungry). For the post-prandial sample, blood is drawn two hours after the animal is fed its regular meal (type of food and amount) to maximize the likelihood of gall bladder contraction. This is often best done at home (where the animal is more likely to eat and have normal gastrointestinal motility). Both blood samples should be collected into red-top vacutainers (serum is preferred for bile acid measurement) and serum should be separated promptly from cells.

Cholinesterase Results: Guidelines for Interpretation

Measurement of cholinesterase activity in serum or plasma is an inexpensive and quick screening test that is indicated for animals with a history of possible exposure to organophosphate or carbamate compounds and/or show clinical signs compatible with exposure.

Serum/plasma cholinesterase activity below the reference interval is consistent with exposure to cholinesterase-inhibiting compounds, including organophosphate and carbamate insecticides. If history and clinical signs are suggestive of organophosphate or carbamate poisoning, then testing of tissue, gastric contents, urine, or blood for these insecticides may be warranted.

Cholinesterase activity within the reference interval does not rule out exposure to organophosphate or carbamate insecticides since the range of activity within a species is so broad that an individual animal may have significant reduction of its pre-exposure activity and still be within the reference interval. Cholinesterase activity above the reference interval has no known significance. Hemolysis can increase cholinesterase activity in serum/plasma samples by release of cholinesterase from red blood cells.

Special Sample Collection Instructions for Ionized Calcium Testing

Test Name: Calcium, Ionized or Ionized Calcium
Test Days: M-Sa
Lag: 1 day
Samples: 1 mL separated serum
Container: non-anticoagulant tube (plain red top)
Coolant: refrigerate

Please note that for ionized calcium testing, blood samples should be collected into non-anticoagulant (plain red top) tubes. The sample should then be centrifuged and the serum removed anaerobically (using an evacuated needle and syringe through the tube cap) and placed into a second non-anticoagulant tube (once again, inserting the needle through the cap of the tube). The tubes should not be uncapped under any circumstances. Keep the serum cool at all times. Analysis should be performed within 48 hours after collection for optimal results. Alternatively the serum can be frozen, shipped on dry ice, and analyzed within seven days.

Special Sample Collection Instructions for Ammonia

Measurement of ammonia is problematic as **it rapidly increases with storage in whole blood and also increases with storage in separated plasma.** As a result the following handling collection and handling instructions should be followed:

Mailed-in samples or samples that will not reach the lab within an hour of sampling:
Blood should be collected into EDTA or heparin tubes, separated immediately and the plasma should befrozen. The frozen plasma sample should be shipped to the lab on dry ice (needs to stay frozen). Mark the outside of the shipping box in large letters with the following: PERISHABLE KEEP FROZEN. If the sample arrives at the lab thawed a comment will be added indicating that the ammonia value may be falsely increased from storage.

Local clients within a 1 hour drive from the lab:
Blood should be collected into **EDTA or heparin tubes, separated immediately and the plasma kept on ice until analysis. Ammonia is stable in plasma for a maximum of 3 hours under these conditions. If sample separation from cells cannot be achieved, the sample should be kept on ice until submission to the laboratory, however ammonia will be less accurate.** Mark the outside of the shipping box in large letters with the following: PERISHABLE KEEP COOL.

Control samples (from a clinically healthy animal) collected and handled in the same manner should always be run in conjunction with patient samples, to ensure that sample collection and handling are not responsible for elevations in ammonia.

Please contact the lab prior to collecting and sending the sample. This way testing can be expedited once the sample arrives.

Non-Esterified Fatty Acid (NEFAs) in Transition (Pre-partum or Post-partum) Dairy Cows:

Guidelines for interpretation

The following interpretation guidelines are based on studies done at Cornell University and are valid for samples collected from 'at risk' TMR-fed cows between **2-14 days precalving** (prepartum NEFAs) or **3-14 days post-calving** (postpartum NEFAs). We recommend sampling **at least 12 'at risk' cows** when evaluating total mixed ration (TMR)-fed herds for negative energy balance.

Cow level testing

- **Prepartum NEFAs:** There is an increased incidence of postcalving diseases (displaced abomasum, metritis/retained placenta and clinical ketosis), decreased milk yield and decreased reproductive performance in the first 30 days in milk in Holstein dairy cows (fed TMR) with NEFA values **> 0.30 mEq/L when tested 2-14 days before calving.**
- **Postpartum NEFAs:** There is an increased incidence of postcalving diseases (displaced abomasum, metritis/retained placenta and clinical ketosis), decreased milk yield and decreased reproductive performance in the first 30 days in milk in Holstein dairy cows (fed TMR) with NEFA values **> 0.60-0.70 mEq/L when tested 3-14 days after calving**. In the Cornell studies, postcalving NEFAs were actually a better predictor of than postcalving beta-hydroxybutyrate concentrations or precalving NEFAs.

Herd level testing

- **Prepartum NEFAs:** At the herd-level, there is a significantly increased risk of post-calving metabolic and infectious diseases, decreased milk production or decreased reproductive performance if **>15% of tested precalving cows have NEFA values > 0.30 mEq/L**. Note, pooling samples from individual cows is not recommended for herd-level testing.
- **Postpartum NEFAs:** At the herd-level, there is a significantly increased risk of post-calving metabolic and infectious diseases, decreased milk production or decreased reproductive performance if **>15-20% of tested postcalving cows have NEFA values > 0.70 mEq/L**. Note, pooling samples from individual cows is not recommended for herd-level testing.

β-Hydroxybutyrate (BHB) Testing in Post-Partum Dairy Cows: Guidelines for Interpretation

The following interpretation guidelines are based on studies done at Cornell University and are valid for samples collected from 'at risk' TMR-fed cows between **3-14 days post-calving**. We recommend sampling **at least 12 'at risk' cows** when evaluating total mixed ration (TMR)-fed herds for subclinical ketosis.

- **Cow level testing: Post-calving BHB > 10 mg/dL** is associated with a significant risk of post-calving metabolic or infectious diseases (displaced abomasum, clinical ketosis and metritis), decreased milk yield and decreased reproductive performance in individual TMR-fed Holstein cows.
- **Herd level testing:** At the herd-level, there is a significantly increased risk of these post-calving diseases, decreased milk production or decreased reproductive performance if **>10% of tested post-calving cows have BHB values > 10 mg/dL**. Note, pooling samples from individual cows is not recommended for herd-level testing.

Clinical ketosis

Clinical ketosis typically occurs in cows during early lactation (usually the first 2-4 weeks). This is also called lactation or spontaneous ketosis and is a consequence of excess negative energy balance due to stresses of calving and lactation. Occasionally, dairy cows in late lactation can also develop clinical ketosis (pregnancy ketosis) due to negative energy balance. Affected cows are dull, inappetant, lose weight and have decreased milk yield. Cows with clinical ketosis in dairy herds fed concentrate rations are frequently concurrently hypoglycemc. This worsens the state of negative energy balance Blood, urine and milk BHB values are often quite high. **Blood BHB values >27 mg/dL are considered compatible with clinical ketosis**. Cows with underlying hepatic lipidosis may have concurrent elevations in liver leakage enzymes (AST, SDH, GLDH) or cholestatic enzymes (GGT, ALP).

Metabolic Profiles in Post-partum Dairy Cows: Guidelines for Interpretation

The following interpretation guidelines are based on studies done at Cornell University and are valid for samples collected from 'at risk' TMR-fed cows between **3-14 days post-calving**. We recommend sampling **at least 12 'at risk' cows** when evaluating total mixed ration (TMR)-fed herds for negative energy balance and subclinical ketosis.

- **NEFA:** NEFAs are a biomarker of negative energy balance. NEFA concentrations are interpreted as the proportion of animals above a specific cut-off value. Based on studies done at Cornell University in total mixed ration (TMR)-fed dairy cows, we interpret results as follows**:**
    - ***For individual dairy cows***, there is an increased incidence of postcalving diseases (displaced abomasum, metritis/retained placenta and clinical ketosis), decreased milk yield and decreased reproductive performance in the first 30 days in milk in Holstein dairy cows with NEFA values **> 0.60-0.70 mEq/L when tested 3-14 days after calving**.
    - ***At the herd-level***, there is a significantly increased risk of post-calving metabolic and infectious diseases, decreased milk production or decreased reproductive performance if **>15-20% of tested postcalving cows have NEFA values > 0.70 mEq/L**. Pooling of samples is not recommended for herd-level testing.
- **Beta-Hydroxybutyrate (BHB):** BHB is used as a marker of subclinical ketosis and values are interpreted similarly to NEFAs.
    - ***For individual dairy cows***, a **post-calving BHB > 10 mg/dL** is associated with a significant risk of post-calving metabolic or infectious diseases (displaced abomasum, clinical ketosis and metritis), decreased milk yield and decreased reproductive performance in individual TMR-fed Holstein cows.
    - ***At the herd-level***, there is a significantly increased risk of these post-calving diseases, decreased milk production or decreased reproductive performance if **>10% of tested post-calving cows have BHB values > 10 mg/dL**. Pooling of samples is not recommended for herd-level testing.
- **AST:** This hepatocellular leakage enzyme is used as a marker of underlying hepatic lipidosis. However, AST is not specific for liver and will be increased with skeletal muscle injury. In addition, it does not appear to be a very sensitive test for lipidosis in dairy cows. Alternatives to AST include GLDH, which is more stable than SDH (both SDH and GLDH are markers of liver injury).
- **Urea:** This is a reflection of the ammonia concentration in the rumen and the protein (and energy) content in the diet. Urea can be measured in blood, serum, plasma or milk, with results being interpreted similarly. The current recommendation (based on previous studies in the literature) is that the average urea concentration of the tested cows should be between 13-17 mg/dL. Both high and low values indicate the need for modifying the content of the ration.
- **Albumin:** Albumin values are also used to reflect the nutrient and energy content of the diet. Some investigators use a goal of > 3 g/dl for an average albumin value of the tested animals. Note that

albumin concentrations are also affected by other conditions including inflammatory states (albumin will decrease because it is a negative acute phase protein), liver disease (albumin is produced in the liver), and renal and gastrointestinal disease (albumin can be lost in these disorders).

Transition Cow Energy Profiles in Post-partum Dairy Cows: Guidelines for Interpretation

The following interpretation guidelines are based on studies done at Cornell University and are valid for samples collected from 'at risk' TMR-fed cows between **3-14 days post-calving**. We recommend sampling **at least 12 'at risk' cows** when evaluating total mixed ration (TMR)-fed herds for negative energy balance and subclinical ketosis.

- **NEFA:** NEFAs are a biomarker of negative energy balance. NEFA concentrations are interpreted as the proportion of animals above a specific cut-off value. Based on studies done at Cornell University in total mixed ration (TMR)-fed dairy cows, we interpret results as follows**:**
    - ***For individual dairy cows***, there is an increased incidence of postcalving diseases (displaced abomasum, metritis/retained placenta and clinical ketosis), decreased milk yield and decreased reproductive performance in the first 30 days in milk in Holstein dairy cows with NEFA values **> 0.60-0.70 mEq/L when tested 3-14 days after calving**.
    - ***At the herd-level***, there is a significantly increased risk of post-calving metabolic and infectious diseases, decreased milk production or decreased reproductive performance if **>15-20% of tested postcalving cows have NEFA values > 0.70 mEq/L**. Pooling of samples is not recommended for herd-level testing.
- **Beta-Hydroxybutyrate (BHB):** BHB is used as a marker of subclinical ketosis and values are interpreted similarly to NEFAs.
    - ***For individual dairy cows***, a **post-calving BHB > 10 mg/dL** is associated with a significant risk of post-calving metabolic or infectious diseases (displaced abomasum, clinical ketosis and metritis), decreased milk yield and decreased reproductive performance in individual TMR-fed Holstein cows.

At the herd-level, there is a significantly increased risk of these post-calving diseases, decreased milk production or decreased reproductive performance if **>10% of tested post-calving cows have BHB values > 10 mg/dL**. Pooling of samples is not recommended for herd-level testing.