Welcome to Unit 11. The lecture for this unit will cover other laboratory assays. There is only one section for unit 11. This week is shorter in order to allow students to continue working on the Application Questions.
We are going to review other laboratory assays that are more commonly used in the healthcare setting. These tests are not intended to detect the presence of a specific pathogen, but rather, to identify that an infection or inflammation process is underway. These tests look at the profile of a certain component of the patient’s blood or other clinical samples, such as CSF. These tests detect the hosts’ response to an infection, rather than targeting the identification of a specific pathogen.
Elevated total protein or C-reactive protein in a patient’s body fluids, cerebrospinal fluid or blood indicates the presence of infection or acute inflammation. C-reactive protein (or CRP) is an abnormal serum glycoprotein produced by the liver during an acute inflammation. Pandy’s test is the recommended screening method of increases in a protein called globulin. An increase in total protein in conjunction with a positive Pandy’s test occurs with meningitis.
Other Laboratory Assays: Protein Analysis

- **Effusion**: fluid which collects in a body
- **Exudate**: fluid which collects due to an inflammatory process (purulent or cloudy, may clot)
- **Transudate**: fluid which forms due to a non-inflammatory condition (pale yellow, clear, and unclotted)

In addition to protein analysis of blood and CSF, this type of test can be conducted on various types of body fluid, including effusion, exudate, and transudate. Effusion is a fluid which collects in the body. Exudate is a fluid which collects due to an inflammatory process and is usually purulent or cloudy and may clot. Transudate is a fluid which forms due to a non-inflammatory condition and is typically pale yellow, clear, and unclotted. In protein analysis tests, the presence of less than 30 grams/liter of protein in transudate and the presence of more than 30 grams per liter in exudate indicates an inflammatory reaction.
Glucose analysis test the levels of glucose in body fluids. Low levels of glucose in body fluids or CSF are indicators of infection, such as bacterial meningitis. Glucose levels may be normal in viral and fungal meningitis. The concentration of glucose in cerebrospinal fluid is typically $\frac{1}{2}$ to $\frac{2}{3}$ that of the concentration of glucose in the blood.
A complete blood count, or CBC, contains counts of various blood components including hemoglobin, hematocrit, red blood cells, red blood cells indices, white blood cells, white blood cell differential, platelets, and a microscopic examination of stained blood smears. The CBC is often used for a screening tool in general health assessments, as well as to track the progress of an infection. For the purposes of diagnosing and monitoring infection, the white blood cell (WBC) count and differential are most useful.
White blood cells, or leukocytes, are instrumental in fighting off infection. The WBC count can be used to determine the severity of disease, based on the type of WBCs seen and how it correlates to the clinical condition. The White Blood Cell count is the total number of white blood cells (leukocytes) in 1 mm$^3$ of peripheral blood. An increased WBC count (i.e. >10,000) indicates infection, inflammation, or leukemic neoplasma. In some severe infections, such as sepsis, extremely high WBC counts may occur, approaching levels associated with leukemia. This phenomenon is called a leukemoid reaction.
Leukopenia or a decreased WBC count (< 4000) can occur with overwhelming infections, such as AIDS, viral hepatitis, mononucleosis, and Legionnaire’s disease.
The White Blood Count Differential measures the percentage of each type of leukocyte present in the blood specimen. There are five types of WBCs found in blood. In order of frequency they are: neutrophils, lymphocytes, monocytes, eosinophils, and basophils.
The primary function of neutrophils is phagocytosis. During acute bacterial infections, neutrophil production may be stimulated, leading to an increase in WBC counts. During this stimulated production, immature neutrophils may enter the bloodstream. Neutrophils are increased when there is inflammation, bacterial infection, or in early stages of viral infections. Conversely, decreased neutrophils can be seen in overwhelming bacterial infections, viral infection and hematopoietic disease.
Eosinophils are typically associated with an allergic reaction. They can be elevated with parasitic infections, including trichnosis tapeworm, and occasionally with leprosy and TB. Eosinophil levels vary with the time of day, so serial or repeat tests should be drawn at the same time so that they can be compared.
Basophil levels are used to monitor chronic inflammation. Increases are sometimes seen with infections with TB, smallpox, chickenpox, or influenza, but can be from a variety of reasons, including leukemia, inflammation, and allergic reaction. Decreases in basophils are seen in the acute phases of an infection, stress reactions, prolonged steroid or chemotherapy treatment, and acute rheumatic fever in children.
An increase in monocytes is associated with bacterial infections, TB, subacute bacterial endocarditis, syphilis, recovery stage of neutropenia, some parasites, and surgical trauma. In severe infection, phagocytic monocytes (macrophages) may be seen. Decreases in monocytes are seen in HIV, aplastic anemia, or overwhelming infection that causes neutropenia.
Lymphocytes can be prominent in viral infections. In addition, increased lymphocytes are associated with certain types of leukemia, viral infections of the upper respiratory tract, cytomegalovirus, infectious mononucleosis, measles, mumps, chickenpox, and viral hepatitis. Decreases may be seen due to chemotherapy, steroids, some immune disorders, CHF, and miliary TB.
Another type of laboratory test is fecal leukocytes, which can help to determine if the cause of a patient’s diarrhea is invasive or non-invasive to the mucosa of the colon. If the fecal sample is positive for leukocytes, then the cause of the diarrhea is an organism or process that is breaking the mucosal barrier of the colon, such as *Salmonella, Shigella, Campylobacter, Amoeba*. Fecal leukocytes are not typically present in infections that do not invade the mucosa, such as viral enteritis or toxin mediated diarrhea.
The erythrocyte sedimentation rate measures the degree that white blood cells (WBCs) settle in a test tube over a set period of time (usually one hour). Inflammatory proteins in the blood make RBCs clump and settle faster. Tests for inflammation in the body. If ↑, then there is an inflammatory process or bacterial infection. Pneumonia, syphilis, TB. Viral infections do not usually result in ↑ sedimentation rate. Used to determine whether additional tests need to be done or to monitor the progress of treatment for a known inflammatory or infectious disease.

The erythrocyte sedimentation rate measures the degree that white blood cells (WBCs) settle in a test tube over a set period of time (usually one hour). Inflammatory proteins in the blood cause the WBCs to clumps and settle faster, so an elevated rate indicates that an inflammatory process or bacterial infection is underway. From an infectious disease perspective, increased erythrocyte sedimentation rates suggest pneumonia, syphilis, and TB. Viral infections do not usually result in an increased sedimentation rate. This test lacks sensitivity and specificity as to the disease process, but can be used to determine whether additional tests need to be done or to monitor the progress of treatment for a known inflammatory or infectious disease.
Urinalysis is used as a screening tool to assess general health, as well as the health of the urinary tract. A total urinalysis includes assessment of the appearance; color; odor; specific gravity; pH; presence of bilirubin, blood, glucose, ketones, leukocyte esterase, nitrite, protein, or urine crystals; as well as observance for various cells such as RBCs, RBC casts, WBCs, and WBC casts.

Appearance of the urine is noted by the laboratory staff, as cloudy urine or presence of a sediments may indicate infection or some other disease state. The color of the urine can be impacted by several factors. Normal color is pale yellow to amber. Colorless urine indicates a large fluid intake or diuretic therapy; orange, concentrated urine can be caused by bilirubin in the urine or certain medications; green urine indicates a pseudomonal infection, and pink to red urine indicates the presence of RBCs or hemoglobin. Urine that presents with a fruity odor is a textbook sign of diabetes mellitus, while foul smelling urine may indicate a urinary tract infection.

Specific gravity is a test of the kidney’s ability to concentrate urine, but this test is not typically involved in the diagnosis of infectious diseases.

The pH of the urine can also be affected by multiple factors; however, urine that tests alkaline may indicate a UTI or bacterial contamination of the sample.
Bilirubin in the urine can indicate liver disease, sepsis, obstructive biliary tract disease, and hyperthyroidism. False results may be obtained if the sample is exposed to light or if the patient is taking certain medications. Blood in the urine, or hematuria, can be due to trauma or disease, including UTI. A positive urine glucose occurs in diabetes mellitus, endocrine disorders, and in liver and pancreatic diseases. Ketonuria, or ketones in the urine, is typically associated with diabetes.

The presence of leukocyte esterase in the urine sample indicates that WBCs are present. Infection, systemic lupus erythematosus, and tuberculosis infection can all result in positive leukocyte esterase. These findings should be confirmed via microscopic examination.

Many bacteria produce an enzyme that can reduce normal urinary nitrates to nitrites. Therefore, the presence of nitrites in urine can be used to screen for the presence of bacteria in urine. If nitrites are found in the urine, then a urine culture should be completed to identify the involved pathogen.

Protein in the urine is an indication of renal disease, but is not necessarily used in the diagnosis of infectious disease. The presence of crystals suggests partial or complete obstruction of urine flow.
Urine RBCs and RBC casts indicate serious renal disease. From an infectious disease perspective, a positive finding on this lab test may indicate malaria, renal tuberculosis, or acute febrile episode. RBC casts result from hemorrhage in the nephron or acute inflammatory or vascular disorders, or in acute bacterial endocarditis. WBCs and WBC casts indicate inflammation in the genitourinary system or an infection. Among other causes, WBCs in the urine may signal a UTI, appendicitis, or tuberculosis. WBC casts show in the urine when there is a renal parenchymal infection, such as pyelonephritis. The microscopy image shown on this slide shows red blood cells, white blood cells, and yeast, identified in a urine sample.
This concludes Unit 11’s lecture. Please be sure to take advantage of the smaller amount of lecture material this week in order to make progress on the Application Questions.