



Synovial Fluid

Reference Books:

- **Urinalysis and body fluids** (Susan King Strasinger- Marjorie Schaub De Lorenzo) Fifth edition

- **Synovial fluid “joint fluid”:** is a viscous liquid found in the cavities of the movable joints or synovial joints.
- The joint is enclosed in a fibrous joint capsule lined by the synovial membrane. The synovial membrane contains specialized cells called synoviocytes.
- The smooth articular cartilage and synovial fluid reduce friction between the bones during joint movement. In addition to providing lubrication in the joints, synovial fluid provides nutrients to the articular cartilage and lessens the shock of joint compression that occurs during activities such as walking and jogging.

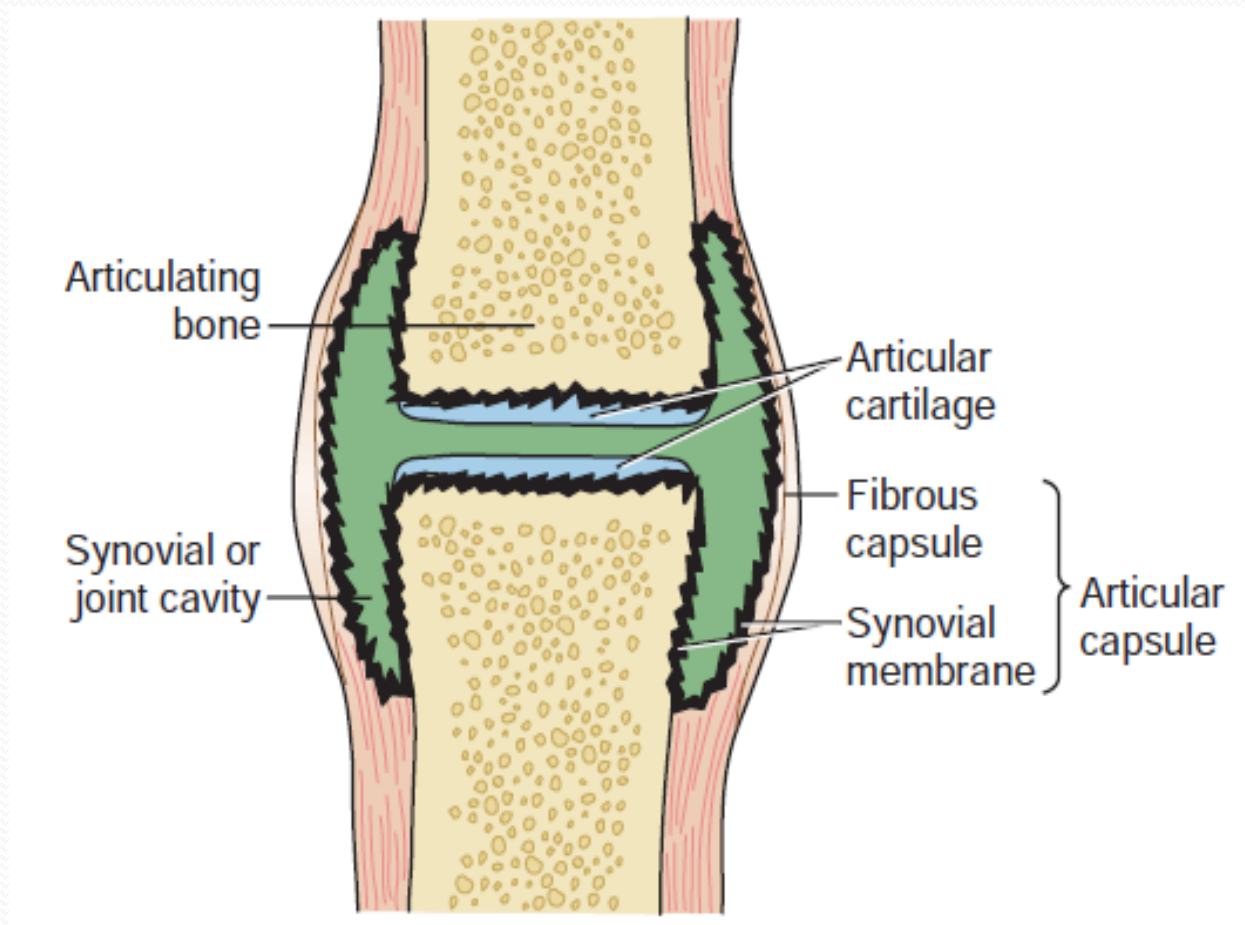


Diagram of a synovial joint

- Synovial fluid is formed as an ultrafiltrate of plasma across the synovial membrane.
- The synoviocytes secrete a mucopolysaccharide containing hyaluronic acid and small amount of protein (approximately one fourth of the plasma concentration) into the fluid.
- A variety of conditions including infection, inflammation, metabolic disorders, trauma, physical stress, and advanced age are associated with arthritis.

Specimen Collection and Handling

- Synovial fluid is collected by needle aspiration called **arthrocentesis**.
- The normal amount of fluid in the adult knee cavity is less than 3.5 mL, but can increase to greater than 25 mL with inflammation.
- The volume of fluid collected should be recorded. Normal synovial fluid does not clot; however, fluid from a diseased joint may contain fibrinogen and will clot.

- A sterile heparinized tube for Gram stain and culture
- A heparin or ethylene diamine tetra acetic acid (EDTA) tube for cell counts
- A non-anticoagulated tube for other tests
- A sodium fluoride tube for glucose analysis

Color and Clarity

- Normal viscous synovial fluid resembles egg white. The color becomes a deeper yellow in the presence of noni-nflammatory and inflammatory effusions and may have a greenish tinge with bacterial infection.

- In synovial fluid the presence of blood from a hemorrhagic arthritis must be distinguished from blood from a traumatic aspiration.
- Turbidity is frequently associated with the presence of WBCs; however, synovial cell debris and fibrin also produce turbidity. The fluid may appear milky when crystals are present.

Viscosity

- Viscosity of the synovial fluid comes from the polymerization of the hyaluronic acid and is essential for the proper lubrication of the joints. Arthritis affects both the production of hyaluronate and its ability to polymerize, thus decreasing the viscosity of the fluid.
- Measurement of the amount of hyaluronate polymerization can be performed using a **Ropes**, or **mucin clot, test**. When added to a solution of 2% to 5% acetic acid, normal synovial fluid forms a solid clot surrounded by clear fluid.

The mucin clot test is reported in terms of good (solid clot), fair (soft clot), low (friable clot), and poor (no clot).



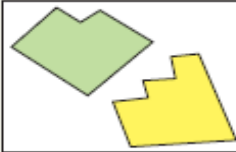
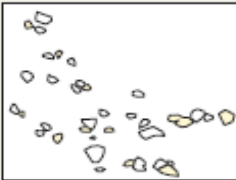
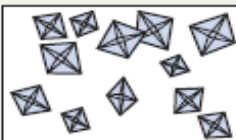
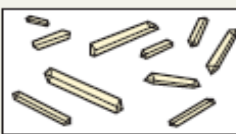
Cell Counts

- The total leukocyte count is the most frequently performed cell count on synovial fluid. Red blood cell (RBC) counts are seldom requested.
- WBC counts less than 200 cells/L are considered normal and may reach 100,000 cells/L or higher in severe infections.

Differential Count

Cell/Inclusion	Description	Significance
Neutrophil	Polymorphonuclear leukocyte	Bacterial sepsis Crystal-induced inflammation
Lymphocyte	Mononuclear leukocyte	Nonseptic inflammation
Macrophage (monocyte)	Large mononuclear leukocyte, may be vacuolated	Normal Viral infections
Synovial lining cell	Similar to macrophage, but may be multinucleated, resembling a <i>mesothelial cell</i>	Normal
LE cell	Neutrophil containing characteristic ingested: "round body"	Lupus erythematosus
Reiter cell	Vacuolated macrophage with ingested neutrophils	Reiter syndrome Nonspecific inflammation
RA cell (ragocyte)	Neutrophil with dark cytoplasmic granules containing immune complexes	Rheumatoid arthritis Immunologic inflammation
Cartilage cells	Large, multinucleated cells	Osteoarthritis
Rice bodies	Macroscopically resemble polished rice Microscopically show collagen and fibrin	Tuberculosis, septic and rheumatoid arthritis
Fat droplets	Refractile intracellular and extracellular globules Stain with Sudan dyes	Traumatic injury Chronic inflammation
Hemosiderin	Inclusions within clusters of synovial cells	Pigmented villonodular synovitis

Crystal Identification

Crystal	Shape		Compensated Polarized Light	Significance
Monosodium urate	Needles		Negative birefringence	Gout
Calcium pyrophosphate	Rhombic square, rods		Positive birefringence	Pseudogout
Cholesterol	Notched, rhombic plates		Negative birefringence	Extracellular
Corticosteroid	Flat, variable-shaped plates		Positive and negative birefringence	Injections
Calcium oxalate	Envelopes		Negative birefringence	Renal dialysis
Apatite (Ca phosphate)	Small particles Require electron microscopy		No birefringence	Osteoarthritis

Chemistry Tests

- Because synovial fluid is chemically an ultrafiltrate of plasma, chemistry test values are approximately the same as serum values. Therefore, few chemistry tests are considered clinically important.
- The glucose determination, as markedly decreased values are indicative of inflammatory or septic disorders. normal synovial fluid glucose should not be more than 10 mg/dL lower than the blood value.
- Other chemistry tests that may be requested are the total protein and uric acid determinations.

- Because the large protein molecules are not filtered through the synovial membranes, normal synovial fluid contains less than 3 g/dL of protein (approximately one third of the serum value). Increased levels are found in inflammatory and hemorrhagic disorders.
- The elevation of serum uric acid in cases of gout is well known; therefore, demonstration of an elevated synovial fluid uric acid level may be used to confirm the diagnosis when the presence of crystals cannot be demonstrated in the fluid.

Microbiologic Tests

- Gram stains and cultures are two of the most important tests performed on synovial fluid.
- Bacterial infections are most frequently seen; however, fungal, tubercular, and viral infections also can occur.
- Routine bacterial cultures should include an enrichment medium, such as chocolate agar, because in addition to *Staphylococcus* and *Streptococcus*, the common organisms that infect synovial fluid are the fastidious *Haemophilus* species and *N. gonorrhoeae*.

Serologic Tests

- Because of the association of the immune system to the inflammation process, serologic testing plays an important role in the diagnosis of joint disorders. However, the majority of the tests are performed on serum. The autoimmune diseases rheumatoid arthritis and lupus erythematosus cause very serious inflammation of the joints and are diagnosed in the serology laboratory by demonstrating the presence of their particular auto antibodies in the patient's serum. These same antibodies can also be demonstrated in the synovial fluid. The extent of inflammation can be determined through measurement of the concentration of acute phase Reactants such as fibrinogen and C-reactive protein.

Normal Synovial Fluid Values

Volume	<3.5 mL
Color	Colorless to pale yellow
Clarity	Clear
Viscosity	Able to form a string 4–6 cm long
Leukocyte count	<200 cells/ μ L
Neutrophils	<25% of the differential
Crystals	None present
Glucose:plasma difference	<10 mg/dL lower than the blood glucose
Total protein	<3 g/dL

Classification and Pathologic Significance of Joint Disorders

Group Classification	Pathologic Significance
1. Noninflammatory	Degenerative joint disorders, osteoarthritis
2. Inflammatory	Immunologic disorders, rheumatoid arthritis, lupus erythematosus, scleroderma, polymyositis, ankylosing spondylitis, rheumatic fever, and Lyme arthritis Crystal-induced gout and pseudogout
3. Septic	Microbial infection
4. Hemorrhagic	Traumatic injury, tumors, hemophilia, other coagulation disorders Anticoagulant overdose

Laboratory Findings in Joint Disorders

Group Classification	Laboratory Findings
1. Noninflammatory	Clear, yellow fluid Good viscosity WBCs <1000 μL Neutrophils <30% Normal glucose (similar to blood glucose)
2. Inflammatory (immunologic origin)	Cloudy, yellow fluid Poor viscosity WBCs 2000–75,000 μL Neutrophils >50% Decreased glucose level Possible autoantibodies present
(crystal-induced origin)	Cloudy or milky fluid Low viscosity WBCs up to 100,000 μL Neutrophils <70% Decreased glucose level Crystals present
3. Septic	Cloudy, yellow-green fluid Variable viscosity WBCs 50,000–100,000 μL Neutrophils >75% Decreased glucose level Positive culture and Gram stain
4. Hemorrhagic	Cloudy, red fluid Low viscosity WBCs equal to blood Neutrophils equal to blood Normal glucose level