Chapter 10

PLEURAL, PERICARDIAL, AND PERITONEAL FLUID ANALYSIS

Serous Cavity Physiology

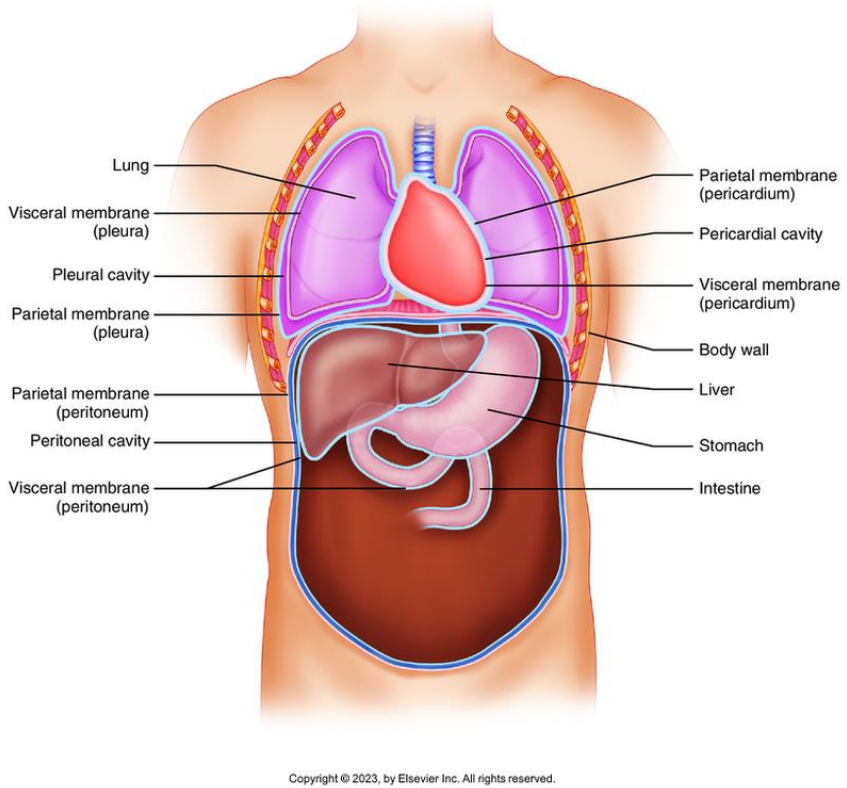
Serous membrane covers lungs, heart, and abdominal organs (visceral membrane) and internal surfaces of body cavity wall (parietal membrane)

Fluid-filled space or cavity between these membranes

Each cavity separate and named for organs it encloses

Pleural—lungs; pericardial—heart; peritoneal—abdominal organs

Figure 10-1. Parietal and visceral membranes of the pleural, pericardial, and peritoneal cavities. Parietal membranes line the body wall, whereas visceral membranes enclose organs. The two membranes are actually one continuous membrane. The space between opposing surfaces is identified as the body cavity (i.e., pleural cavity, pericardial cavity, peritoneal cavity).



Fluid Formation

Formation and absorption of fluid is dynamic

Controlled by four factors:

- Permeability of capillaries in parietal membrane
- Hydrostatic pressure in these capillaries
- Oncotic pressure (colloid osmotic pressure) produced by plasma proteins in capillaries
- Absorption of fluid by lymphatic system

Hydrostatic pressure (blood pressure) forces plasma ultrafiltrate to form in cavity

At the same time, plasma proteins in capillaries produce oncotic pressure opposing this filtration

Fluid Formation (Cont.)

Permeability of capillary endothelium regulates rate of ultrafiltrate formation and its protein composition

Increased permeability causes increased movement of protein into cavity fluid

Protein-rich fluid causes further movement of fluid into cavity

Effusion—accumulation of fluid in a body cavity indicating an abnormal or pathologic process

Specimen Collection Terms

Paracentesis—percutaneous puncture of a body cavity for aspiration of fluid

Thoracentesis—to obtain pleural fluid

Pericardiocentesis—for pericardial fluid

Peritoneocentesis (or abdominal paracentesis) for peritoneal fluid

- Ascites—an effusion in peritoneal cavity
- Ascitic fluid—same as peritoneal fluid

Collection of fluid is an invasive surgical procedure performed by a physician

Collection

Sterile tubes coated with anticoagulant used for fluid specimens for microscopic examination or microbiological studies to prevent clotting of abnormal specimens containing fibrinogen or blood

Nonanticoagulant red-top tubes for chemistry studies

Maintain tubes at room temperature and transport to laboratory immediately

Collect a blood sample for comparison purposes

Classification of Fluids

Transudate

- Results from systemic disease that causes an increase in hydrostatic pressure or a decrease in plasma oncotic pressure
- Noninflammatory

Exudate

- Results from inflammatory processes that increase permeability of capillary endothelium or a decrease in absorption by lymphatic system
- Infections, neoplasms, trauma, inflammatory conditions

TABLE 10.3 Serous Effusions: Types, Mechanism of Formation, and Associated Conditions

Effusion	Type	Mechanism of Formation	Conditions
Pleural and peritoneal	Transudates	Decreased hydrostatic pressure Decreased oncotic pressure	Congestive heart failure Hepatic cirrhosis Nephrotic syndrome
Pleural and peritoneal	Exudates	Increased capillary permeability	Infection (e.g., bacterial, tuberculous, viral, fungal) Tumors/neoplasms Pleural: lung and metastatic cancers Peritoneal: hepatic and metastatic cancers Systemic disease (e.g., rheumatoid arthritis, systemic lupus erythematosus) Gastrointestinal disease (e.g., pancreatitis)
		Decreased lymphatic absorption	Tumors/neoplasms (e.g., lymphoma, metastasis) Trauma or surgery
Pericardial	Not categorized as transudate or exudate	Increased capillary permeability due to changes in parietal membrane	Infections (e.g., bacterial, tuberculous, viral, fungal) Cardiovascular disease (e.g., myocardial infarction, aneurysms) Tumors/neoplasms (e.g., metastatic cancers) Hemorrhage Systemic disease (e.g., rheumatoid arthritis, systemic lupus erythematosus)

Physical Examination

Transudates

- Clear, pale yellow
- Viscosity similar to serum
- Do not clot (have no fibrinogen)

Exudates

- Usually cloudy
- Various colors—yellow, green, or pink to red
- May have shimmer or sheen
- Can form clots

Fluid Appearance

Cloudy paracentesis fluid: large numbers of white blood cells (WBCs), other cells, chyle, and/or lipids; milky after centrifugation indicates chyle

Chylous effusions: caused by obstruction of or damage to lymphatic system

Pseudochylous effusions: chronic effusions can be differentiated from chylous effusions by their lipid content

- Chylous: high triglycerides and chylomicrons present
- Pseudochylous: low triglycerides and no chylomicrons

Microscopic Examination May Include

Total cell count

Red and white blood cell counts

Differential cell count

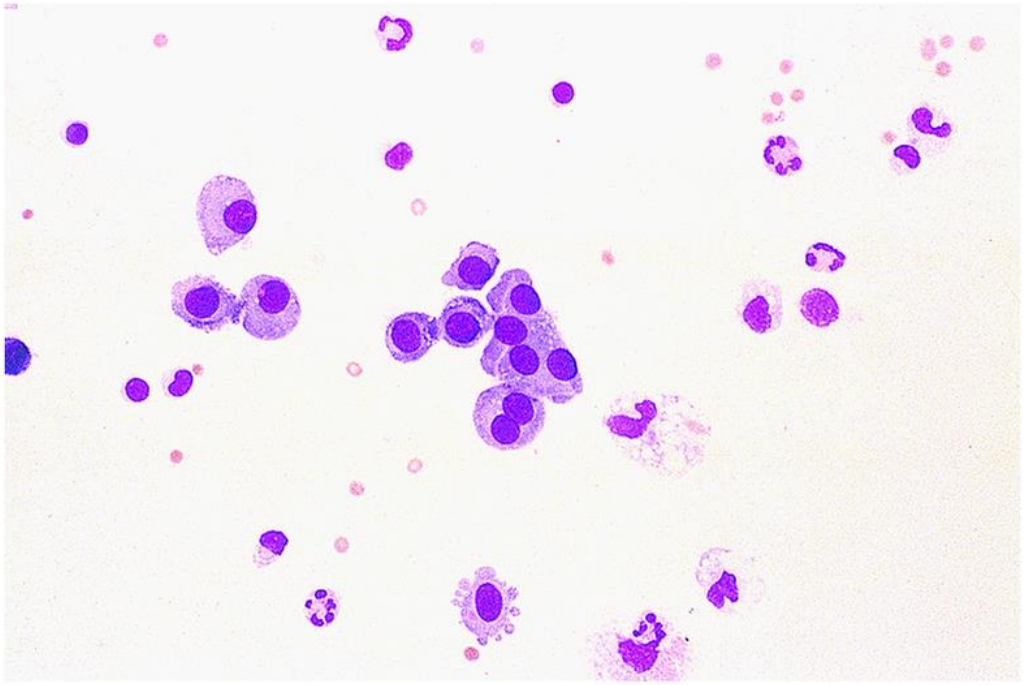
Cytology studies

Identification of crystals

Gram stain

Cytologic examination for malignant cells

Figure 10-2. Overview of a peritoneal (ascites) fluid. Mesothelial cells, macrophages, neutrophils, and lymphocytes are apparent. Cytocentrifuged smear, Wright's stain, ×200. (From Rodak BF, Fritsma GA, Doig K: *Hematology: clinical principles and applications*, ed 3, St. Louis, 2007, Saunders.)



(From Rodak BF, Fritsma GA, Doig K: *Hematology: clinical principles and applications*, ed 3, St. Louis, 2007, Saunders.)

Figure 10-4. Peritoneal (ascites) fluid. (A) Cytocentrifuged smear, Wright's stain, ×1000. (B) Cell identification: monocyte-macrophage *(A, B, C)*, macrophage *(D–J)*, mast cell *(K)*, and lymphocyte *(L)*.

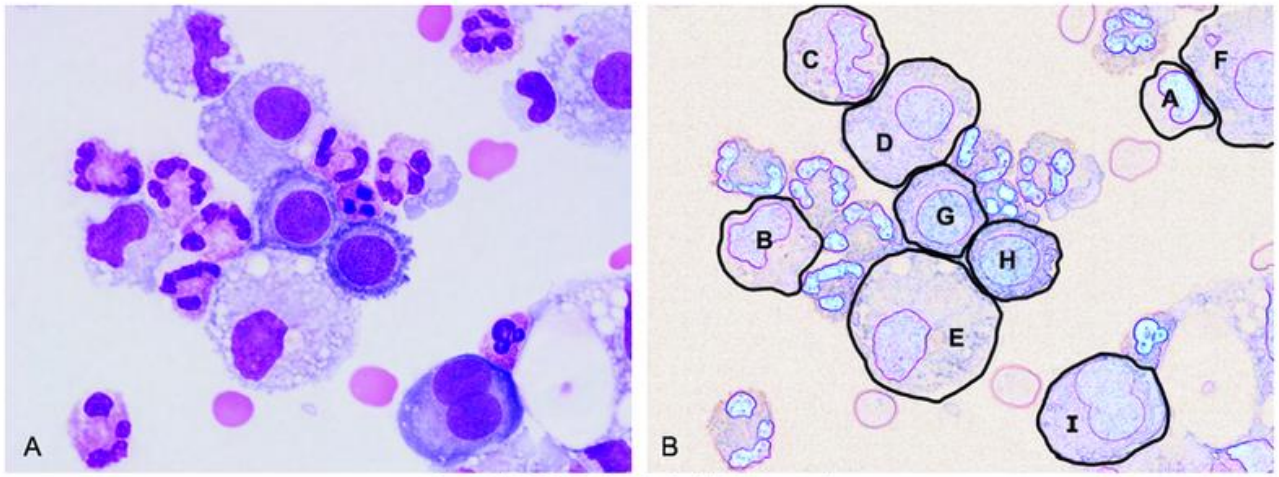


Figure 10-5. Pleural fluid. A “signet ring” macrophage and red blood cells. Cytocentrifuged smear, Wright’s stain, ×400. (Courtesy Charlotte Janita.)

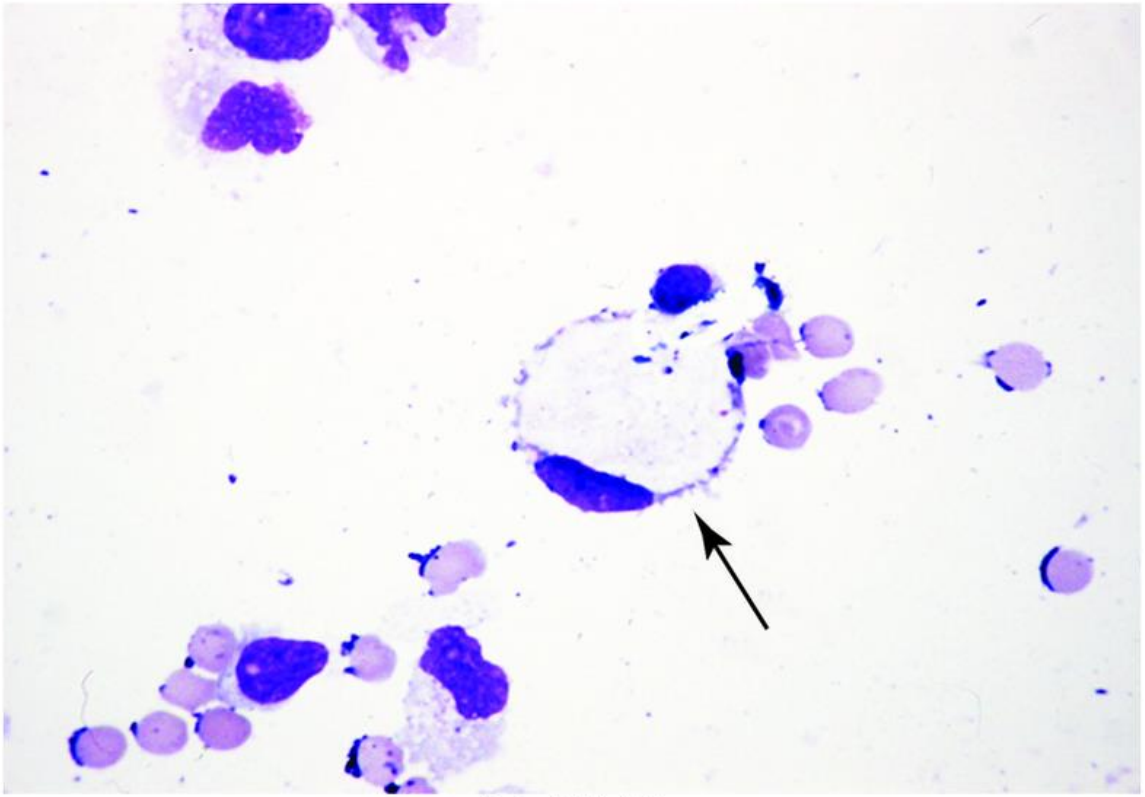
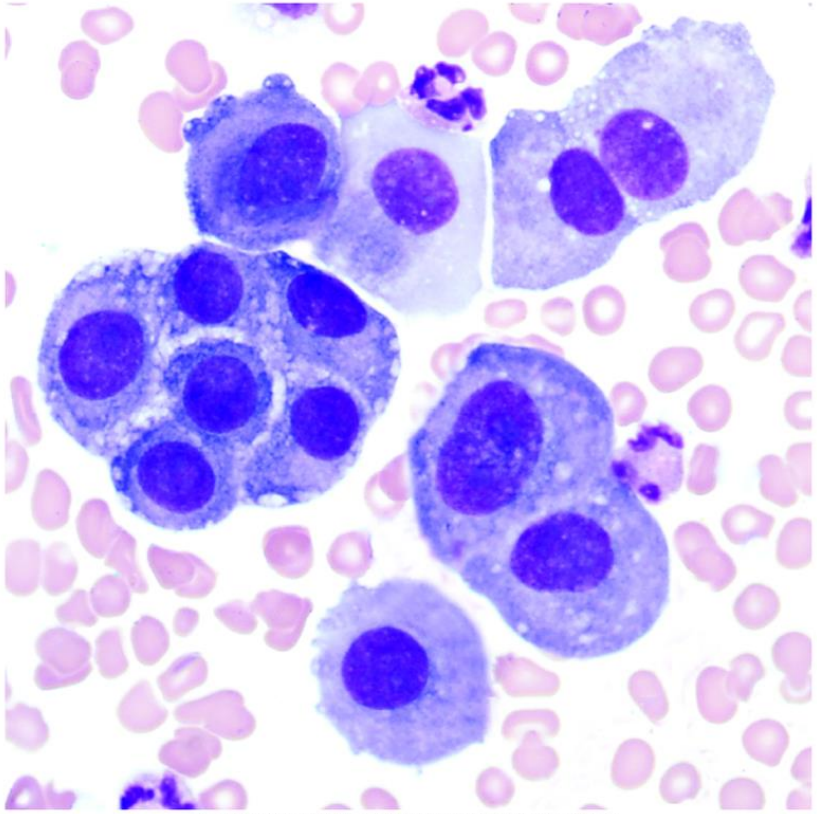
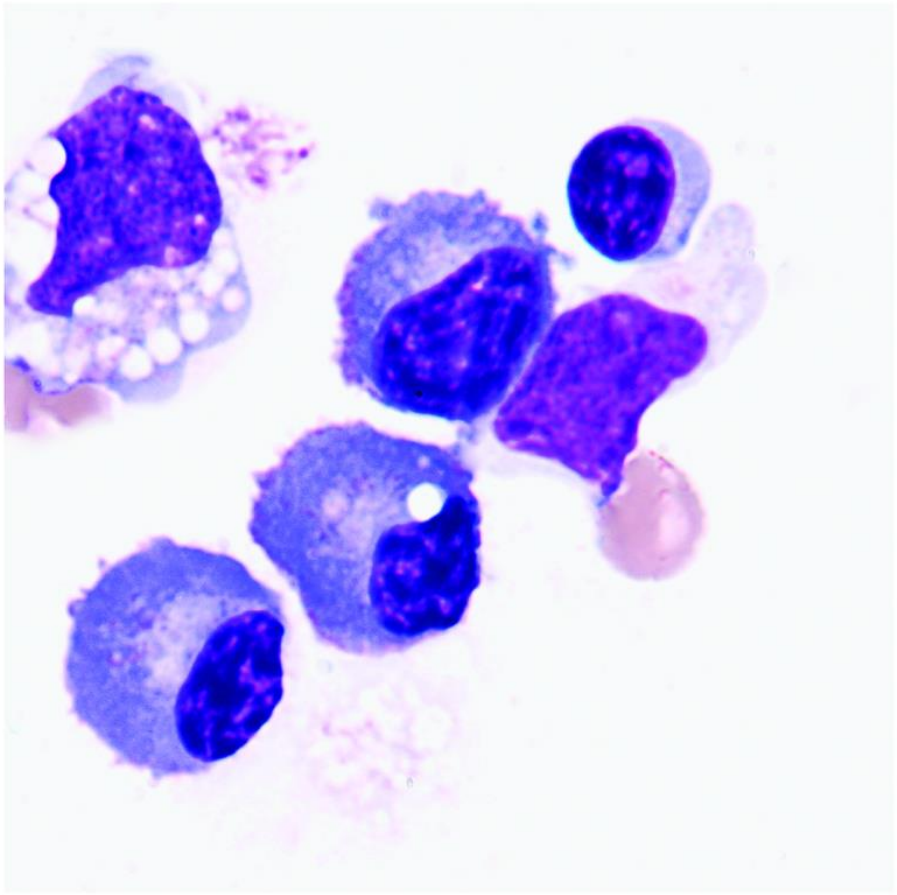


Figure 10-6. Pleural fluid. Wright's stain, ×500. Mesothelial cells, singly and in small clumps. Note the "windows" between cells in the larger cluster. (From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)



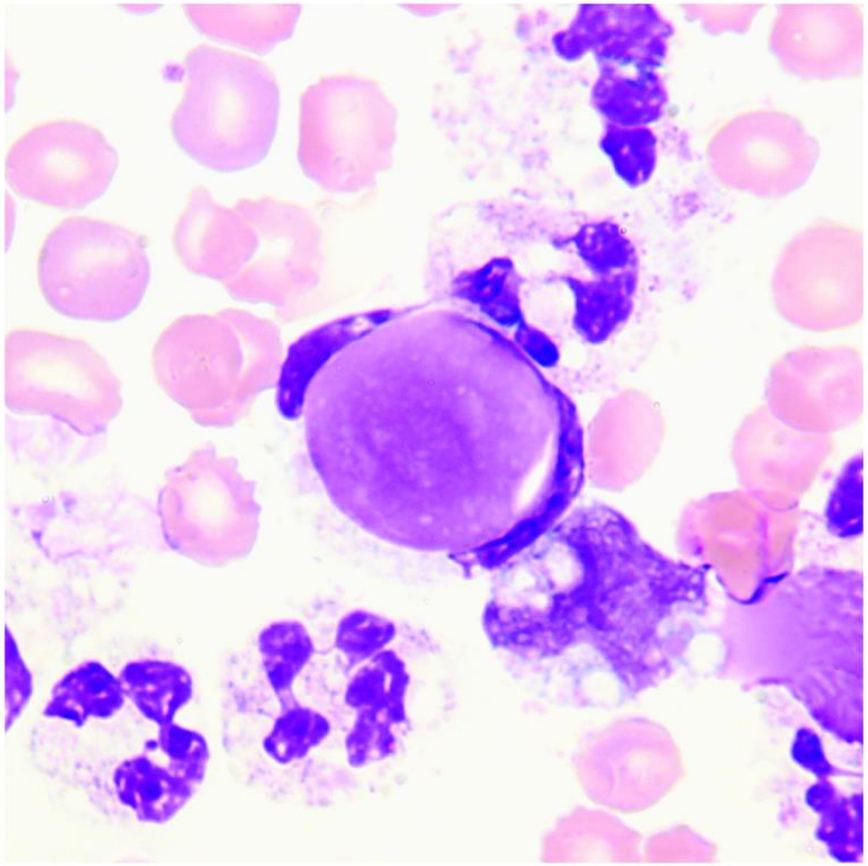
(From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)

Figure 10-7. Three plasma cells in pleural fluid (×1000). Other nucleated cells present are: a small lymphocyte, a reactive lymphocyte, and a macrophage *(upper left edge)*. (From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)



(From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)

Figure 10-8. Pleural fluid. A lupus erythematosus cell. Note the engulfed homogeneous mass that pushes the nucleus of the neutrophil to its periphery. Additional neutrophils, red blood cells, and a macrophage also present. Cytocentrifuged smear, Wright's stain, ×1000. (From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)



(From Carr JH, Rodak BF: *Clinical hematology atlas*, ed 3, St. Louis, 2008, Saunders.)

Figure 10-9. Peritoneal dialysate. Numerous eosinophils; also present are small lymphocytes (2) and monocyte-macrophages (3). Cytocentrifuged smear, Wright's stain, ×1000.

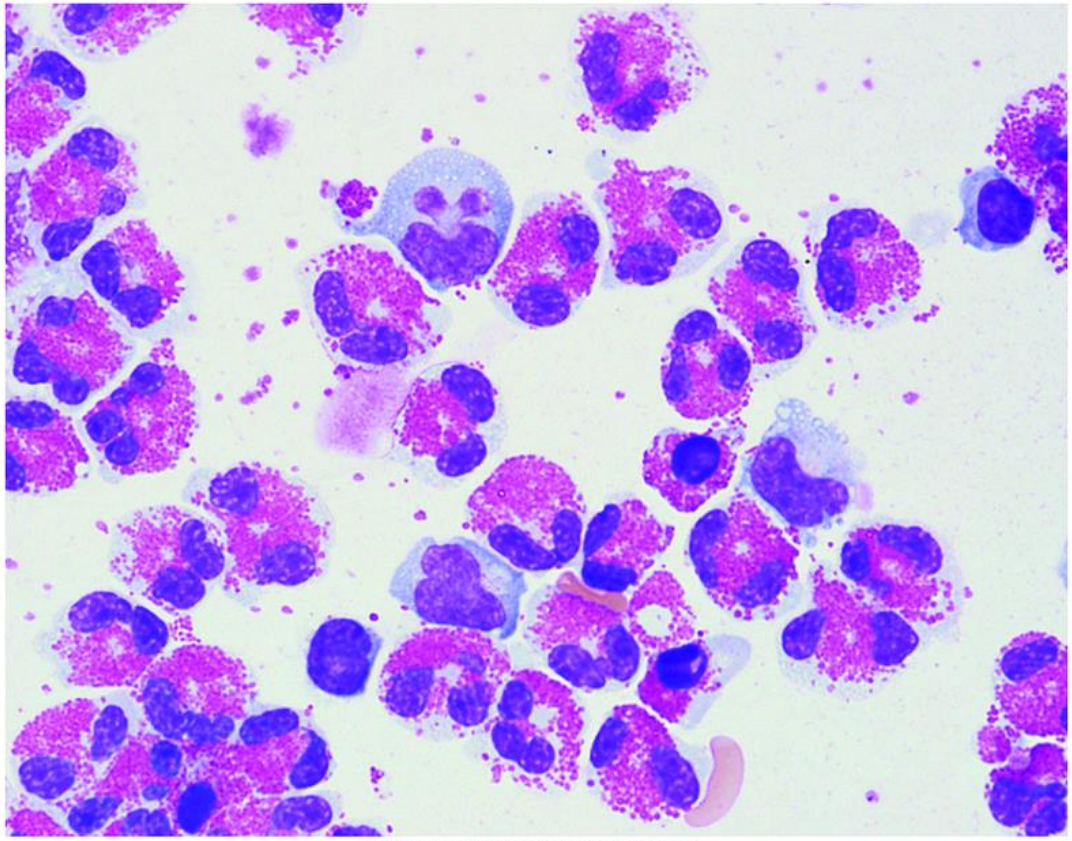


Figure 10-10. A "Mott" cell *(arrow)*, that is, a plasma cell with vacuoles containing immunoglobulin. Also present are a lymphocyte and red blood cells. Cytocentrifuged smear, Wright's stain, ×1000.

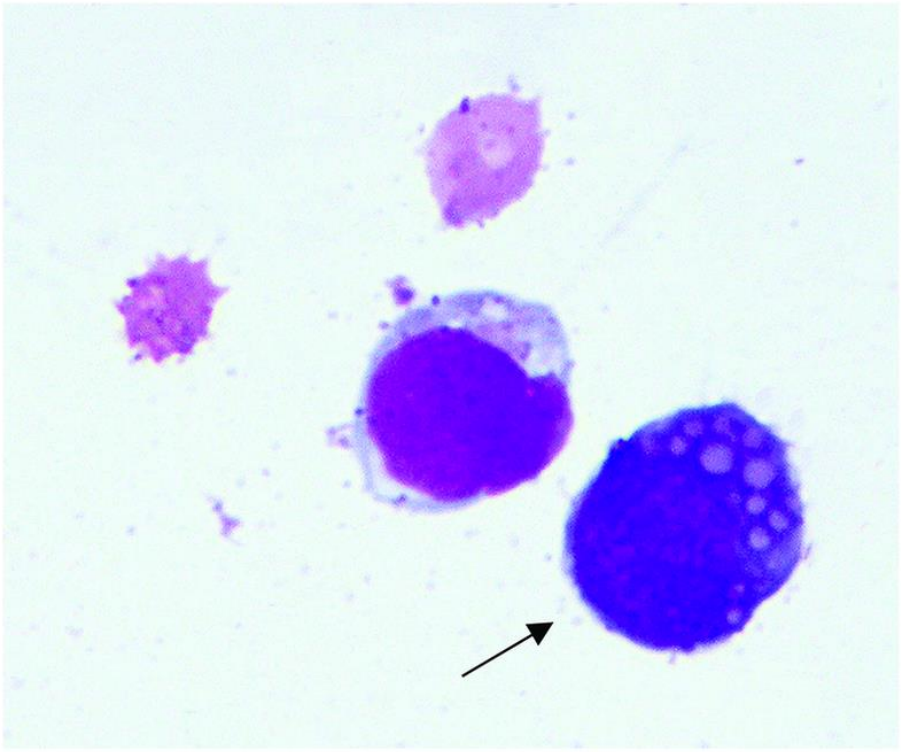
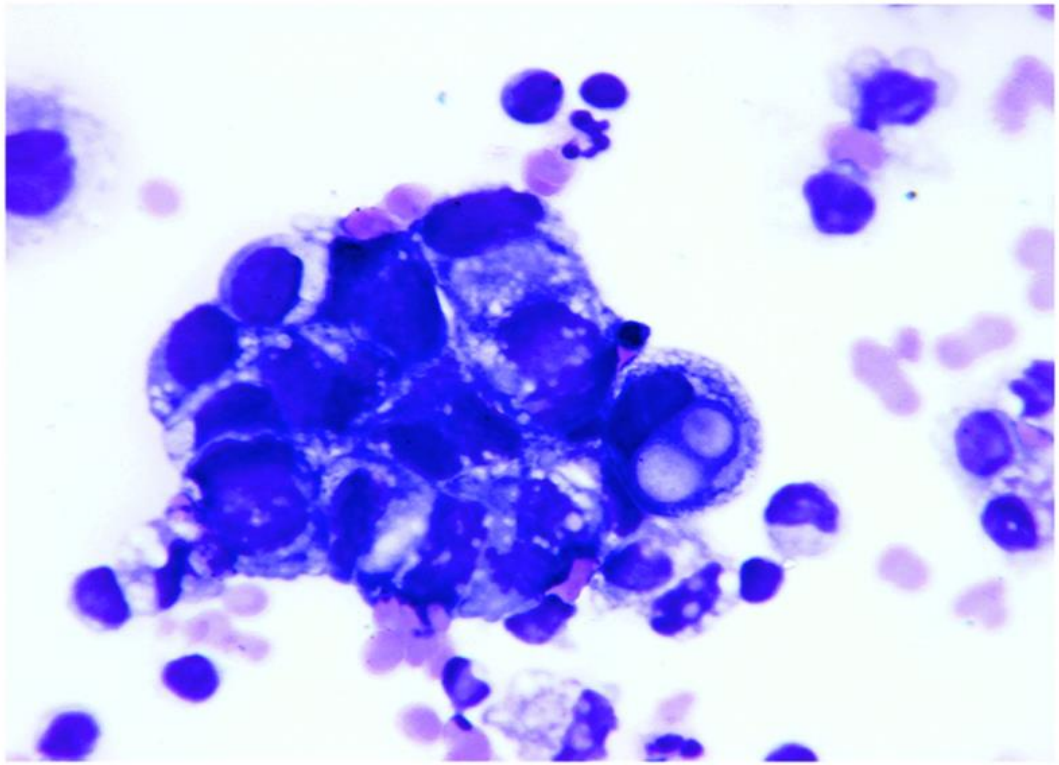


Figure 10-11. Peritoneal (ascites) fluid. Wright's stain, ×400. Adenocarcinoma in a cytocentrifuged smear. Note the numerous features in Box 10.2 that apply to this prominent cell clump. (Courtesy Charlotte Janita.)



(Courtesy Charlotte Janita.)

Results

WBC counts less than 1000 cells/µL in transudates; greater than 1000/µL in exudates

Red blood cells (RBCs) in fluid may be from bloody taps or a disease process

- Traumatic taps: RBCs decrease later in collection; small clots may form
- Hemorrhagic effusion: blood homogeneously distributed; no clotting

Differential Cell Count

Cytocentrifuge-prepared slide

Neutrophils predominate in most exudates of pleural and peritoneal fluid

Lymphocytes predominate in pleural effusions from tuberculosis (TB), neoplasms, and systemic diseases

Lymphocytes also predominate in peritoneal transudates and exudates caused by decreased lymphatic absorption

Other cells: monocytes, macrophages, eosinophils, plasma cells, lupus erythematosus (LE) cells, malignant cells, and mesothelial cells

Chemical Examination

Chemistry tests assist in differentiating fluid as transudate or exudate, which aids in establishing cause of fluid accumulation

Possible chemistry tests include:

- Total protein
- pH
- LD
- CEA
- Glucose
- Lipids
- Amylase

Chemical Results

Fluid/serum protein ratio:

- Less than 0.5 transudate
- Greater than 0.5 exudate

Fluid/serum lactate dehydrogenase (LD) ratio:

- Less than 0.6 transudate
- Greater than 0.6 exudate

Glucose:

- Only low-fluid glucose significant
- Associated with a variety of disease processes
  - Particularly rheumatoid arthritis; also infection, TB, and malignant neoplasm

Chemical Results (Cont.)

Amylase—high pleural or peritoneal fluid amylase associated with:

- Pancreatitis
- Esophageal rupture
- Gastric duodenal perforation
- Metastatic disease

Lipids—used to identify chylous effusions

pH—abnormally low pH helps identify pleural exudates caused by pneumonia or lung abscess

- If less than 7.30 while on antibiotics, placement of drainage tubes is necessary for resolution of the effusion

Carcinoembryonic antigen (CEA)—a tumor marker

Microbiological Examination

Requires experienced technologist for interpretation

May include:

- Gram stain
- Acid-fast stain
- Other stains
- Bacterial cultures