

Serology and Immunoassays

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Introduction to Serologic Reactions

- Serology studies in vitro reactions between antigens and antibodies, essential for identifying infections.
- The system relies on immune specificity. An antibody reacts only with its inducing antigen, allowing for precise identification of pathogens.
- Cross-reactions can occur between related antigens limiting a test's specific utility.
- Serology diagnoses infectious diseases and autoimmune disorders. It is also critical for blood and tissue typing.

Major Uses of Serologic Tests

- 1) diagnose infectious disease in case of dangerous culturing
- 2) diagnose Autoantibodies against human components
- 3) determine ABO + RH factor
- 4) determine HLA during organ transplantation
- 5) used instead of culturing IF the organism grows too slowly.

- Tests ^①diagnose infections when organisms are hard or dangerous to culture (syphilis and hepatitis viruses, *Rickettsia*).
- Serology helps when ^②organisms grow too slowly. It provides answers when cultures would take weeks.
- Tests detect ^③autoimmune antibodies against body components (Anti-DNA antibodies in lupus or rheumatoid factor).
- Known antibodies determine ^④ABO and Rh blood types. They also ^⑤identify HLA antigens before transplantation.

TABLE 64-1 Major Uses of Serologic (Antibody-Based) Tests

I. Diagnosis of infectious diseases

- When the organism cannot be cultured (e.g., syphilis and hepatitis A, B, and C).
- When the organism is too dangerous to culture (e.g., rickettsial diseases).
- When culture techniques are not readily available (e.g., HIV, EBV).
- When the organism takes too long to grow (e.g., *Mycoplasma*).

One problem with this approach is that it takes time for antibodies to form (e.g., 7–10 days in the primary response). For this reason, acute and convalescent serum samples are taken, and a fourfold or greater rise in antibody titer is required to make a diagnosis. By this time, the patient has often recovered and the diagnosis becomes a retrospective one. If a test is available that can detect IgM antibody in the patient's serum, it can be used to make a diagnosis of current infection. In certain infectious diseases, an arbitrary IgG antibody titer of sufficient magnitude is used to make a diagnosis.

II. Diagnosis of autoimmune diseases

- Antibodies against various normal body components are used (e.g., antibody against DNA in systemic lupus erythematosus, antibody against human IgG [rheumatoid factor] in rheumatoid arthritis).

III. Determination of blood type and HLA type

- Known antibodies are used to determine ABO and Rh blood types.
- Known antibodies are used to determine class I and class II HLA proteins prior to transplantation, although DNA sequencing is also being used.

EBV = Epstein-Barr virus; HIV = human immunodeficiency virus; HLA = human leukocyte antigen.

Understanding Titers

1:32
 ↳ one unit of patient serum
 ↳ total volume after dilution
 → the body serum has been diluted 32 times.

• A **titer** is the highest dilution yielding a positive reaction. It quantifies the antibody concentration in serum. A higher denominator indicates more antibodies.

• higher titer → More Antibodies present
 • lower titer → Fewer Antibodies present
 • given as Ratio

• A titer of 1/64 implies more antibodies than 1/4. This value estimates the strength of the immune response.

→ higher titer → higher amount of antibodies → ∴ the Body Responds strongly to that infection or vaccine.

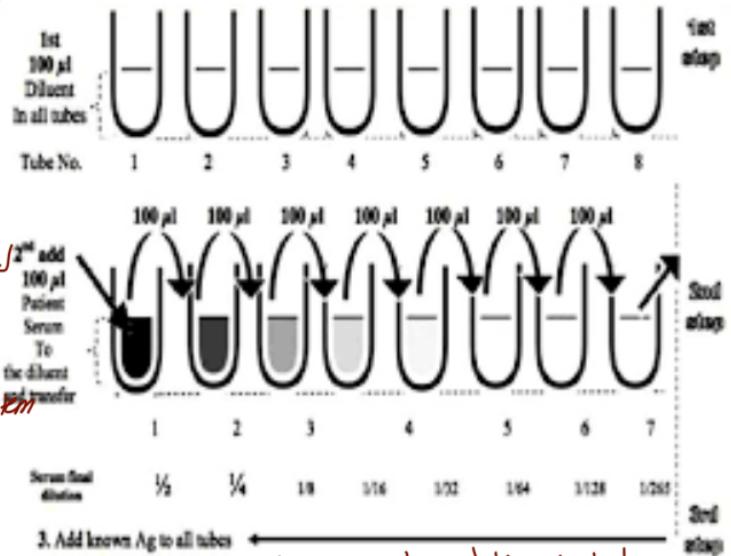
• A fourfold IgG rise between acute and convalescent samples is required.

Reflecting the strength of immune system response

• High (early) IgM titers suggest a current infection. IgG titers usually indicate past exposure or immunity.

like from 1:16 to 1:64 confirm result and on going infection

IgM → current infection "Active"
 IgG → past-exposure or Immunity "Recovery"



the serum is diluted stepwisly and then tested the last dilution that give positive result is called the titer

Overview of Diagnostic Test Types

Agglutination test → Antibody + particulate Antigen → clump
precipitation test → Antibody + soluble Antigen → precipitate

• Labs use different methods based on antigen type. Agglutination tests use particulate antigens. Precipitation tests use soluble antigens.

← Radio Immuno assay
• RIA and ELISA provide high sensitivity. They quantify minute amounts of antigens or antibodies.

• Immunofluorescence visualizes antigens directly on cells. It uses fluorescently labeled antibodies.

• Complement fixation detects antibody consumption. Western blotting confirms specific protein presence.

↳ proteins are separated according to size and identified using specific antibodies

RIA → Radio Active Labels

ELISA → use enzyme-labeled Antibody

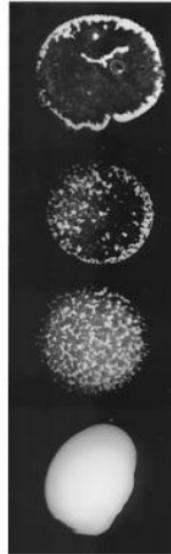
Agglutination Reactions

• Agglutination involves particulate antigens like bacteria. It also works with inert particles like latex beads.

• Multivalent antibodies cross-link these particles. This forms a lattice structure. The result is visible clumping on a slide.

• This reaction is simple and rapid. It requires minimal laboratory equipment.

Multivalent Antibody + particulate organism or inert particles → clumping = lattice structure visible on slide.



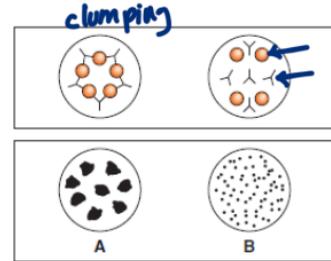
Agglutinating activity

+++ (3)

++ (2)

+ (1)

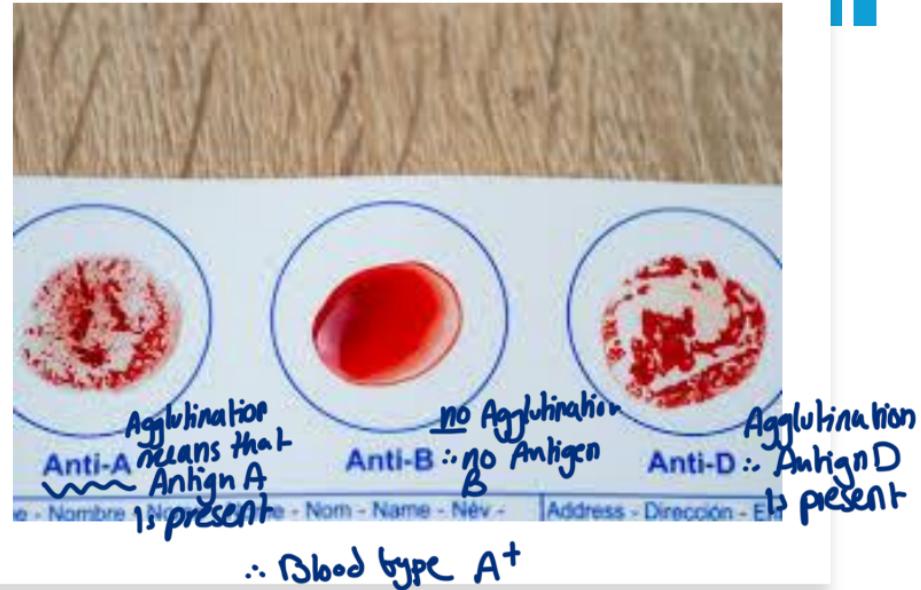
- (0)



JRE 64-1 Agglutination test to determine ABO blood type. On the slide at the bottom of the figure, a drop of the patient's blood was mixed with antiserum against either type A (left) or type B (right) blood cells. Agglutination (clumping) has occurred in the left containing the type A antiserum but not in the right containing the type B antiserum, indicating that the patient is type A. The slide at the top shows that red blood cells (circles) are cross-linked by the antibodies ("Y" shapes) to form a lattice structure. If agglutination had occurred in the right side as well, it would indicate that the patient was producing B antigen as well as A and was type AB.

Clinical Applications of Agglutination

- **ABO blood typing** relies on agglutination. Patient **red blood cells clump** with specific antisera.
- **Latex agglutination** uses antigen-coated beads. This allows for quick detection of pathogens.
- **Hemagglutination** specifically refers to red cell clumping. This is distinct from blood clotting.
- These tests serve as effective screening tools. They provide immediate visual results.



Precipitation Reactions

• **Precipitation** tests use **soluble antigens**. Antibodies cross-link molecules **into large aggregates**. These aggregates fall out of solution.

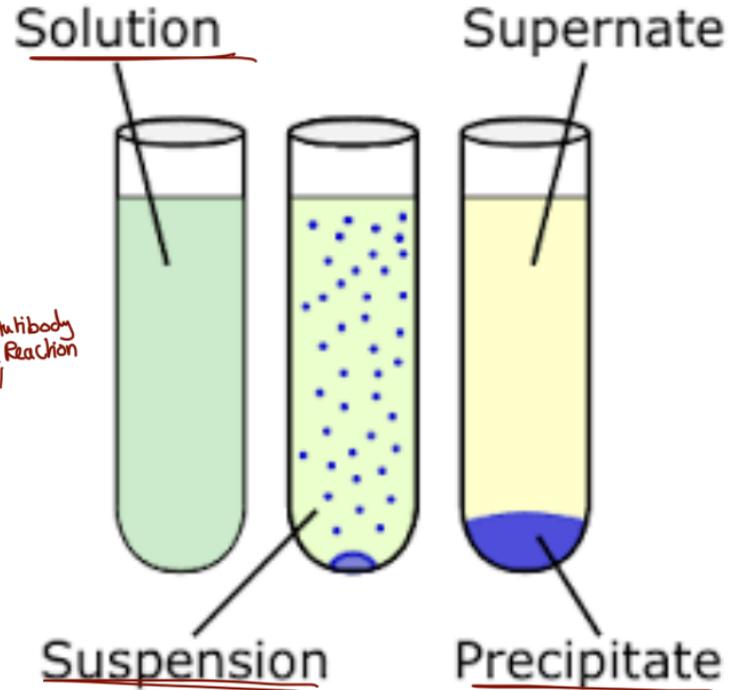
• **Optimal proportions** of antigen and antibody are required. This state is called the **zone of equivalence**.

If Antigen or Antibody excess the Reaction fail
↳ *Optimal concentration of Antigen and Antibody*

• **Maximal lattice formation occurs in this zone**. The reaction fails if ratios are unbalanced.

• Both **antigen and antibody must be multivalent**. This ensures the formation of a stable lattice.

soluble Multivalent Antigen + Multivalent Antibody → precipitation
At the zone of equivalence



The Precipitin Curve & Prozone Effect

- The precipitin curve plots reaction efficiency. The peak represents the zone of equivalence.
- Antibody excess inhibits efficient lattice formation. This is known as the prozone effect.
- The prozone effect can cause false-negative results. Labs dilute serum to fix this issue.
- Antigen excess also prevents visible precipitation (postzone). The resulting complexes are too small to settle.

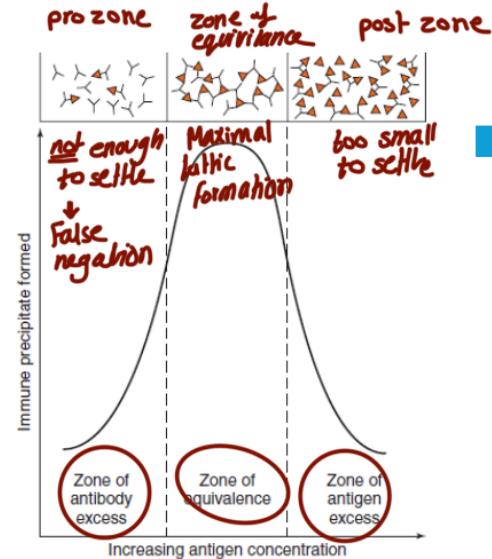


FIGURE 64-2 Precipitin curve. In the presence of a constant amount of antibody, the amount of immune precipitate formed is plotted as a function of increasing amounts of antigen. In the top part of the figure, the binding of antigen (A) and antibody (Y) in the three zones is depicted. In the zones of antibody excess and antigen excess, a lattice is not formed and precipitation does not occur, whereas in the equivalence zone, a lattice forms and precipitation is maximal. (Reproduced with permission from Sites DP, Terr A, Parslow T, eds. *Basic & Clinical Immunology*, 9th ed. Originally published by Appleton & Lange. Copyright 1997 McGraw-Hill.)

- **Precipitation in Solution**

- Used to measure immunoglobulins in plasma.
- The lab test is called: nephelometry ^{*soluble*} amount of precipitate is measured by optical density (light refraction).
- The value is compared with a standard curve.

Immunodiffusion (Precipitation in Agar)

• **Single radial diffusion** mixes antibody into agar. Antigen diffuses from a well to form a ring.

Ring size indicates antigen concentration (e.g. IgG, IgM, complement).

• **Double diffusion (Ouchterlony)** involves two diffusing reactants. Antigen and antibody move toward each other.

• **Precipitin lines** form where concentrations meet. Patterns indicate antigen identity or non-identity.

→ Identity
non Identity
partial Identity

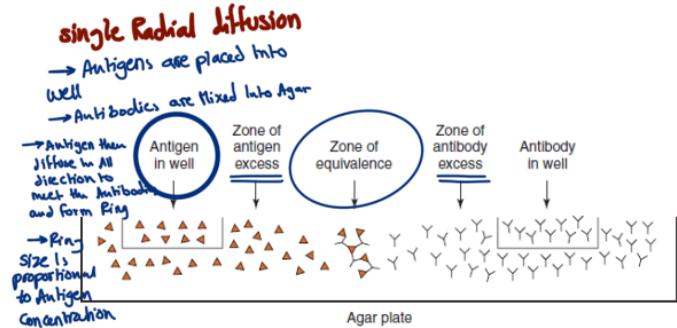
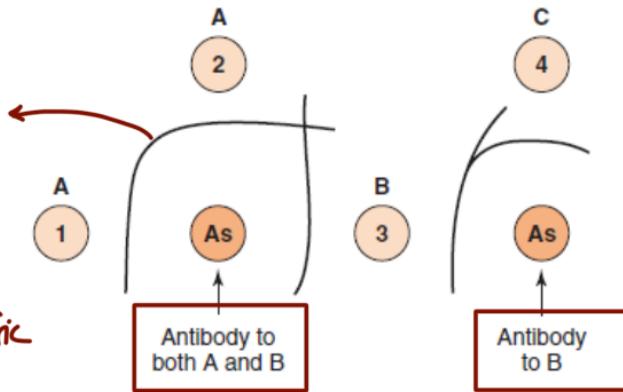


FIGURE 64-3 Double diffusion in agar. Antigen is placed in the well on the left, and antibody is placed in the well on the right. The antigen and antibody diffuse through the agar and form a precipitate in the zone of equivalence. Close to the antigen-containing well is the zone of antigen excess, and close to the antibody-containing well is the zone of antibody excess. No precipitate forms in the zones of antigen and antibody excess.

* Multiple wells with different antigens and central well for specific antibody.

Line of equivalence



Identity → lines fuse smoothly
 Non-identity → lines cross
 partial identity → spur formation

LEGEND:

As = Antiserum in wells
 1, 2, 3, 4 = Antigens in wells

Double diffusion

Lines between	Reaction of
1 and 2	<u>Identity</u>
2 and 3	<u>Nonidentity</u>
3 and 4	<u>Partial identity</u>

FIGURE 64-4 Double-diffusion (Ouchterlony) precipitin reactions. In these Ouchterlony reactions, wells are cut into an agar plate and various antigens and antisera are placed in the wells. The antigens and antibodies diffuse toward each other within the agar, and a line of precipitate forms in the zone of equivalence. Close to the antigen-containing well, a zone of antigen excess exists and no precipitate forms; close to the antibody-containing well, a zone of antibody excess exists and no precipitate forms. A and B are unrelated antigens (i.e., they have no epitopes in common). B and C are related antigens (i.e., they have some epitopes in common but some that are different). For example, chicken lysozyme (well B) and duck lysozyme (well C) share some epitopes because they are both lysozymes but have unique epitopes as well because they are from different species. The line of identity between B and C is caused by the reaction of the anti-B antibody with the shared epitopes on antigens B and C. The spur pointing toward well 4 is caused by the reaction of some of the anti-B antibody with the unique epitopes on antigen B in well 3. These lines of partial identity occur because antibody to B (chicken lysozyme) is polyclonal and has some immunoglobulins that react with the epitopes common to chicken and duck lysozyme and other immunoglobulins that react only with the epitopes unique to chicken lysozyme. (Reproduced with permission from Brooks GF et al. *Medical Microbiology*. 19th ed. Originally published by Appleton & Lange. Copyright 1991 McGraw-Hill.)

(Immuno diffusion + Electrophoresis)

- **Immunoelectrophoresis**
- Combines electrophoresis with immunodiffusion. Serum proteins are first separated by charge (electrical current).
- Antibody then diffuses to form precipitin arcs. The shape of arcs reveals specific proteins.
- It detects abnormal globulin production (e.g. myeloma proteins).
- **Counter-immunoelectrophoresis** uses electricity. It drives antigen and antibody together rapidly.

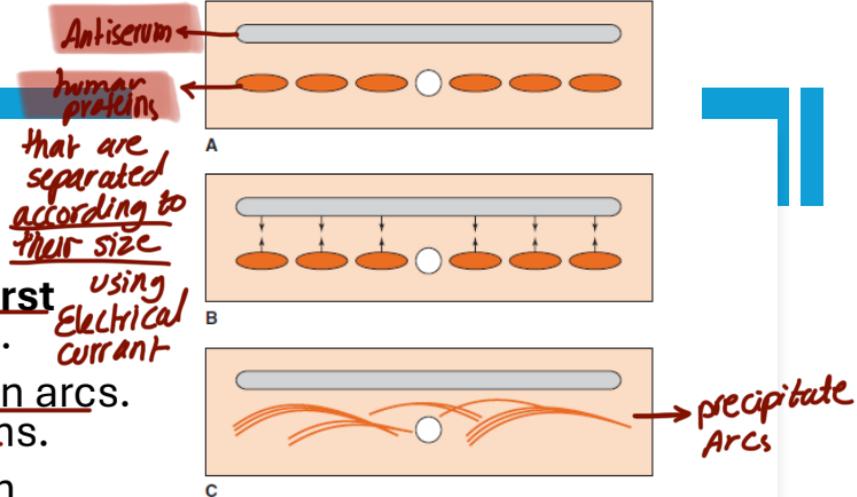


FIGURE 64-5 Immunoelectrophoresis. **A:** Human serum placed in the central well is electrophoresed, and the proteins migrate to different regions (orange ellipses). Antiserum to human serum is then placed in the elongated trough (gray areas). **B:** Human serum proteins and antibodies diffuse into agar. **C:** Precipitate arcs (orange lines) form in the agar. (Reproduced with permission from Sites DP, Terr A, Parslow T, eds. *Basic & Clinical Immunology*. 9th ed. Originally published by Appleton & Lange. Copyright 1997 McGraw-Hill.)

Radioimmunoassay (RIA)

RIA
+ ELISA

are highly sensitive
+ detect the small
amounts of Antigen → to measure
hormones and
drugs.

- RIA is a highly sensitive quantitative method. It measures antigens in low concentrations.

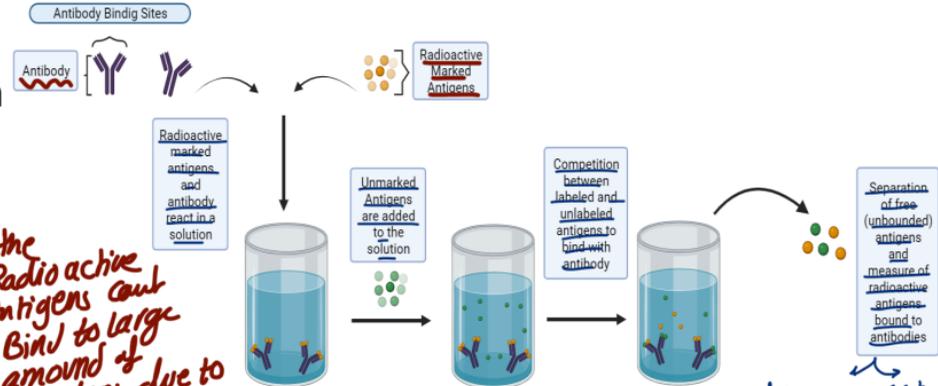
- Radio-labeled antigens compete with patient antigens for antibody binding sites.

- Less radioactivity in the complex means more patient antigen. The relationship is inversely proportional.

- RIA measures hormones and drugs. The radioallergosorbent test RAST is a specialized RIA for IgE antibodies.

∴ the Radioactive Antigens can Bind to large amount of Antibodies due to small amounts of patient Antigen.

Radioimmunoassay (RIA)



less radio Activity
↓
∴ ↑ patient Antigens

High Radio Activity
↓
∴ ↑ patient Antigens

Enzyme-Linked Immunosorbent Assay (ELISA)

- ELISA quantifies antibodies without radiation. It uses enzyme-linked conjugates instead.
- The method is as sensitive as RIA. It requires no radioactive waste handling.
- Enzymes convert a substrate into a colored product, measured by a spectrophotometer (optical density-absorbance).
- A standard tool for screening, safe and widely available.

no radioactive waste



ELISA Methodology

- A known antigen is attached to a surface. Patient serum is added to the well.
- Patient antibodies bind to the fixed antigen. An enzyme-linked anti-human IgG is then added.
- This secondary antibody binds the patient's antibody. A substrate is added to react with the enzyme.
- The resulting color indicates the antibody level. Intensity correlates with the amount of patient antibody.

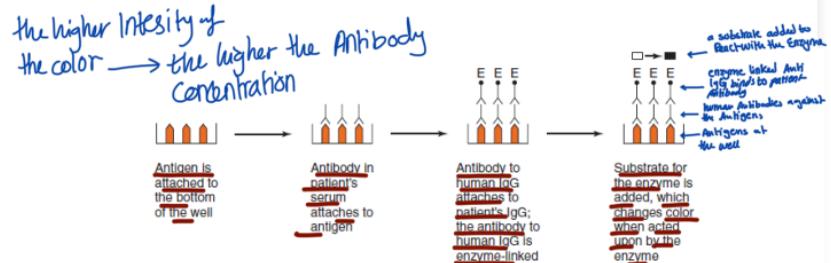
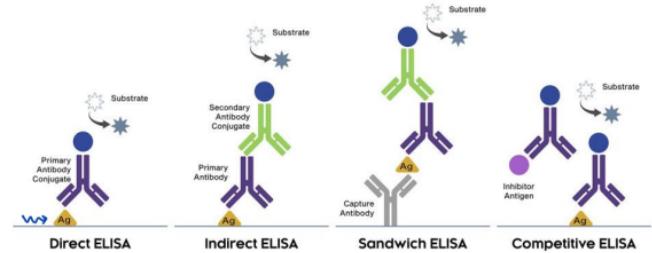


FIGURE 64-6 Enzyme-linked immunosorbent assay (ELISA). The term enzyme-linked refers to the covalent binding (linking) of an enzyme to antibody to human IgG. If the patient has antibodies to the microbial or viral antigen, those antibodies will bind to the microbial or viral antigens. The antibody to human IgG linked to the enzyme will then bind to the patient's antibodies. Then when the substrate of the enzyme is added, the substrate changes color, indicating that the patient's serum contained antibodies.

Western Blot (Immunoblot)

• Western Blot **confirms** positive screening results. .

• Viral proteins are separated by electrophoresis. They are transferred onto filter paper.

• Patient serum is applied to the paper. Antibodies bind to specific protein bands.

• Enzyme-labeled anti-IgG visualizes the bands. This confirms specific antibodies are present.

by Electrical charge

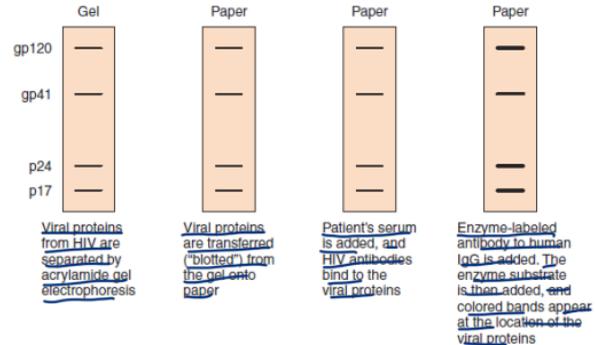
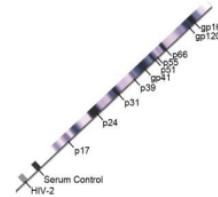


FIGURE 64-9 Western blot (immunoblot test). In this test, microbial or viral proteins are separated on an acrylamide gel and then transferred (blotted) onto paper. The patient's serum then interacts with the separated proteins. If antibodies are present in the patient's serum, they bind to the proteins. The patient's antibodies are then detected by using labeled antibody to human IgG.

Immuno fluorescence ← Direct Method
↳ Direct Method "More sensitive"

Immunofluorescence (Direct)

↳ one step Method
↳ used in Biopsy specimen

[here we use fluorescence microscope]

- This method uses **fluorescent dyes on antibodies**.
Dyes like fluorescein glow under **UV light**.
- Labeled antibodies are applied directly to tissue.
They bind to specific antigens if present.
- The reaction is viewed with a **fluorescence microscope**.
- This is a "one-step" rapid diagnosis. It detects antigens in biopsy specimens.

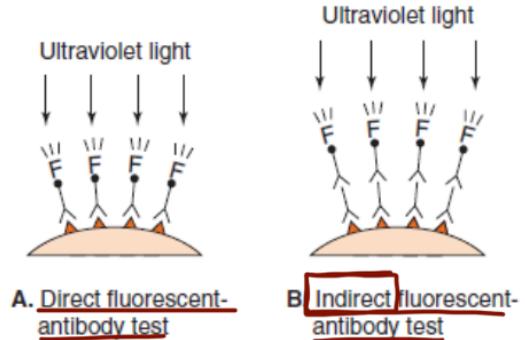
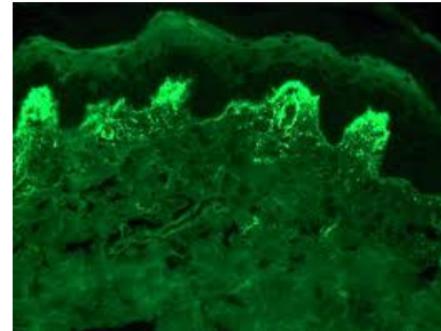
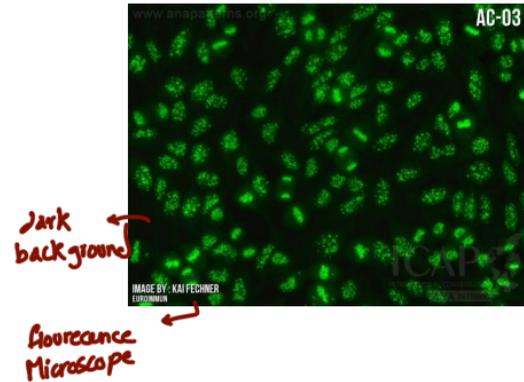


FIGURE 64-7 Fluorescent antibody test. **A:** In the direct fluorescent antibody test, the fluorescent dye is attached directly to the antibody that is interacting with the antigen (dark triangles) on the surface of the cell. **B:** In the indirect fluorescent antibody test, the fluorescent dye is attached to antibody made against human IgG.



Immunofluorescence (Indirect)

- Indirect immunofluorescence is a two-stage test. Patient serum reacts with a fixed (known) antigen first.
- A labeled anti-human IgG is added second. This binds to the patient's antibody.
- This method is more sensitive than the direct test.

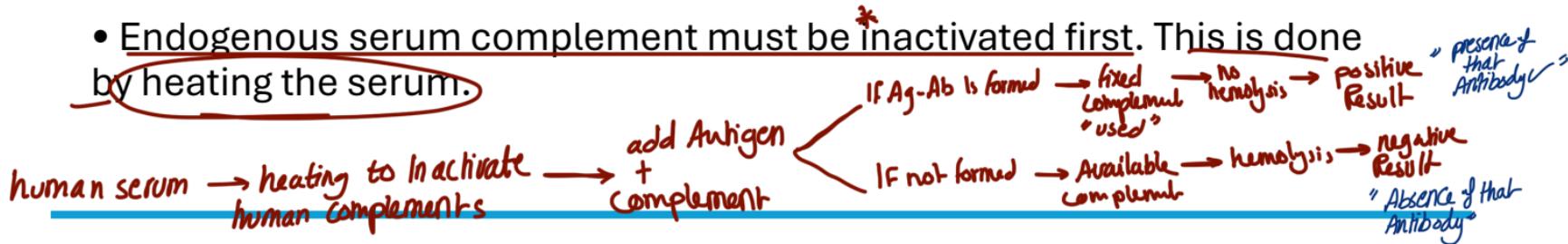


Complement Fixation Test

• Some Antibodies when binds to Antigen use complement proteins from serum $\xrightarrow{\text{fix}}$ \therefore no hemolysis
↓
lyse RBC !!

\therefore this test screen for specific Antibodies that consume Complement proteins \rightarrow fixing them \rightarrow no RBCs lysis

- Ag-Ab complexes fix (consume) complement (test principle).
- Patient serum is mixed with known antigen and complement. If antibodies are present, complement is fixed.
- If antibodies are absent, complement remains free. The second stage tests for this free complement.
- Endogenous serum complement must be inactivated first. This is done by heating the serum.



Interpreting Complement Fixation

- **Sensitized red blood cells are the indicator.** They lyse in the presence of free complement. *when no Ag-Ab → ∴ no complement fixation*
- **No hemolysis indicates a positive result.** It means complement was consumed by patient antibodies.
- **Hemolysis indicates a negative result.** It means complement was left free to attack the RBCs.

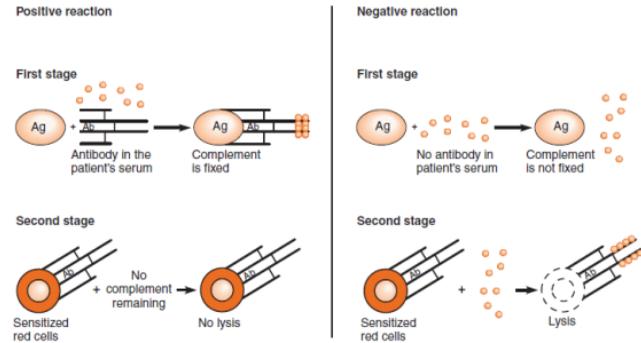


FIGURE 64-8 Complement fixation. **Left:** Positive reaction (i.e., the patient's serum contains antibody). If a known antigen is mixed with the patient's serum containing antibody against that antigen, then complement (solid circles) will be fixed. Because no complement is left over, the sensitized red cells are not lysed. **Right:** Negative reaction. If a known antigen is mixed with the patient's serum that does not contain antibody against that antigen, complement (solid circles) is not fixed. Complement is left over and the sensitized red cells are lysed. Ab, antibody; Ag, antigen.

Neutralization Tests

- Virus neutralization → detect the presence of Anti-viral Antibodies
- Toxin neutralization → detect the presence of Anti-toxin Antibodies
"Anti diphtheria"
"Anti tetanus"

• (Antibodies can block toxin or viral effects). This biological activity is measured in neutralization tests.

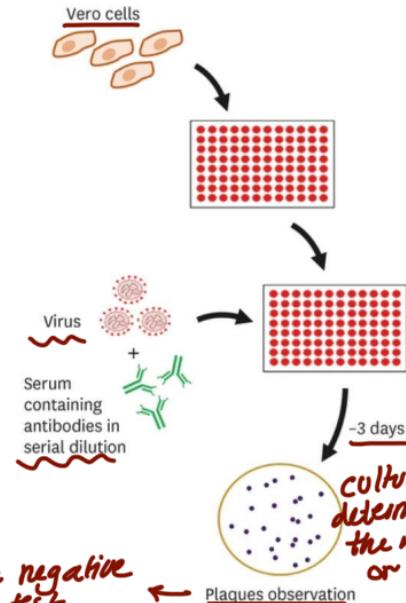
• Antibodies prevent viral damage in cell culture (inhibition of cytopathic effects).

• Tests can also use host animals. Antibodies protect mice from lethal toxins by neutralizing them.

• These tests are highly specific.

e.g Plaque Reduction Neutralization Test (PRNT).

Virus based neutralization assay

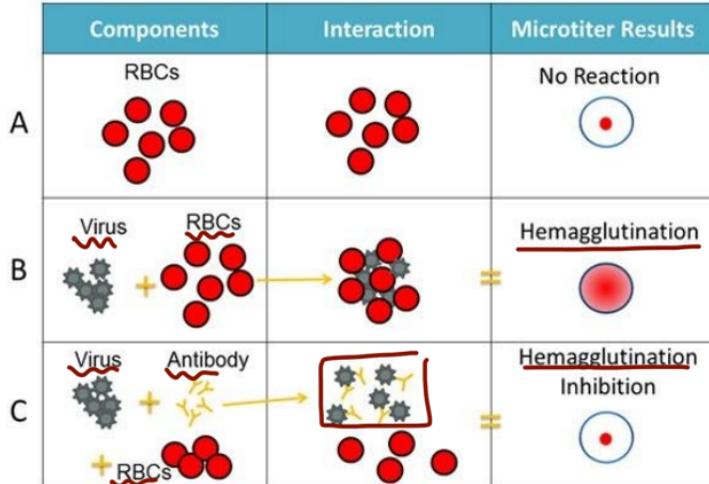


∴ negative test
"no neutralizing Antibodies"

culturing to determine whether the virus still present or neutralized

Hemagglutination Tests

- Some viruses naturally clump red blood cells (Influenza viruses). This is called active hemagglutination. *→ have HA + NA*
- Patient antibodies can inhibit this clumping (basis of **Hemagglutination Inhibition tests**)
- **Passive hemagglutination** uses antigen-coated RBCs. The RBCs act as carriers for soluble antigens.
- Antibodies cross-link these cells to cause clumping. This makes precipitation reactions visible.



Antiglobulin (Coombs) Test

→ used Before
Blood transfusion
to avoid post
transfusion Reactions

- Some patients with certain diseases (e.g., hemolytic disease of the newborn [Rh incompatibility] and drug-related hemolytic anemias) become sensitized but do not exhibit symptoms of disease.
 - Antibodies against Red Blood cells are formed and bind to the red cell surface but do not cause hemolysis.
 - The Coombs reagent is an anti-human immunoglobulin. It binds to these human antibodies on RBCs causing agglutination.
 - The test diagnoses hemolytic anemias. It detects antibodies on RBCs (direct Coombs test) or in serum (indirect Coombs).
-

Direct vs. Indirect Coombs Test

*to detect Antibodies
or complement that
already attach to RBCs*

*to detect specific
unbound antibodies*

*from un
bound ←
Anti-bodies*

- Direct Coombs detects bound antibodies in vivo. It tests washed patient red blood cells (autoimmune hemolytic anemia, hemolytic disease of the newborn).
- Indirect Coombs test, the patient's serum is mixed with normal red cells, and antiserum to human immunoglobulins is added. If antibodies are present in the patient's serum, agglutination occurs.
- This is crucial for blood transfusion cross-matching. It prevents transfusion reactions.

Flow Cytometry

to Analyze the physical and chemical characteristics of a cells or particles in a fluid as they flow through a lesser.

* Cells that have CD4 marker will bind to fluorescent monoclonal Antibody then they pass through lesser to detect these cells and count them.

- Flow cytometry counts cells in a fluid stream. It uses laser analysis of single cells.
- Cells are labeled with fluorescent monoclonal antibodies. These target surface markers like CD4.
- The machine analyzes cell size and fluorescence. It quantifies specific immune cell populations.
- fluorescence-activated cell sorter (FACS) is a specialized form of this technology. It physically sorts cells based on markers

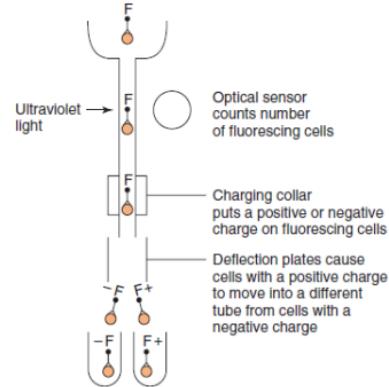


FIGURE 64-10 Flow cytometry. At the top of the figure, a cell has interacted with monoclonal antibody labeled with a fluorescent dye. As the cell passes down the tube, ultraviolet light causes the dye to fluoresce and a sensor counts the cell. Farther down the tube, an electrical charge can be put on the cell, which allows it to be deflected into a test tube and subjected to additional analysis.

ABO Blood Groups (Antigens)

- ABO antigens are specific surface sugars (genetically encoded).
- The H antigen is the base structure. Group A adds N-acetylgalactosamine.
- Group B adds galactose to the H antigen. Group O lacks these modifying enzymes.
- Group O cells display only the H antigen. This is the precursor for A and B antigens.

A serotype → H-Antigen + N-acetyl galactosamine
B serotype → H Antigen + Galactose
O serotype → only H Antigen "the precursor" only.

TABLE 64-2 ABO Blood Groups

Group	Antigen on Red Cell	Antibody in Plasma
<u>A</u>	A	<u>Anti-B</u>
<u>B</u>	B	<u>Anti-A</u>
<u>AB</u>	A and B	<u>No anti-A or anti-B</u>
<u>O</u>	No A or B	<u>Anti-A and anti-B</u>

ABO Blood Groups (Antibodies)

- People have antibodies against missing antigens. Type A blood has Anti-B antibodies.
- Type O blood has both Anti-A and Anti-B. This follows Landsteiner's Law.
- These are "**natural**" **(IgM) antibodies**, ^{pentamer} detectable in the first 3-6 months of age, develop against cross-reacting bacterial antigens.
- They activate complement and cause hemolysis. They are detectable early in life.

TABLE 64-3 Compatibility of Blood Transfusions Between ABO Blood Groups¹

Donor	Recipient			
	O	A	B	AB
O	Yes	Yes	Yes	Yes
A (AA or AO)	No	Yes	No	Yes
B (BB or BO)	No	No	Yes	Yes
AB	No	No	No	Yes

¹Yes indicates that a blood transfusion from a donor with that blood group to a recipient with that blood group is compatible (i.e., that no hemolysis will occur). No indicates that the transfusion is incompatible and that hemolysis of the donor's cells will occur.

Transfusion Compatibility

- Transfusions must match donor and recipient. Incompatibility causes immediate cell lysis.
- Group O is the universal red cell donor. Their cells lack A and B antigens.
- Group AB is the universal recipient. Their plasma lacks A and B antibodies.
- Mismatches trigger shock and hemolysis. This is due to complement activation.

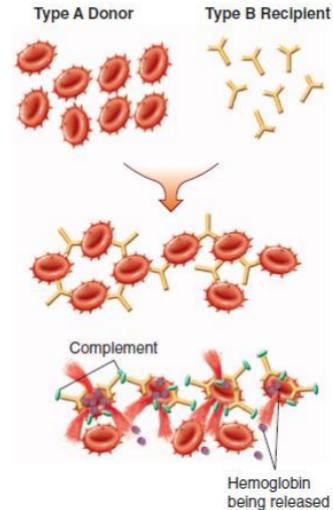


FIGURE 64-12 Transfusion reaction. **Top panel:** Red blood cells bearing A antigen are transfused into a person who is type B and therefore has antibodies to A antigen. **Middle panel:** Anti-A antibodies bind to A antigen on the red cells causing agglutination of red cells that can block movement of blood through capillaries causing anoxia to tissue. **Bottom panel:** Complement is activated by the antigen-antibody complexes and the membrane attack complex lyses the red cells, causing hemolysis and anemia. (Reproduced with permission from Cowan MK, Talaro KP, eds. *Microbiology: A Systems Approach*. New York: McGraw-Hill; 2009.)

Rh Blood Group System

Anti A / Anti B → IgM
Anti D → IgG

Rh⁺ → 85% of people

- The Rh system is defined by the D antigen. Presence of D means Rh-positive (85% of humans are Rh positive).
- Rh antibodies are not naturally occurring. They are IgG antibodies.
- They form after exposure to Rh-positive RBCs. This occurs via transfusion or pregnancy.
- Rh incompatibility is a major clinical concern. It differs from ABO in antibody type.

IgM
Anti A or B → formed early in life due to cross-reaction with Bacteria Antigen

IgG
Anti D → due to transfusion or pregnancy

Rh⁺ → have Antigen D → 85%
Rh⁻ → X

Hemolytic Disease of the Newborn – erythroblastosis fetalis (HDN)

Is due to

- HDN involves Rh incompatibility. An Rh-negative mother carries an Rh-positive fetus.
- Maternal IgG antibodies cross the placenta. They attack Rh positive fetal red blood cells.
- This causes hemolysis in the newborn (the Direct Coombs test is positive).
- Prevention involves high titers Anti-Rh immunoglobulins RhoGAM injection at 28 weeks of gestation and upon delivery. This prevents maternal sensitization.

← Anti-D

Indicate that antibodies are already attached to baby's RBCs

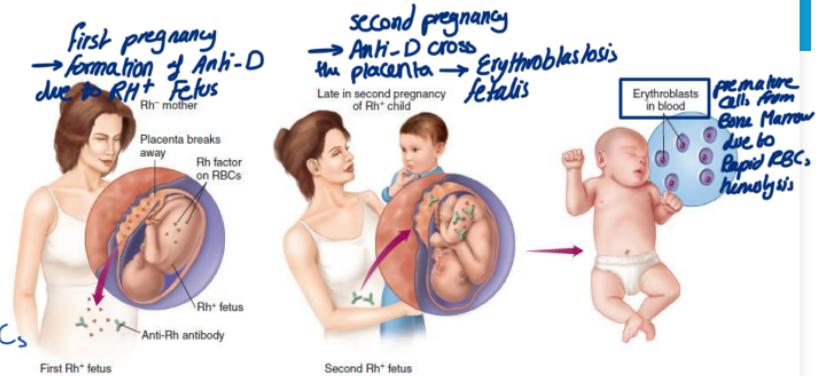


FIGURE 64-13 Hemolytic disease of the newborn (erythroblastosis fetalis). **Left panel:** Fetal red cells (RBCs) bearing the Rh antigen enter the mother's blood when the placenta separates during the birth of the first Rh-positive child. IgG antibodies to Rh antigen are then produced by the mother. **Center panel:** During a second pregnancy with an Rh-positive fetus, IgG antibodies pass from the mother into the fetus via the placenta. The antibodies bind to the fetal red cells, complement is activated, and the membrane attack complex lyses the fetal red cells. **Right panel:** Anemia and jaundice occur in the fetus/newborn. As a result of the anemia, large numbers of erythroblasts are produced by the bone marrow and are seen in the blood of the newborn. (Reproduced with permission from Cowan MK, Talaro KP, eds. Microbiology: A Systems Approach. New York: McGraw-Hill; 2009.)

Anti-Rh IgG given during:
1) 28 week of gestation
2) upon delivery

Immune Complexes in Diagnosis

of Inflammatory diseases.

- Immune complexes are antigen-antibody lattices. They can deposit in tissues and be detected by Fluorescent labeled complement.
- (Serum ^{Ig-Ab} complexes) bind to complement as C1q or specific cells in culture.
- Detection aids in diagnosing inflammatory diseases. It identifies pathology like glomerulonephritis.