

Ebola

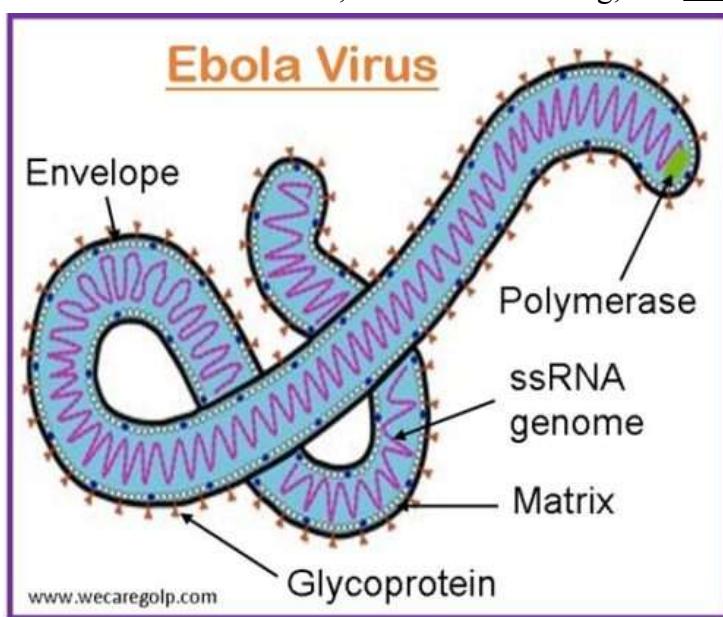
General Facts

Ebola virus disease (EVD), AKA Ebola hemorrhagic fever (EHF), is very contagious and deadly.



Causative Agent & Biological Characteristics:

- EVD is caused by ebolaviruses, a group of filamentous, enveloped RNA viruses
- The envelope has glycoproteins on its surface and is 80 nanometers in diameter
 - Linked to the nucleocapsid via matrix proteins
- The nucleocapsid contains the single-stranded, positive-sense RNA genome ($-ssRNA$), which is around 19,000 nucleotides long, and RNA-dependent RNA polymerase



Ebola Virus Types

Four Ebola virus species infect humans:

1. Ebola (Zaire) virus – EBOV (most common and deadly)
 - a. Responsible for the largest outbreaks, including West Africa (2014–2016)

- b. Only type with approved antibody treatments and vaccine
- 2. Sudan virus – SUDV
 - a. High fatality rate but no approved vaccines or antibody treatments
 - b. Treated mainly with supportive care
- 3. Bundibugyo virus – BDBV
 - a. Identified in Uganda in 2007
 - b. Typically causes less severe disease than EBOV
 - c. No specific treatments or vaccines available
- 4. Tai Forest virus – TAFV
 - a. Very rare in humans
 - b. Few recorded human cases and lower mortality
 - c. No specific treatments or vaccines available

Reservoirs

- Natural reservoir likely fruit bats
- Non-human primates (monkeys, apes) can be infected
- Spillover occurs when humans contact infected wildlife or bodily fluids



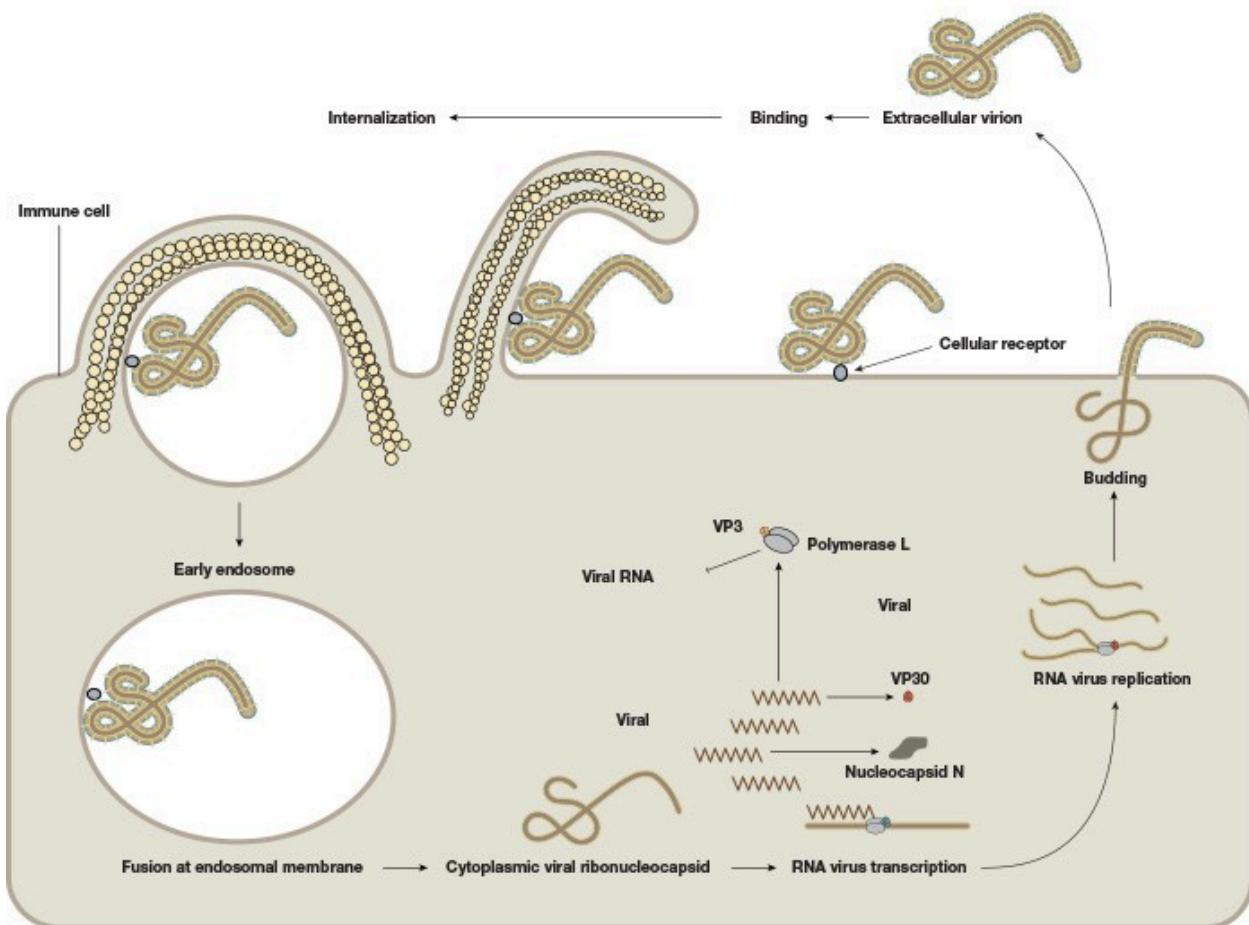
Transmission

- Spread through direct contact with bodily fluids:
 - Blood, vomit, diarrhea, urine, feces, sweat, saliva, breast milk, semen
- Spread via contaminated objects (fomites) such as needles, syringes, bedding, or clothing
- Not airborne
- Person-to-person transmission occurs when symptoms are present

Pathogenesis: Life Cycle

- Virus enters body through mucous membranes and wounds
- Virus enters host cell via receptor-mediated endocytosis

- Specifically, macropinocytosis: cell uses actin cytoskeleton to non-selectively engulf extracellular fluid into a large vesicle, called a macropinosome, usually to absorb nutrients or antigens
- Virus envelope fuses with the macropinosome membrane, releasing nucleocapsid into the cytoplasm
- Viral RNA polymerase uses (-)ssRNA as a template for mRNA synthesis; mRNA is translated into viral proteins by the host cell's cellular machinery
 - mRNA is single-stranded, positive-sense; it serves as an intermediary between the RNA genome and proteins
- After enough viral proteins are made, RNA polymerase uses (-)ssRNA as a template for synthesis of (+)ssRNA antigenome, which will also be used as a template to synthesize new (-)ssRNA for new Ebola virus virions
- Viral proteins and RNA associate at the plasma membrane before exiting the cell via budding, using the plasma membrane to form new envelopes
 - The budding process kills the host cell as a result



Pathogenesis: Suppressed Immunity

- Leukocytes—specifically monocytes, macrophages, and dendritic cells—are the preferred targets of the Ebola virus
- Infected leukocytes bring the virus to lymph nodes, where it can spread and infect other cells throughout the circulatory system
- Infected immune cells are impaired
 - EX: infected macrophages and dendritic cells do not mature or function properly (e.g., presenting antigens), so they cannot signal other immune cells and initiate an adaptive immune response
 - Both innate and adaptive immunity are suppressed, allowing virus to proliferate
- Infected immune cells eventually undergo apoptosis, releasing cytokines that trigger an inflammatory response, causing other immune cells to also undergo apoptosis
- Apoptosis and subsequent inflammation results in an overproduction of cytokines, known as a “cytokine storm.”
 - This cytokine storm causes extreme inflammatory responses that damages the body and induces severe symptoms of EVD, eventually killing the patient

Signs and Symptoms

- Early (“Dry”) Stage – Days 1–3
 - Fever
 - Severe headache
 - Muscle & joint pain
 - Weakness & fatigue
 - Sore throat
- Progressive (“Wet”) Stage – Days 4–5
 - Vomiting
 - Rash
 - Diarrhea
 - Nausea
 - Abdominal pain
 - Loss of appetite
- Severe / Late Stage – Day 7+
 - Internal and external bleeding (gums, mouth, eyes, rectum)
 - Organ failure
 - Encephalitis & seizures
 - Shock
- Untreated: ~50–90% fatality rate
- Treated: ~25–40% fatality rate (lower with antibodies)



Treatments

- No known cure for Ebola
- Early diagnosis is critical
- Treatment focuses on supportive care:
 - IV fluids & electrolytes
 - Oxygen therapy
 - Blood pressure management
 - Pain and fever control
- **Antibody Treatments**
 - Approved only for Zaire ebolavirus:
 - Ebanga® (single monoclonal antibody)
 - Inmazeb® (three monoclonal antibodies)
 - Other Ebola virus types treated mainly with supportive care
- **Vaccines**
 - ERVEBO® (rVSV-ZEBOV)
 - FDA-approved
 - Live, recombinant vesicular stomatitis virus (rVSV) vaccine
 - Effective only against Zaire ebolavirus
- Used in outbreak response
- Ervebo works by using a weakened virus (rVSV) that carries a protein from the Zaire ebolavirus to trigger an immune response

Current Events

- No current Ebola cases in the United States
- Overall U.S. risk remains very low
- Outbreak reported in Kasai Province, DRC (2025)
 - 64 confirmed/probable cases
 - 45 deaths
- Over 42,000 people vaccinated during outbreak response
- Dec. 1, 2025: DRC declared end of its 16th Ebola outbreak