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DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

OBT357 BIOTECHNOLOGY IN HEALTH

CARE UNIT- 2 CLINICAL DISEASES

2.2 Communicable diseases: COVID -19

Definition: COVID-19 (Coronavirus Disease 2019) is a communicable disease caused by the SARS-CoV-2 virus, primarily affecting the respiratory system but capable of causing systemic complications.

Transmission:

1. **Respiratory Droplets and Aerosols**:

   - **Primary Mode**: Infected individuals release droplets or aerosols containing the virus when coughing, sneezing, talking, singing, or breathing.
   - **Close Contact**: Transmission is most likely within 6 feet (2 meters) via inhalation of these particles.
   - **Aerosols**: Smaller particles can remain suspended in the air, especially in poorly ventilated indoor spaces, increasing risk over longer distances or time.

2. Surface Contact (Fomite Transmission):

- **Less Common**: The virus can survive on surfaces (e.g., plastic, metal) for hours to days, depending on conditions. Touching contaminated surfaces and then touching the face (eyes, nose,

mouth) may lead to infection.

- **Mitigation**: Regular handwashing and surface disinfection reduce this risk.

3. Airborne Transmission:

- **High-Risk Settings**: Prolonged exposure in enclosed, poorly ventilated spaces (e.g., crowded indoor gatherings) increases transmission risk via aerosols.
- **Variants**: Recent variants (e.g., XEC, KP.3.1.1) are more transmissible, partly due to enhanced aerosol spread.

4. Asymptomatic/Pre-symptomatic Spread:

- Infected individuals can transmit the virus before showing symptoms (pre-symptomatic) or without ever developing symptoms (asymptomatic), complicating control efforts.

5. Other Potential Routes:

- **Fecal-Oral**: Rare, but viral RNA has been detected in stool; not a significant transmission route.
- **Animal-to-Human**: Minimal risk, though SARS-CoV-2 can infect some animals (e.g., mink, cats); human-to-animal transmission is more documented.

6. Factors Increasing Transmission:

- **Crowded Settings**: Indoor gatherings, public transport, or events with poor ventilation.
- **Seasonal Trends**: Higher transmission in colder months due to indoor crowding and lower humidity.
- **Variant Dynamics**: Variants like XEC (noted in recent web sources) show increased transmissibility but not necessarily higher severity.

Symptoms:

COVID-19, caused by the SARS-CoV-2 virus, presents a range of symptoms that vary in severity and may differ slightly depending on the variant, vaccination status, and individual factors. Below is a concise overview of symptoms based on current data:

Common Symptoms:

- Fever or chills
- Dry cough
- Fatigue
- Shortness of breath or difficulty breathing
- Muscle or body aches
- Headache
- Loss of taste or smell (anosmia/ageusia, though less common with newer variants)
- Sore throat
- Nasal congestion or runny nose
- Nausea, vomiting, or diarrhea (gastrointestinal symptoms are more common in some variants)

Less Common Symptoms:

- Skin rashes or discoloration (e.g., "COVID toes")
- Conjunctivitis (pink eye)
- Chest pain
- Confusion or brain fog

Severe Symptoms (requiring immediate medical attention):

- Severe difficulty breathing or persistent chest pain/pressure
- Confusion or inability to stay awake
- Bluish lips, face, or extremities (indicating low oxygen levels)
- Signs of organ dysfunction (e.g., severe abdominal pain, kidney

issues)

Variant-Specific Notes:

- Recent variants (e.g., XEC, KP.3.1.1, noted in 2025 web sources) may present with milder or flu-like symptoms, such as sore throat, nasal congestion, or cough, especially in vaccinated individuals.
- Loss of taste/smell is less frequent with newer variants compared to earlier strains (e.g., Delta).

Special Populations:

- **Children**: Often milder symptoms (e.g., fever, cough, or gastrointestinal issues); rare cases may involve multisystem inflammatory syndrome (MIS-C).
- **Immunocompromised/Elderly**: Higher risk of severe symptoms, including pneumonia or acute respiratory distress syndrome (ARDS).
- **Long COVID**: Persistent symptoms (e.g., fatigue, brain fog, shortness of breath) may linger for weeks or months in some patients, even after mild cases.

Onset and Duration:

- Symptoms typically appear 2–14 days after exposure (incubation period).
- Mild cases usually resolve within 1–2 weeks; severe cases may require hospitalization and longer recovery.

Current Context:

- Symptoms in 2025 are often milder due to widespread immunity from vaccines and prior infections, but severe outcomes remain a risk for unvaccinated or high-risk groups.
- Asymptomatic infections are still possible, contributing to transmission.

2.1.2 Epidemiology of COVID-19 (as of July 23, 2025):

❖ **Global Burden**:

- ❒ **Cases**: Over 700 million confirmed cases worldwide since 2019 (exact numbers vary due to underreporting and reduced testing). In 2025, case counts are lower than peak pandemic years (2020–2022) but fluctuate with seasonal waves driven by new variants.
- ❒ **Deaths**: Approximately 7 million deaths globally by 2023, with mortality rates significantly reduced in 2025 due to immunity from vaccinations and prior infections.
- ❒ **Current Trends**: Recent web sources indicate ongoing waves, particularly in the Northern Hemisphere, with variants like XEC and KP.3.1.1 driving increased transmission in mid-2025. Hospitalizations and deaths remain lower than earlier peaks, primarily affecting unvaccinated or high-risk groups.

❖ Transmission Dynamics:

- ❒ **Basic Reproduction Number (R_0)**: Varies by variant; early strains had R_0 of 2–3, while Omicron subvariants (e.g., XEC) have higher R_0 (5–10), reflecting increased transmissibility.
- ❒ **Incubation Period**: 2–14 days (average 5–6 days), though shorter for recent variants.
- ❒ **Key Drivers**: Indoor crowding, poor ventilation, low vaccination coverage in some regions, and waning immunity over time.

❖ Geographic Distribution:

- ❒ **High-Income Countries**: High vaccination rates (70–90% in many regions) have reduced severe outcomes, but breakthrough infections occur. Seasonal surges persist, as seen in North America and Europe in 2025.
- ❒ **Low- and Middle-Income Countries**: Lower vaccination coverage (20–60% in some areas) and limited testing lead to underreported cases and higher

mortality risk in vulnerable populations.

- **Recent Hotspots**: Web sources suggest increased cases in parts of Europe, North America, and Asia (e.g., UK, US, India) in mid-2025, linked to XEC variant spread.

❖ Demographic Impact:

- **Age**: Elderly (65+) and those with comorbidities (e.g., diabetes, hypertension, obesity) face higher risks of severe outcomes. Children generally experience milder disease, though rare complications like MIS-C occur.
- **Sex**: Males have slightly higher mortality rates, potentially due to biological factors (e.g., immune response) and comorbidities.
- **Socioeconomic Factors**: Marginalized communities, including low-income groups and racial minorities, face disproportionate impacts due to limited healthcare access and higher exposure risks.

❖ Variants of Concern:

- **Current Variants (2025)**: XEC and KP.3.1.1 (Omicron sublineages) are dominant, with increased transmissibility but no clear evidence of higher severity compared to earlier Omicron strains (per web sources).
- **Impact**: Variants evade some immunity from older vaccines or prior infections, necessitating updated boosters (e.g., 2024–2025 vaccines targeting KP.2, JN.1).

❖ Vaccination and Immunity:

- **Global Coverage**: Over 13 billion vaccine doses administered worldwide by 2025. High-income countries have robust booster programs, while access remains uneven in low-resource settings.
- **Effectiveness**: Vaccines reduce severe outcomes (hospitalization, death) by 70–90% but are less effective against infection with newer variants.

Boosters restore protection.

- **Natural Immunity**: Prior infections provide partial, time-limited protection, with hybrid immunity (vaccination + infection) offering the strongest defense.

❖ Public Health Measures:

- **Surveillance**: Reduced testing in many regions limits precise case tracking, but wastewater monitoring and hospital data provide insights into trends.
- **Interventions**: Mask mandates and lockdowns are rare in 2025, but targeted measures (e.g., masking in healthcare settings) persist during surges.
- **Long COVID**: Affects 5–20% of cases, with symptoms like fatigue, cognitive issues, and respiratory problems, posing ongoing public health challenges.

❖ Challenges:

- **Data Gaps**: Underreporting of cases due to reduced testing and surveillance.
- **Vaccine Hesitancy**: Persists in some populations, limiting control efforts.
- **Variant Evolution**: Ongoing mutations require continuous vaccine updates and monitoring.

❖ Current Context (July 2025):

- Seasonal waves continue, with XEC variant driving upticks in cases, particularly in temperate regions.
- Hospitalization rates are low but rise in unvaccinated or immunocompromised groups.
- Public health focus is on protecting vulnerable populations, updating vaccines, and managing long COVID.

Treatment:

The treatment of COVID-19, caused by the SARS-CoV-2 virus, depends on the severity of the disease, patient risk factors, and available medical resources. Below is a concise overview of current treatment approaches, reflecting data up to July 2025.

Mild to Moderate Cases (Managed at Home):

- ✓ Supportive Care:
  - ✓ Rest, hydration, and a balanced diet.
  - ✓ Over-the-counter medications: Acetaminophen or ibuprofen for fever, body aches, or headaches.
  - ✓ Monitor symptoms, especially oxygen levels (using a pulse oximeter) and breathing difficulties.
- ✓ **Antivirals** (for high-risk patients):
  - ✓ **Paxlovid (nirmatrelvir/ritonavir)**: Oral antiviral for adults with mild-to-moderate disease at high risk of progression (e.g., elderly, immunocompromised). Must be started within 5 days of symptom onset. Reduces hospitalization risk by ~85%.
  - ✓ **Molnupiravir**: Alternative oral antiviral, less effective but used when Paxlovid is contraindicated.
  - ✓ **Availability**: Varies by region; more accessible in high-income countries.
- ✓ **Monoclonal Antibodies**: Less commonly used in 2025 due to reduced effectiveness against newer variants (e.g., XEC, KP.3.1.1), but some formulations may be used for high-risk outpatients.

Moderate to Severe Cases (Hospital-Based):

- Antivirals:
  - **Remdesivir**: Intravenous antiviral for hospitalized patients, typically given for 3–5 days. Effective in reducing recovery time and

progression to severe disease.

- Corticosteroids:
  - **Dexamethasone**: Standard for patients requiring oxygen or mechanical ventilation. Reduces mortality in severe cases by suppressing inflammatory response.
  - Other steroids (e.g., prednisone) may be used in specific cases.
- Immunomodulators:
  - Drugs like **tocilizumab** or **baricitinib** for patients with severe inflammation or cytokine storm, often in ICU settings.
- Oxygen Therapy:
  - Supplemental oxygen via nasal cannula or high-flow devices for patients with low oxygen saturation (<92%).
  - Non-invasive ventilation (e.g., CPAP) for moderate respiratory distress.
- Anticoagulants:
  - Heparin or other blood thinners to prevent clotting complications, common in severe COVID-19.

Critical Cases (ICU-Based):

- **Mechanical Ventilation**: For patients with acute respiratory distress syndrome (ARDS) or severe respiratory failure.
- **Extracorporeal Membrane Oxygenation (ECMO)**: Used in select cases for severe lung failure when ventilation is insufficient.
- **Supportive Care**: Management of multi-organ failure, sepsis, or secondary infections.

Long COVID Management:

- **Symptoms**: Fatigue, brain fog, shortness of breath, or cardiac issues persisting weeks to months post-infection.
- **Approach**: Multidisciplinary care, including physical therapy, cognitive rehabilitation, and symptom-specific treatments (e.g., inhalers for respiratory

issues). No standardized treatment; research ongoing.

- **Prevalence**: Affects 5–20% of patients, per recent studies.

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