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DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

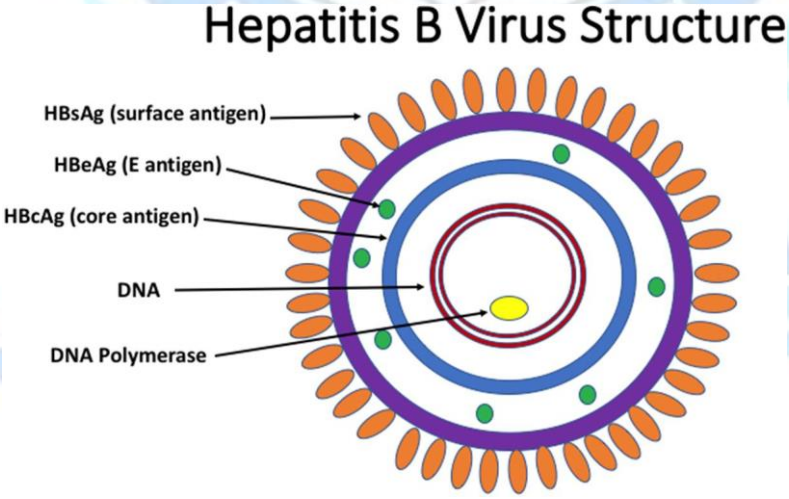
OBT357 BIOTECHNOLOGY IN HEALTH CARE

UNIT- 2 CLINICAL DISEASES

2.4 Communicable diseases: Hepatitis B, Hepatitis C

- Hepatitis B is a viral infection caused by the Hepatitis B virus (HBV), primarily affecting the liver.
- It's a major global health issue, with around 257 million people chronically infected and nearly 900,000 deaths annually from related complications like cirrhosis and liver cancer, based on WHO estimates.

2.4.1 Structure of Hepatitis B Virus:



- **HBsAg (Surface Antigen)**: The outermost layer consists of spike-like

structures (orange), formed by the Hepatitis B surface antigen. This envelope helps the virus enter liver cells and is the target of the immune response and vaccines.

- **HBcAg (Core Antigen)**: Inside the envelope, a purple layer represents the core antigen, which forms the viral capsid. This protein shell encases the viral genetic material and is key for viral assembly.
- **HBeAg (E Antigen)**: Found within the core, this antigen (green dots) is a marker of active viral replication and infectivity, though it's not part of the virus structure itself but released during infection.
- **DNA**: At the center, a red double circle indicates the viral DNA, a partially double-stranded circular genome that contains the genetic instructions for replication.
- **DNA Polymerase**: A yellow oval within the core represents the enzyme DNA polymerase, which helps replicate the viral DNA and repair its structure during infection.

This layered structure allows HBV to infect liver cells, replicate, and evade the immune system, contributing to both acute and chronic liver disease.

2.4.2 Modes of Transmission:

1. Bloodborne Transmission

- **Unsafe injections** or **needle sharing** (e.g., IV drug use)
- **Contaminated medical or dental instruments** (if not properly sterilized)
- **Blood transfusions** (rare today due to screening)

2. Perinatal (Mother to Child)

- Transmission from **infected mother to baby during childbirth**
- Major cause of chronic HBV in high-prevalence regions

3. Sexual Transmission:

- Unprotected sex with an infected person
- Especially high risk in individuals with multiple sexual partners or with STDs

4. Household Contact:

- Sharing personal items like **razors, toothbrushes**, or **nail clippers**
- **Minor cuts or abrasions** may allow the virus to spread

. 5. Occupational Exposure:

- Healthcare workers exposed to **needle-stick injuries** or infected blood

2.4.3 Symptoms:

Common Symptoms of Acute Hepatitis B:
(Usually appear **1 to 4 months** after exposure)

- **Fever**
- **Fatigue or weakness**
- **Loss of appetite**
- **Nausea and vomiting**
- **Abdominal pain** (especially in the upper right side)
- **Dark urine**
- **Pale or clay-colored stool**
- **Joint pain**
- **Jaundice** (yellowing of the skin and eyes)

Symptoms of Chronic Hepatitis B

Many people with chronic HBV may be **asymptomatic for years**, but over time, chronic infection can lead to:

- **Persistent fatigue**
- **Right upper abdominal discomfort**
- **Mild jaundice**
- **Liver enlargement**
- **Signs of liver damage** (in advanced stages):
  - ✓ **Ascites** (fluid in abdomen)

- ✓ Easy bruising or bleeding
- ✓ **Confusion** (hepatic encephalopathy)
- ✓ **Cirrhosis or liver cancer** (in severe cases)

2.4.4 Diagnosis of Hepatitis B Virus (HBV):

- ❒ **Serological Tests**:
  - ❖ **HBsAg (Hepatitis B Surface Antigen)**: Detects current infection; positive in acute or chronic cases.
  - ❖ **Anti-HBs (Antibody to HBsAg)**: Indicates immunity (from vaccination or recovery).
  - ❖ **Anti-HBc (Antibody to HBcAg)**: Detects past or present infection (IgM for acute, IgG for past).
  - ❖ **HBeAg (Hepatitis B e Antigen)**: Signals high viral replication and infectivity.
  - ❖ **Anti-HBe**: Indicates lower replication in chronic cases.
- ❒ **Viral Load Test**: PCR-based HBV DNA test measures viral levels, guiding treatment decisions.
- ❒ **Liver Function Tests**: Assess liver damage via enzymes (ALT, AST), bilirubin, and albumin levels.
- ❒ **Imaging**: Ultrasound or CT scans evaluate liver condition (e.g., cirrhosis or cancer).
- ❒ **Liver Biopsy**: Rarely used, confirms chronic damage or fibrosis extent.

2.4.4 Diagnosis of Hepatitis B Virus (HBV):

Hepatitis B virus (HBV) treatment focuses on controlling the infection, preventing liver damage, and managing symptoms, as there is no cure for HBV. Treatment varies based on whether the infection is acute or chronic, and decisions are guided by viral load, liver function, and disease stage. Below is a concise overview of HBV treatment strategies based on current medical understanding:

Acute HBV:

- **Supportive Care**: Acute HBV often resolves on its own in immunocompetent adults (90-95% of cases). Treatment focuses on:
  - Rest, hydration, and nutrition.
  - Avoiding alcohol and hepatotoxic drugs to reduce liver stress.
  - Monitoring liver function tests (ALT, AST) to assess recovery.
- **Antiviral Therapy**: Rarely needed unless severe (e.g., fulminant hepatitis or acute liver failure). In such cases, antivirals like tenofovir or entecavir may be used to reduce viral replication.
- **Hospitalization**: Indicated for severe symptoms like coagulopathy, encephalopathy, or jaundice.

Chronic HBV

Chronic HBV requires long-term management to prevent progression to cirrhosis, liver failure, or hepatocellular carcinoma (HCC). Treatment is tailored based on HBeAg status, HBV DNA levels, ALT levels, and liver fibrosis stage.

1. Antiviral Therapy

Antiviral drugs suppress viral replication, reduce liver inflammation, and lower the risk of complications. First-line treatments include:

- Nucleos(t)ide Analogues (NAs):
  - **Tenofovir Disoproxil Fumarate (TDF)**: Highly effective, taken orally once daily. Side effects include potential kidney and bone toxicity.
  - **Tenofovir Alafenamide (TAF)**: A newer formulation with fewer renal and bone side effects, preferred in patients with comorbidities.
  - **Entecavir (ETV)**: Effective with a high barrier to resistance. Preferred for patients without prior NA exposure. Side effects are minimal but may include headache or fatigue.
- Indications for Treatment:
  - HBeAg-positive or -negative chronic hepatitis with HBV DNA >2,000 IU/mL and elevated ALT (>2x upper limit of normal).

- Cirrhosis with detectable HBV DNA, regardless of ALT or viral load.
- Special populations (e.g., pregnant women, immunocompromised patients) to prevent transmission or flares.

- **Duration**: Often lifelong, as NAs suppress but do not eradicate HBV due to persistent covalently closed circular DNA (cccDNA) in hepatocytes. Discontinuation may be considered in select HBeAg-negative patients with sustained undetectable HBV DNA and HBsAg loss.

2. Interferon Therapy :

- **Pegylated Interferon Alfa (Peg-IFN)**:
  - Administered as weekly subcutaneous injections for 48 weeks.
  - Stimulates immune response to control HBV and may lead to HBsAg loss in some cases (3-7% of patients).
  - Suitable for younger patients, HBeAg-positive cases, or those with mild disease and favorable predictors (e.g., low HBV DNA, high ALT).
  - Side Effects: Flu-like symptoms, fatigue, depression, and bone marrow suppression. Not suitable for decompensated cirrhosis or pregnancy.
- **Limitations**: Less commonly used due to side effects and lower tolerability compared to NAs.

3. Monitoring and Supportive Care:

❖ **Regular Monitoring**:
- Blood tests every 3-6 months to assess HBV DNA, ALT, and HBeAg/HBsAg status.
- Liver imaging (ultrasound, CT, or MRI) and alpha-fetoprotein (AFP) every 6-12 months to screen for HCC, especially in high-risk patients (e.g., cirrhosis, family history of HCC).
- FibroScan or liver biopsy to assess fibrosis stage.

❖ Lifestyle Modifications:
- Avoid alcohol and smoking to protect liver health.
- Maintain a healthy weight to prevent fatty liver disease.
- Vaccinate against hepatitis A to prevent additional liver injury.

4. Special Populations

- **Pregnancy**: Antivirals (usually TDF) may be started in the third trimester for women with high viral loads (>200,000 IU/mL) to reduce mother-to-child transmission. HBV vaccine and immunoglobulin are given to newborns.
- **Coinfections**: HBV/HIV or HBV/HCV coinfections require coordinated antiviral regimens (e.g., TDF-based therapy for HBV/HIV).
- **Immunosuppressed Patients**: Antiviral prophylaxis is recommended during immunosuppressive therapy (e.g., chemotherapy) to prevent HBV reactivation.

5. Emerging Therapies

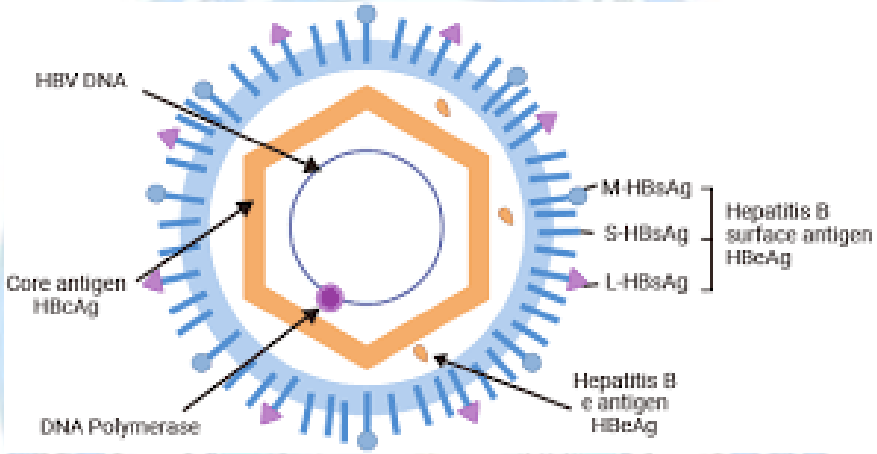
- Research is ongoing for functional cures (HBsAg loss with undetectable HBV DNA). Promising approaches include:
  - ✓ **Immune Modulators**: Therapeutic vaccines, TLR agonists, or checkpoint inhibitors to enhance immune clearance.
  - ✓ **Viral Entry Inhibitors**: Drugs like bulevirtide (approved in some regions for HBV/HDV coinfection).
  - ✓ **Gene Therapies**: CRISPR-based approaches or siRNAs to target cccDNA.
  - ✓ Clinical trials are exploring combination therapies to achieve higher rates of functional cure.

Key Considerations

- **Vaccination**: HBV vaccination is critical for prevention, especially for household contacts and high-risk groups.
- **Drug Resistance**: Resistance is rare with first-line NAs (TDF, TAF, ETV) but can occur with older drugs like lamivudine.
- **Access and Cost**: Treatment availability varies globally. Generic TDF and ETV have improved access in low-resource settings.
- **Patient Adherence**: Consistent medication adherence is crucial to prevent viral rebound and resistance.

For personalized treatment plans, consult a hepatologist or infectious disease specialist, as decisions depend on individual factors like age, comorbidities, and viral genotype. If you have specific details (e.g., lab results, disease stage), I can tailor the response further. Would you like me to search for recent advancements or clinical trial updates on HBV treatment?

2.4.5 Structure of Hepatitis C Virus



- **HBV DNA**: The genetic material of the virus, located at the center.
- **Core antigen (HBcAg)**: A protein that forms the inner capsid, enclosing the HBV DNA.
- **DNA Polymerase**: An enzyme within the core that helps replicate the viral DNA.
- **Hepatitis B e antigen (HBeAg)**: A marker of viral replication, found inside the core.
- **Surface antigens (HBsAg)**: Proteins on the outer envelope that help the virus infect cells, including M HBsAg (middle), S HBsAg (small), and L HBsAg (large).
- **Hepatitis B surface antigen**: The outer lipid envelope derived from the host cell, studded with HBsAg.

2.4.5.2 Causes of Hepatitis C Virus (HCV):

Hepatitis C is caused by the Hepatitis C virus, primarily spread through:

- **Blood-to-blood contact**: Sharing needles, syringes, or other drug injection equipment.
- **Unscreened blood transfusions**: Rare in areas with proper screening.
- **Needlestick injuries**: Common in healthcare settings.
- **From mother to child**: During childbirth if the mother is infected.
- **Sexual contact**: Less common, but possible with exposure to infected blood.
- **Sharing personal items**: Like razors or toothbrushes contaminated with infected blood.

2.4.5.3 Symptoms of Hepatitis C Virus (HCV):

Hepatitis C infections can be acute or chronic, with many cases being asymptomatic:

- **Acute Hepatitis C:** Often asymptomatic, but when symptoms occur, they may include fatigue, fever, nausea, abdominal pain, dark urine, clay-colored stools, and jaundice (yellowing of skin and eyes). Symptoms are typically mild and resolve within weeks.
- **Chronic Hepatitis C**: Up to 85% of acute cases progress to chronic infection, which may remain asymptomatic for decades. Symptoms, when present, include chronic fatigue, joint pain, and liver-related issues like jaundice or abdominal swelling due to cirrhosis or liver cancer.

Many individuals are unaware of their infection until significant liver damage occurs.

2.4.5.4 Diagnosis of Hepatitis C Virus (HCV):

Diagnosis of Hepatitis C involves:

- **Blood tests**: Initial screening for HCV antibodies (anti-HCV) to detect exposure, followed by a PCR test to confirm active infection by detecting HCV RNA.
- **Liver function tests**: To assess liver damage through elevated enzyme levels (ALT, AST).
- Ultrasound, CT, or MRI to evaluate liver condition in chronic cases.
- **Liver biopsy or elastography**: To assess the extent of liver fibrosis or cirrhosis in chronic cases.

Routine screening is recommended for high-risk groups, including individuals with a history of injection drug use, those with HIV, or those born between 1945 and 1965 (in some regions).

2.4.5.5 Treatment of Hepatitis C Virus (HCV):

Hepatitis C is treatable, with high cure rates:

- **Acute Hepatitis C**: Often resolves spontaneously in 15-25% of cases. Antiviral treatment may be considered to prevent progression to chronic infection.
- **Chronic Hepatitis C**: Direct-acting antivirals (DAAs), such as sofosbuvir, ledipasvir, or glecaprevir/pibrentasvir, are highly effective, curing over 95% of cases with 8-12 weeks of treatment. These medications target specific viral proteins to eliminate the virus.
- **Care:** Avoiding alcohol and hepatotoxic drugs to reduce liver strain. Regular monitoring is needed for those with advanced liver disease.
- **Transplant**: In cases of severe liver damage or liver failure. Treatment is tailored based on HCV genotype, liver damage, and patient health

2.4.5.5 Treatment of Hepatitis C Virus (HCV):

Prevention There is no vaccine for Hepatitis C, so prevention focuses on reducing transmission:

- **Safe practices**: Using sterile needles and syringes, avoiding sharing personal items like razors or toothbrushes, and practicing safe sex, particularly for high-risk groups.
- **safety:** Screening blood donations and ensuring sterile medical equipment in healthcare settings.
- Reduction: Providing needle exchange programs and substance use treatment for injection drug users.
- **Early treatment**: Routine testing for high-risk individuals to identify and treat infections early, reducing transmission risk.
- **Raising awareness** about transmission risks and prevention strategies.

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