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DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

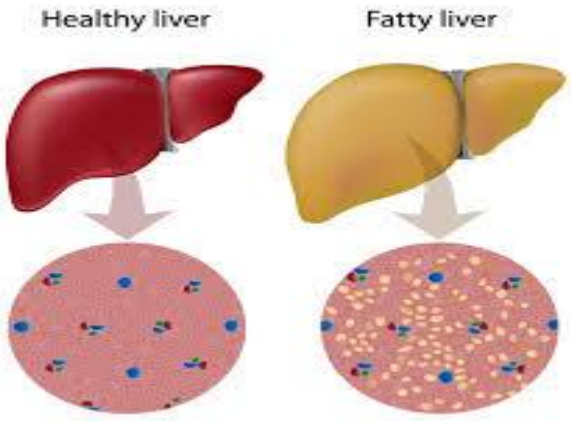
OBT357 BIOTECHNOLOGY IN HEALTH CARE

UNIT- 2 CLINICAL DISEASES

2.8 Fatty liver, Obesity

2.8.1 Fatty Liver:

- Non-communicable diseases (NCDs) are chronic conditions not caused by infectious agents, often linked to lifestyle, genetics, or environmental factors.
- Fatty liver disease, specifically Non-Alcoholic Fatty Liver Disease (NAFLD), is a common NCD characterized by excessive fat buildup in the liver, not caused by alcohol consumption.



2.8.2 Causes of Fatty Liver:

- **Excessive Alcohol Consumption:** This is the most common cause of alcoholic fatty liver disease (AFLD). Alcohol interferes with the liver's ability to metabolize fats, leading to their buildup.
- **Obesity and Insulin Resistance:** These are the leading causes of non-alcoholic fatty liver disease (NAFLD). Excess weight, particularly around the

abdomen, can lead to insulin resistance, a condition where the body's cells don't respond properly to insulin. This causes the pancreas to produce more insulin, which can lead to fat being stored in the liver.

- **High Blood Sugar (Diabetes):** Poorly controlled type 2 diabetes often leads to NAFLD. High blood sugar levels and insulin resistance contribute to fat accumulation in the liver.
- **High Cholesterol and Triglycerides:** Abnormal lipid levels in the blood, such as high triglycerides and low levels of high-density lipoprotein (HDL) cholesterol, are strongly associated with NAFLD.
- **Sedentary Lifestyle**: **Mechanism**: Lack of physical activity reduces fat metabolism and exacerbates insulin resistance, promoting liver fat accumulation.
- **Medications and Toxins**: Long-term use of certain medications (e.g., corticosteroids, tamoxifen, methotrexate) can cause or worsen fatty liver. Exposure to chemicals (e.g., pesticides) may disrupt liver metabolism.

2.8.3 Symptoms of Fatty Liver:

- Often, fatty liver has **no noticeable symptoms**, especially in its early stages. Many people only find out they have it after routine blood tests show elevated liver enzymes, or if they get an ultrasound or other imaging for another reason.
- When symptoms do appear, they are usually a sign that the disease has progressed. The most common symptoms include:
  - ✓ **Fatigue and weakness**: A persistent feeling of tiredness.
  - ✓ **A dull ache or pain in the upper right side of the abdomen**: This is where the liver is located.
  - ✓ **Weight loss**: Unexplained weight loss can be a sign of liver problems.
  - ✓ **Loss of appetite**: A general disinterest in food.
  - ✓ **Swelling in the abdomen, legs, or ankles**: This is known as edema and can be a sign of advanced liver disease (cirrhosis).
  - ✓ **Yellowing of the skin and eyes (jaundice)**: This is another sign of advanced liver disease.
  - ✓ **Nausea**: A feeling of sickness.

2.8.4 Diagnosis of Fatty Liver:

- **Medical History and Physical Exam:** The doctor will ask about the patient's lifestyle, including alcohol consumption, diet, and exercise habits. They'll also check for risk factors like obesity, diabetes, and high cholesterol. A physical exam may reveal an enlarged liver, which can be a sign of fatty liver.
- **Blood Tests:** Routine blood tests can be an early indicator. Elevated levels of liver enzymes, such as Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST), can signal liver inflammation or damage. However, these markers alone aren't enough for a definitive diagnosis.

    - ✓ **Imaging Studies:** Imaging is the most common way to confirm a diagnosis of fatty liver. These non-invasive tests allow doctors to visualize the liver and detect the presence of fat.
    - ✓ **Ultrasound:** This is often the first imaging test used. It's inexpensive and can show fat buildup in the liver.
    - ✓ **Computed Tomography (CT) Scan:** CT scans can also detect fatty liver and provide more detailed images.
    - ✓ **Magnetic Resonance Imaging (MRI):** MRI is more sensitive than ultrasound and CT and can accurately quantify the amount of fat in the liver.

- **Liver Biopsy (If Necessary):** A liver biopsy is the gold standard for a definitive diagnosis, especially to determine the severity of the disease and rule out other liver conditions. During a biopsy, a small tissue sample is taken from the liver and examined under a microscope. This can confirm the presence of fat and identify any inflammation or scarring (fibrosis) that may be present, which is crucial for determining the stage of the disease.

2.8.5 Treatment of Fatty Liver:

No specific FDA-approved drug is available for NAFLD, so treatment primarily involves lifestyle modifications, management of comorbidities, and, in advanced cases, targeted interventions to prevent or treat complications like cirrhosis or liver cancer.

- **Lifestyle and Dietary Changes:**
  - ✓ **Weight Loss:** This is the most crucial treatment for fatty liver, especially for those with obesity or who are overweight. Losing weight, even a modest amount, can significantly reduce liver fat and inflammation. A doctor or a registered dietitian can help create a safe and effective weight loss plan.
  - ✓ **Healthy Diet:** A balanced diet rich in fruits, vegetables, and whole grains is recommended. It's important to limit or avoid foods high in saturated fats, trans fats, and sugar, as these can exacerbate the condition.
  - ✓ **Exercise:** Regular physical activity helps reduce liver fat, improves insulin sensitivity, and aids in weight loss. Aim for at least 30 minutes of moderate exercise most days of the week.
  - ✓ **Avoid Alcohol:** For individuals with alcoholic fatty liver disease (AFLD), complete abstinence from alcohol is essential. For those with non-alcoholic fatty liver disease (NAFLD), reducing alcohol intake is still highly recommended.

- **Medical Management:**
  - ✓ **Diabetes and Cholesterol Control:** If fatty liver is linked to diabetes or high cholesterol, managing these conditions is a key part of the treatment. This may involve medication prescribed by a doctor to control blood sugar levels or lower cholesterol and triglycerides.
  - ✓ **Medication:** While there are no drugs specifically approved for fatty liver, doctors may prescribe medications to manage associated conditions like diabetes or high cholesterol. In some cases, and under a doctor's supervision, certain vitamins or supplements like Vitamin E may be used, though their effectiveness can vary.

- ✓ **Bariatric Surgery** (For Severe Obesity):

  For patients with BMI >35 and NAFLD, bariatric surgery (e.g., gastric bypass) can reduce liver fat and improve NASH. Studies show significant improvement in steatosis and fibrosis post-surgery. Risk involved are surgical complications; rapid weight loss may temporarily worsen liver inflammation.

2.8.6 Obesity:

Obesity is a complex **non-communicable disease** characterized by an excessive accumulation of body fat that may impair health. It's not just a cosmetic issue; it's a medical condition that significantly increases the risk of other serious health problems. A person is generally considered obese when their **Body Mass Index (BMI)**, a measure calculated from weight and height, is 30 or higher.

2.8.7 Causes for Obesity:

- ❖ **Dietary Factors**:
  - ✓ **High-Calorie Foods**: Consuming energy-dense foods, such as processed snacks, sugary drinks, and fast food, contributes significantly. For example, frequent consumption of high-fructose corn syrup in beverages is linked to weight gain.
  - ✓ **Overeating**: Large portion sizes and frequent snacking, often driven by emotional or stress-related eating, increase calorie intake.
  - ✓ **Poor Nutritional Choices**: Diets low in fruits, vegetables, and fiber but high in refined carbohydrates and unhealthy fats promote fat accumulation.

- ❖ **Physical Inactivity**:
  - ✓ Sedentary lifestyles, common in urban settings, reduce calorie burning. Prolonged screen time, desk jobs, and reliance on vehicles limit physical activity.
  - ✓ In India, for instance, urbanization has decreased traditional physical tasks, with studies showing only 10-20% of adults meet recommended activity levels.

❖ **Genetic and Biological Factors**:

- ✓ Genetics can influence metabolism, fat storage, and appetite regulation. Variants in genes like FTO are associated with higher obesity risk.
- ✓ Hormonal disorders (e.g., hypothyroidism, polycystic ovary syndrome) or medications (e.g., antidepressants, corticosteroids) can contribute to weight gain.

❖ **Environmental and Socioeconomic Factors**:

- ✓ **Access to Food**: Limited access to healthy foods in low-income areas or "food deserts" pushes reliance on cheap, calorie-dense options.
- ✓ **Urbanization**: In countries like India, rapid urbanization has shifted diets toward processed foods. For example, a 2020 study noted a 10-15% rise in obesity in urban India over a decade.
- ✓ **Cultural Norms**: In some cultures, larger body sizes are associated with prosperity, discouraging weight management efforts.

❖ **Psychological and Behavioural Factors**:

- ✓ **Stress and Mental Health**: Chronic stress or conditions like depression can lead to overeating as a coping mechanism, often targeting comfort foods.
- ✓ **Sleep Deprivation**: Poor sleep disrupts hormones like ghrelin and leptin, increasing appetite. Studies show less than 6 hours of sleep nightly raises obesity risk by 20-30%.
- ✓ **Habits**: Irregular eating patterns, skipping meals, or binge eating contribute to weight gain.

❖ **Social and Economic Influences**:

- ✓ **Marketing and Advertising**: Aggressive marketing of unhealthy foods, especially to children, drives poor dietary choices.
- ✓ **Economic Constraints**: Lower-income groups may prioritize affordable, calorie-heavy foods over healthier, costlier options.

- ✓ **Social Networks**: Obesity can be "socially contagious," where behaviors like overeating spread within peer groups.

- ❖ **Medical and Developmental Factors**:

  - ✓ **Early Life Influences**: Poor nutrition during pregnancy or childhood can program metabolism for higher fat storage later in life.
  - ✓ **Medications**: Certain drugs, like antipsychotics or insulin, can cause weight gain as a side effect.

2.8.8 Symptoms for Obesity:

Symptoms for obesity can include:

- ❖ **Excessive body fat:** An accumulation of extra body fat, especially around the waist.
- ❖ **High BMI:** A Body Mass Index (BMI) of 30 or higher is the primary indicator of obesity.
- ❖ **Physical discomforts:** Shortness of breath, increased sweating, fatigue, and snoring are common symptoms.
- ❖ **Joint pain:** The excess weight can cause pain in the joints and back.
- ❖ **Psychological impacts:** Low self-esteem and social isolation can also be associated with obesity.
- ❖ **Sleep apnea:** This sleep disorder where breathing repeatedly stops and starts is a major symptom of obesity.

2.8.9 Diagnosis of Obesity:

- ❖ Diagnosing obesity involves assessing a person's body fat levels and related health risks using standardized measurements and clinical evaluations. Below is a clear overview of the methods and criteria used to diagnose obesity:
- ❖ **Body Mass Index (BMI)**:

  - ✓ BMI is the primary tool for diagnosing obesity, calculated as weight (kg) divided by height (m).
  - ✓ **Criteria**:

    - ➢ Normal: 18.5–24.9

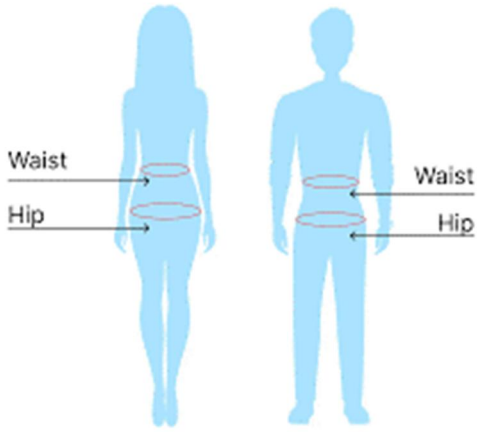
- Overweight: 25–29.9
- Obesity: ≥30
    - Class 1: 30–34.9
    - Class 2: 35–39.9
    - Class 3 (Severe): ≥40

- ✓ **Limitations**: BMI doesn't account for muscle mass, bone density, or fat distribution. For example, athletes may have high BMI without excess fat.
- ✓ **Context in India**: Indian populations may have higher health risks at lower BMI levels (e.g., ≥25 considered obese in some guidelines due to higher visceral fat).

❖ **Waist Circumference**:

- **Purpose**: Measures abdominal fat, which is a strong indicator of health risks like heart disease or diabetes.
- **Criteria**:
    - Men: >94 cm (increased risk); >102 cm (high risk)
    - Women: >80 cm (increased risk); >88 cm (high risk)
    - In India: Cutoffs are lower (e.g., >90 cm for men, >80 cm for women) due to higher visceral fat prevalence.
- **Method**: Measured at the midpoint between the lower rib and iliac crest using a tape measure.

❖ **Waist-to-Hip Ratio (WHR)**:



- Assesses fat distribution by comparing waist to hip measurements.
- **Criteria**:
  - Men: >0.9 indicates higher risk
  - Women: >0.85 indicates higher risk
- **Relevance**: Useful for identifying central obesity, which is common in South Asians, including Indians.

❖ **Body Fat Percentage**:

- ✓ **Method**: Measured using tools like skinfold calipers, bioelectrical impedance (e.g., smart scales), or advanced techniques like DEXA scans.
- ✓ **Criteria**: Varies by age and sex, but generally:
  - Men: >25% body fat
  - Women: >32% body fat
- ✓ **Use**: More precise than BMI but less commonly used due to equipment costs.

❖ **Clinical Evaluation**:

- ✓ **Medical History**: Assessing family history of obesity, lifestyle (diet, physical activity), medications, or conditions (e.g., hypothyroidism, PCOS) that contribute to weight gain.
- ✓ **Physical Exam**: Checking for symptoms like high blood pressure, joint pain, or acanthosis nigricans (dark skin patches indicating insulin resistance).
- ✓ **Comorbidities**: Screening for related conditions like type 2 diabetes, high cholesterol, or sleep apnea.

❖ **Laboratory Tests**:

- ✓ **Blood Tests**: Measure fasting glucose, HbA1c, lipid profile, or thyroid function to identify metabolic issues.
- ✓ **Other Tests**: In some cases, tests for cortisol levels (e.g., Cushing's syndrome) or liver function (e.g., fatty liver disease) are conducted.

- **Advanced Imaging (Rare Cases)**:
  - ✓ **DEXA or MRI**: Used in research or specialized settings to quantify fat distribution.
  - ✓ **Purpose**: To confirm obesity-related complications or for surgical planning (e.g., bariatric surgery).

2.8.10 Treatment for Obesity:

Treating obesity involves a combination of lifestyle changes, medical interventions, and, in some cases, surgical options, tailored to the individual's needs, health status, and severity of obesity. The goal is to achieve sustainable weight loss, improve overall health, and reduce the risk of related conditions like diabetes, heart disease, and joint issues. Below is a concise overview of treatment approaches:

1. **Lifestyle Modifications**:
   - **Dietary Changes**:
     - ✓ Adopt a balanced, calorie-controlled diet rich in vegetables, fruits, lean proteins, whole grains, and healthy fats.
     - ✓ Reduce intake of processed foods, sugary drinks, and high-fat items. In India, where high-carb diets (e.g., rice, rotis) are common, portion control and incorporating low-glycemic foods are key.
     - ✓ Work with a dietitian to create a personalized plan, often targeting a 500–1,000 kcal daily deficit for 0.5–1 kg weekly weight loss.
   - **Physical Activity**:
     - ✓ Aim for at least 150–300 minutes of moderate aerobic exercise (e.g., brisk walking, cycling) per week, plus strength training 2–3 times weekly.
     - ✓ In India, culturally relevant activities like yoga or dancing can improve adherence.
   - **Behavioral Changes**:

- ✓ Address emotional eating through cognitive-behavioral therapy (CBT) or counseling.
- ✓ Set realistic goals, track progress (e.g., food diaries), and build healthy habits like mindful eating.
- ✓ Improve sleep hygiene, as poor sleep (less than 6 hours) can hinder weight loss by affecting hunger hormones.

2. **Medical Interventions**:

   - ❖ **Medications**:
     - Prescribed for BMI ≥30 or ≥27 with comorbidities (e.g., diabetes, hypertension) when lifestyle changes alone are insufficient.
     - Common drugs include orlistat (reduces fat absorption), liraglutide (appetite suppressant), or naltrexone-bupropion (reduces cravings).
     - In India, medications are used cautiously due to cost and side effects, with orlistat being more common.
     - Requires doctor supervision to monitor efficacy and side effects (e.g., gastrointestinal issues, mood changes).
   - ❖ **Medical Monitoring**:
     - Regular check-ups to track weight, blood pressure, glucose levels, and lipid profiles.
     - Address underlying conditions like hypothyroidism or PCOS that may contribute to weight gain.

3. **Surgical Interventions**:
   - o **Bariatric Surgery**:
     - Considered for severe obesity (BMI ≥40 or ≥35 with comorbidities) when other methods fail.
     - Common procedures: gastric bypass, sleeve gastrectomy, or adjustable gastric banding.
     - In India, bariatric surgery is growing in urban centers, with ~20,000 procedures annually (per recent estimates), but it's costly and requires lifelong follow-up.

        - Risks include nutrient deficiencies, infections, or surgical complications.
    - **Eligibility**: Assessed by a multidisciplinary team (surgeon, dietitian, psychologist) to ensure suitability and commitment to lifestyle changes post-surgery.
4. **Support Systems**:
    - **Counseling and Support Groups**: Group therapy or community programs (e.g., weight loss clubs) provide motivation and accountability.
    - **Family Involvement**: In India, family support is crucial, as shared meals and cultural practices influence dietary habits.
    - **Technology**: Apps for tracking diet, exercise, or teleconsultations with healthcare providers are increasingly used in urban India.
5. **Addressing Underlying Causes**:
    - Treat hormonal or psychological conditions (e.g., depression, stress) that contribute to obesity.
    - Adjust medications (e.g., antipsychotics, corticosteroids) that cause weight gain, if possible, under medical guidance.

Context in India: With obesity affecting ~13% of adults (per WHO data) and higher rates in urban areas (20–30%), treatment emphasizes affordable lifestyle changes due to limited access to medical or surgical options in rural regions. Cultural dietary preferences (e.g., high-carb meals) and sedentary urban lifestyles require tailored interventions, like promoting millets or community exercise programs.

Effectiveness: Lifestyle changes can yield 5–10% weight loss in 6–12 months, significantly reducing health risks. Medical or surgical options are more effective for severe cases but require stricter adherence. Long-term success depends on sustained effort and addressing environmental or psychological barriers.

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