**Biology ES**

**UNIT 1: NUTRITION AND HEALTH**

Chapter 2: The basic principles of balanced diets.

**Document 1: Food supply.**

- **Introduction:** Our consumed food could be classified into two classes according to its components.

<table>
<thead>
<tr>
<th>Our consumed food</th>
<th>Organic matter (C,H and O)</th>
<th>Inorganic matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Carbohydrates</td>
<td>1. Water (Rich in anions and cations)</td>
<td></td>
</tr>
<tr>
<td>2. Proteins</td>
<td>2. Minerals (Functional food)</td>
<td></td>
</tr>
<tr>
<td>3. Few Vitamins</td>
<td>3. Vitamins (functional food)</td>
<td></td>
</tr>
</tbody>
</table>

- **Classes of organic food:**

<table>
<thead>
<tr>
<th>Classes Criteria</th>
<th>Carbohydrates</th>
<th>Lipids</th>
<th>Proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>Found in potato, wheat, honey...</td>
<td>Found in oil, butter</td>
<td>Found in meat, fish, chicken, beef..</td>
</tr>
</tbody>
</table>
| Role             | **Simple sugars:** Monosaccharide  
|                  | Formed of one sugar unit.    
|                  | Example: 1- Glucose  
|                  | 2- Fructose  
|                  | 3- Galactose. |
|                  | **Double sugars: Disaccharide** 
|                  | Composed of two sugar units. 
|                  | Example: 1- Maltose: 2 glucose units, 
|                  | 2- Sucrose: glucose + fructose, 
|                  | 3- Lactose: glucose + galactose. |
|                  | **Polysaccharides:** 
|                  | Composed of more than two sugar units. 
|                  | Example: 1- Starch (plant origin)  
|                  | 2- Glycogen (animal origin) 
|                  | 3- Cellulose (plant origin) |

**Note:**

- **Complex food:** Food rich in carbohydrates, lipids and proteins. Example: bread.
- **Complete nutriment:** food that contains both organic and inorganic substances.
Document 2: Quantitative needs: Energetic needs

- **Rational diet**: diet that includes balance between the quantity of eaten food and energy expenditure.
- Energy is usually produced by oxidation reaction.

### Oxidation reaction in the cell:
- **Word equation**: Oxygen + Glucose → Carbon dioxide + Water + Energy
- **Chemical equation**: \( \text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{Energy} \)

**Note:**
This energy produced is directly proportional to quantity of nutrients (usually glucose) and quantity of oxygen.

- **Calorimetric bomb**: used to measure the energy produced by a certain nutrient by burning this nutrient.

**Remark**: 1 Kcal = 4.18 KJ

- 1g carbohydrates liberates 17 KJ or 4 Kcal
- 1g protein liberates 17 KJ or 4 Kcal
- 1g lipids liberates 38 KJ or 9 Kcal

**Calculation of energy expenditure:**
- Thermal coefficient = 20Kj/L
- Respiratory intensity: To calculate the volume of consumed oxygen = \( \text{VO}_2 \) L/Kg/hour.

So the “Energy expenditure” = \( \text{VO}_2 \times 20 \text{ KJ/L} = .... \text{ KJ/Kg/h} \).

- **Basal metabolism**: minimal expenditure in energy that covers basic function of the organism’s systems (respiration, excretion, ...
Document 3: Qualitative requirements: Energetic needs

A) Carbohydrates: Starch Digestion glucose oxidation energy

- Excess glucose is stored as:
  1. Glycogen in liver cells (hepatocytes).
  2. Glycogen in muscles.
  3. Lipids in adipose tissue.

- In case of deficiency, energy is produced by using:
  1. **Glycogen of liver**: Glycogen → glucose → into the blood
  2. **Lipids of adipose tissue**: Stored Lipids → fatty acids + glycerol → liver → glucose → blood
  3. **Proteins of muscles**: Stored proteins → amino acids → liver → glucose (causes a decrease in muscular weight)

B) Lipids:

Lipids → **Digestion** → Fatty acids + glycerol.

Used in:

1. **Production of energy**: to be used during sports and exercises.
2. **Synthesis of structural lipids**: structure of cells, cell membrane, vitamins and certain hormones such as sex hormones.

- Lipids deficiency: vitamins deficiency, sex hormones deficiency.
Document 4: Qualitative needs: Proteins requirements

**Definition:** Proteins are made up of amino acids. Twenty different amino acids can form thousands of proteins.

**Classification of amino acids:**

<table>
<thead>
<tr>
<th>Essential amino acids</th>
<th>Non-essential amino acids</th>
<th>Conditionally non-essential amino acids.</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are <strong>not synthesized by the human body</strong> that's why we should compensate their lack by consuming food rich in these amino acids.</td>
<td>They are <strong>synthesized by the human body.</strong></td>
<td>Due to some acquired diseases, the human body will not be able to synthesize these amino acids anymore, reason why their consumption is required through food or medicines.</td>
</tr>
</tbody>
</table>

**Proteins differ from each other by:**
- Different types of amino acids forming the protein.
- Different numbers of amino acids forming the protein.
- Different arrangement (sequence) of amino acids in the protein.

**Note:** Synthesis of proteins is according to genetic information found in the nucleus of the cell. Food proteins --- Digestion --- > amino acid --- Genetic info--- > Synthesis of human proteins.

**Functions of proteins:**
1- **Structural:** Involved in structuring our cells. **Example:** dystrophin
2- **Functional:** To maintain the functioning of our systems of regulation. **Example:** hemoglobin

**Daily protein requirements:**
- For a normal person, the daily protein requirements are **1g/Kg/day**
- **In case of deficiency:** Destruction of structural protein and decrease in muscular portion of body (loss of muscular tissue).
- **In case of excess:** increase lipid reserves and insufficient elimination of nitrogenous wastes by kidneys and liver.
**Document 5: Qualitative needs: Vitamins requirements**

<table>
<thead>
<tr>
<th>Role of vitamins</th>
<th>Classification of vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considered as micronutrients because they are needed by the body in small quantities.</td>
<td>Hydro-soluble vitamins</td>
</tr>
<tr>
<td>Essential because <strong>they are not produced by the body so they must be supplied by food.</strong></td>
<td>Lipo-soluble vitamins</td>
</tr>
<tr>
<td><strong>Do not have energetic value.</strong></td>
<td><strong>Water soluble vitamins.</strong></td>
</tr>
<tr>
<td>They are <strong>fragile:</strong> can be lost easily (example by heating).</td>
<td><strong>8 Vitamins B and 1 Vitamin C.</strong></td>
</tr>
<tr>
<td>Some are oxidized by light and others are destroyed by humidity and PH.</td>
<td>Can be <strong>easily eliminated</strong> outside the body by the urine.</td>
</tr>
</tbody>
</table>

**Note:** deficiency in vitamins can cause certain diseases (disorders) such as Beriberi and Scurvy.

<table>
<thead>
<tr>
<th>Hydro-soluble vitamins</th>
<th>Lipo-soluble vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fat soluble vitamins.</strong></td>
<td>Vitamins A, D, K, and E.</td>
</tr>
<tr>
<td><strong>Cannot be eliminated</strong> from the body because they are stored in the body in the form of fats.</td>
<td><strong>In case of excess consumption, they lead to intoxication.</strong></td>
</tr>
</tbody>
</table>
Document 6: Qualitative needs: Mineral requirements

<table>
<thead>
<tr>
<th>Water requirements</th>
<th>Minerals requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 60-70% of our body is made up of water.</td>
<td>• Inorganic substances</td>
</tr>
<tr>
<td>• Water is found in all our tissues and is needed for many vital reactions.</td>
<td>• Micronutrients.</td>
</tr>
<tr>
<td>• Water helps in regulating body temperature and supply the body with mineral salts.</td>
<td>• Do not have energetic value.</td>
</tr>
<tr>
<td>Note: water is lost by urination, defecation, transpiration and respiration. Water losses must be substituted.</td>
<td>• Found free in the body or fixed by the tissues.</td>
</tr>
<tr>
<td></td>
<td>• Provided by food or as supplements.</td>
</tr>
<tr>
<td></td>
<td>• Needed for proper functioning of the body (sodium chloride dissolved in water ensures electrolytic equilibrium).</td>
</tr>
<tr>
<td></td>
<td>• Lack of certain minerals (calcium, iron ...) leads to severe disorders.</td>
</tr>
</tbody>
</table>
### Document 7: A BALANCED DIET!

**Food Ration:**
- A food ration is represented by a balanced food diet that consists of varied nutrients, which can supply sufficient energetic and qualitative needs to maintain proper body functions and structures without any excessive calories intake to avoid obesity.

- A Food ration is said to be balanced if it responds to all needs of the body:
  1. Ensure the body’s proper function.
  2. Ensure the body’s proper structure.
  3. Maintain good health.

- To maintain a balanced food ration we must obey to the CPL formula which is: CPL= 4, 2, 1 which stands for: 55% carbohydrates, 30% Proteins and 15% lipids.

<table>
<thead>
<tr>
<th>Energetic needs</th>
<th>Qualitative needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energetic needs depend on <strong>age, gender and physiological state.</strong></td>
<td>Avoid replacing a nutrient by another to maintain a varied food diet.</td>
</tr>
<tr>
<td>The energetic intake should be distributed throughout the day.</td>
<td><strong>Balanced animal and plant protein:</strong></td>
</tr>
<tr>
<td>To have the same body mass you must evaluate the needs and bring sufficient quantity of organic nutrient to cover them. Additional energy intake is required for supplementary physical activities.</td>
<td><strong>Balance lipid intake:</strong></td>
</tr>
<tr>
<td><strong>Balance the carbohydrates intake:</strong></td>
<td>Note: fiber food has no energetic value, improve intestinal transit, and give sensation of satiety.</td>
</tr>
</tbody>
</table>


**Document 8: The Fate of nutrients**

Complex foods (Carbohydrates, lipids and proteins) are consumed, digested and transformed into simple nutrients in the digestive tract. Nutrients (amino acids, sugars, fatty acids and glycerol) are transported by blood to the cells. In the cells, nutrients are oxidized to produce energy and the excess of carbohydrates and lipids is stored as reserves (Glycogen and lipids). The excess of proteins is degraded (by liver) and cleared (by kidneys) as nitrogenous wastes.
Chapter 3: Nutritional diseases: Characteristics, causes and prevention

<table>
<thead>
<tr>
<th>Quantitative diseases</th>
<th>Qualitative diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Related to the quantity of consumed food)</td>
<td>(Related to the quality of consumed food)</td>
</tr>
<tr>
<td>Under-nutrition</td>
<td>Over-nutrition</td>
</tr>
<tr>
<td>(Low quantity of consumed food)</td>
<td>(High quantity of consumed food)</td>
</tr>
</tbody>
</table>

Both can coexist such as in Africa.

Document 1: Food Deficiency Disease

A. Marasmus disease: [Quantitative deficiency]
   - It is due to insufficient energy intake (in child < 4500Kj/day)
   - Effects:
     1. Reduced Growth
     2. Smaller brain
     3. Alteration in cell composition
     - It is an irreversible and life threatening disease.

B. Kwashiorkor disease: [Qualitative deficiency]
   - It is due to the lack of proteins in the diet and lack of some essential amino acids.
   - Effects:
     1. Apathy
     2. Skin edemas
     3. Dermatoses
     4. Gastro-intestinal trouble
     - It leads to death in child under 5 years.

Note: Maternal milk supplies the child with needed nutritional and energetic substances.

C. Treatment and prevention:
   1. Watch their growth and weight.
   2. Feed the children quantitatively and qualitatively.
   3. Treat children for infections and parasites.
   4. Improve the standard of living of the population.
   5. Educate mothers about principles of hygiene and nutrition.
Document 2: Diseases of excessive food intake: Cardiovascular diseases.

There is a relation between the level of cholesterol in blood and cardiovascular diseases.

A. Atherosclerosis: Narrowing of any artery inside the body

   Steps of Atherosclerosis:
   1. Lesion in the interior wall of the artery.
   2. Accumulation of cholesterol and triglycerides on the walls of arteries.
   3. Formation of plaque called atheroma.
   4. Narrowing of the artery which causes a decrease in blood supply.

Note: If the narrowed artery in the heart (coronary artery which is a blood vessel that supplies the cardiac muscle with oxygen and nutrients), it leads to myocardial infarction and if the narrowed artery is in the brain, it leads to hemiplegia and paralysis.

B. Good and Bad cholesterol:

1. Cholesterol:
   - One of the constituents of cell membranes.
   - Precursor of sexual hormones, corticoids, vitamin D and biliary salts.
   - Insoluble in plasma: it binds to huge protein molecules forming lipoproteins.

2. Lipoproteins:
   i. HDL (high density lipoprotein):
      - Good cholesterol.
      - 13% cholesterol.
      - It has a protective role: prevent accumulation of cholesterol in blood → low risk of cardiovascular disease.

   ii. LDL (Low density lipoprotein):
      - Bad cholesterol.
      - 55% cholesterol.
      - Provide cholesterol for body cells.
      - May deposit on the internal walls of artery → Accumulate → plaque → high risk of cardiovascular diseases.

C. Risk factors and Coronary morbidity:

- Hypercholesterolemia - Heredity
- Arterial hypertension - Sex
- Smoking - Age
- Stress - Diabetes
- Obesity - **Note:** Not all risk factors are controlled.
Document 3: Obesity: Affliction of rich countries

- If the food intake exceeds the body needs, the mass increases.
- If the mass increases, the number of blood vessels increases and the work of the heart increases.

1. Criteria for obesity:

<table>
<thead>
<tr>
<th>First method:</th>
<th>Second method:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal weight (M) = (T-100) – (T-150)/x</td>
<td>BMI (body mass index) = weight (Kg) / height $^2$ (m)</td>
</tr>
<tr>
<td>T: height in cm</td>
<td>BMI &lt;18 ➞ very thin</td>
</tr>
<tr>
<td>x= 4 for a man; x= 2 for a woman</td>
<td>BMI: 18-20 ➞ thin</td>
</tr>
<tr>
<td>➢ Obesity is defined as a 20% increase over the ideal weight.</td>
<td>BMI: 20-25 ➞ Normal</td>
</tr>
<tr>
<td></td>
<td>BMI: 25-29 ➞ moderate</td>
</tr>
<tr>
<td></td>
<td>BMI &gt; 29 ➞ obese</td>
</tr>
<tr>
<td>➢ Fatal obesity: when weight is 2 to 3 times more than the ideal weight.</td>
<td>➢ It is accompanied by hypertension, diabetes, and atherosclerosis.</td>
</tr>
</tbody>
</table>

2. Factors that may lead to obesity:

1. Bad feeding habits / overfeeding.
2. Meals rich in sugar and fats.
3. Sedentary life.
4. Pregnancy / menopause / quitting smoking.
5. Genetic factor.
UNIT II: NEUROBIOLOGY, HUMAN BEHAVIOR AND HEALTH.

Chapter 1: Neural communication

Document 1: The Nervous System

The nervous system is made up of two parts:

<table>
<thead>
<tr>
<th>Central Nervous System:</th>
<th>Peripheral Nervous System:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formed of:</td>
<td>Formed of:</td>
</tr>
<tr>
<td>2. Encephalon containing:</td>
<td>2. Nerves:</td>
</tr>
<tr>
<td>- Cerebrum.</td>
<td>a. Cranial nerves: originated from the brain</td>
</tr>
<tr>
<td>- Cerebellum.</td>
<td>b. Spinal nerves: originated from the spinal cord.</td>
</tr>
<tr>
<td>- Medulla oblongata</td>
<td></td>
</tr>
</tbody>
</table>

A neuron:
It is the nerve cell; it is the structural and functional unit of the nervous system.

There are several types of neurons:

<table>
<thead>
<tr>
<th>1. According to structure:</th>
<th>2. According to function:</th>
<th>3. According to myelin:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unipolar neuron.</td>
<td>1. Sensory neuron: It transmits the nervous message from the receptors toward the CNS. (Centripetal direction, afferent neuron).</td>
<td>Myelin sheath: it is a lipid white substance that surrounds the axon of a neuron.</td>
</tr>
<tr>
<td>2. Bipolar neuron</td>
<td>2. Association neuron or Inter neuron: It is found in CNS; it receives nervous messages from sensory neurons or interneuron and conducts them to sensory or motor neurons.</td>
<td>1. Myelinated neuron: myelin covers the axon of the neuron but not the dendrites.</td>
</tr>
</tbody>
</table>
2. **Classification of nerves:**
   1. **Sensory nerve:** carries messages from receptors to center.
   2. **Motor nerve:** carries message from center into effectors
   3. **Mixed nerve:** composed of both sensory and motor nerve fibers.

   ✤ **Receptor vs. Effector:**

<table>
<thead>
<tr>
<th>Receptor:</th>
<th>Effector:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous structure that creates a nervous message when it is excited (strongly stimulated). This nervous message is conducted to C.N.S by sensory neurons.</td>
<td>Tissue or organ that responds after receiving a nervous impulse conducted by motor neuron from central nervous system.</td>
</tr>
</tbody>
</table>

![Functional diagram](image)

**Title:** Functional diagram that shows the pathway of nervous impulse in a certain behavior.
Document 2: Nervous Information: Nature & propagation

<table>
<thead>
<tr>
<th>Resting potential:</th>
<th>Action potential:</th>
<th>Stimulus:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The potential difference due to membrane polarization of a nerve fiber (unequal distribution of ions between intracellular and extracellular medium).</td>
<td>Very rapid change in the membrane potential that occurs when the nerve cell is effectively stimulated.</td>
<td>Any change in the environment that initiates an action potential when it is strong (effective). It can be: 1. Mechanical stimulus:</td>
</tr>
</tbody>
</table>

- **The “Threshold intensity (Ti)” of stimulation:** It is the minimum intensity of a certain stimulus that stimulates a receptor and elaborates a nervous message (generates AP). Below this value, the stimulus is ineffective (no AP). Equal to this value or beyond, the stimulus is effective (generates AP).

- **Factors that affect the propagation of nervous message:**
  - Nervous message is unidirectional at the level of neuron, it has the following direction:
    Dendrites → cell body → axon → Terminal Arborization → another neuron.
  - The speed of the propagation of the nervous message depends on two factors:

<table>
<thead>
<tr>
<th>External factors</th>
<th>Internal factors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, medicines, drugs</td>
<td>a. Diameter of the nerve fiber: as diameter increases, the speed of the nervous message at the level of a nerve fiber increases. b. Myelination: The speed of the nervous message in a myelinated nerve fiber is faster than in the non-myelinated nerve fiber.</td>
</tr>
</tbody>
</table>

- **The “Nerve fiber”:**
  The isolated nerve fiber obeys “Law of all or none”. Either there is no action potential (if the intensity of stimulation is below threshold intensity) or there is an A.P of constant amplitude even if the intensity of effective stimulus is increased.

**Coding of nervous message along a nerve fiber:**
The nervous message is coded in terms of changes (modulations) in the frequency of A.P in a nerve fiber not by amplitude.
Document 3: Synaptic transmission

Synapse is a functional junction between a neuron and another structure (neuron, gland or muscle).

Types of synapses:

<table>
<thead>
<tr>
<th>According to shape:</th>
<th>According to function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Neuro-neuronal synapse: it is between a neuron and another neuron.</td>
<td>1. Excitatory synapse: It is the synapse that allows the transmission of nervous message from neuron 1 to neuron 2.</td>
</tr>
<tr>
<td>2. Neuro-effector synapse:</td>
<td>2. Inhibitory synapse: It is the synapse that prevents (blocks) the transmission of nervous message from neuron 1 to neuron 2.</td>
</tr>
<tr>
<td>2.1 Neuro muscular synapse (motor end plate): it is between a neuron and a muscle</td>
<td></td>
</tr>
<tr>
<td>2.2 Neuro-glandular synapse: it is between a neuron and a gland.</td>
<td></td>
</tr>
</tbody>
</table>

Synaptic transmission is in one direction (unidirectional): From the axon of the first neuron (presynaptic neuron) into the second structure (postsynaptic structure).

Steps of message transmission through a synapse:
1. Arrival of an A.P to the terminal bud of presynaptic neuron.
2. Opening of the Ca\(^{2+}\) channels and inflow of Ca\(^{2+}\) ions into the presynaptic neuron.
3. Excitation of the synaptic vesicles that move.
4. Fusion of the synaptic vesicles with the presynaptic membrane.
5. Exocytosis of the neurotransmitter in synaptic cleft.
6. Fixation of the neurotransmitter to the receptors of the channels on postsynaptic membrane.
7. Transmission of the nervous message into the postsynaptic part.
8. Fate of the neurotransmitters that remain in the synaptic cleft:
   a. Either they will be degraded (decomposed/digested) by specific enzymes into wastes.
   b. Or they will be recaptured by the recapture pump into the presynaptic part.

Note:
1- If Na\(^+\) channels open it will cause a hypopolarization and the change in the potential is called excitatory postsynaptic potential (EPSP), then it is an excitatory synapse.
2- If K\(^+\) channels open or Cl\(^-\) channels open, K\(^+\) go outside or Cl\(^-\) ions move inside, it will cause a hyper polarization and the change in the potential is called inhibitory postsynaptic potential (IPSP), then it is an inhibitory synapse.

Examples on some neurotransmitters:

<table>
<thead>
<tr>
<th>Acetylcholine</th>
<th>Dopamine</th>
<th>Endorphin (Enkephalin)</th>
<th>Serotonin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitatory (in muscles)</td>
<td>Excitatory</td>
<td>Natural algesic Inhibitory</td>
<td>Excitatory</td>
</tr>
<tr>
<td>Inhibitory (in cardiac muscle),</td>
<td>Responsible for the pleasure sensation for a short period of time</td>
<td>It blocks partially the exocytosis of P-Substance.</td>
<td>Induces sleep</td>
</tr>
</tbody>
</table>
### Document 4: Chemical perturbation of the synapse

<table>
<thead>
<tr>
<th>Probable cause</th>
<th>Parkinson’s Disease</th>
<th>Alzheimer’s Disease</th>
<th>Toxic Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>- Virus, toxicity to Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Genetic modification</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Insufficient supply of oxygen to the brain</td>
<td></td>
</tr>
<tr>
<td>Affected area of C.N.S</td>
<td>Degeneration of neurons that produce dopamine</td>
<td>Degeneration of neurons that produce acetylcholine</td>
<td></td>
</tr>
<tr>
<td>Symptoms</td>
<td>Mainly tremors, slow movement...</td>
<td>Hard time remembering events</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Increase the amount of dopamine in the brain</td>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>

---

**Parkinson’s Disease**

- Mainly tremors, slow movement...

**Alzheimer’s Disease**

- Hard time remembering events
Chapter 5: Drugs and drug addiction

Document 1: Drug addiction, an artificial paradise

Definition of drug: Drug is a psychoactive product that affects the behavior of person by causing the feeling of "euphoria". If it is consumed in high quantities, it causes serious problems or even death.

Definition of drug addiction: Drug addiction is "a state of physical and/or psychic dependence toward a product, due to periodic or continuous use of this product.

Characteristics of a drug addict:
1. Irresistible desire to obtain the drug no matter what the cost is.
2. Tendency to increase the dose.
3. Physical and/or psychic symptoms when there is an interruption of consumption.
4. The individual's tendency to cause harm to himself or to society.

Psychic dependency: the pleasant feeling encourages the addict to ask for more.
Tolerance: when the same amount of drug starts to have less effect (adaptation of an organism to repeated doses), so he starts to increase the dose to have the same effect.
Physical dependency: where symptoms of drug withdrawal such as pain and physical troubles appear when the quantity of the circulating drugs in the organism decreases.
Document 2: The drug's mode of action

- **Endogenous chemical**: A substance that is found or produced naturally in the body (like hormone, neurotransmitter...)

- **Exogenous chemical**: An artificial substance that is provided from external sources into the body (like drugs, medicine...)

- **Agonistic drug**: If the drug has the **same function** (effect) of an endogenous neurotransmitter, or at least enhances its effect.

- **Antagonistic drug**: If the drug has **opposite function** (effect) of an endogenous neurotransmitter, or at least blocks or inhibits it.

- **Algesic substance**: It causes pain, like the P substance

- **Analgesic substance**: It reduces (relieves) the feeling of pain, like morphine...

- **Mode of Action of “Amphetamine” in the pain circuit**

<table>
<thead>
<tr>
<th>Normal case</th>
<th>With Amphetamine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due to a stimulus, <strong>Dopamine</strong> (a neurotransmitter responsible for the pleasure sensation) is released from the presynaptic part of the synapse and it binds to its receptors located on the postsynaptic part leading for a sensation of pleasure that last for a short period of time.</td>
<td>Due to the injection of amphetamine at the level of the presynaptic part, a massive release (exocytosis) of dopamine will occur leading to an increase in the amount of Dopamine neurotranmitters at the level of the synaptic cleft. Thus an amplified sensation of pleasure will be obtained for a longer period of time. Amphetamine has an agonistic effect on the exocytosis of Dopamine and it prolongs the sensation of pleasure desired.</td>
</tr>
</tbody>
</table>

- **Mode of Action of Enkephalin and Morphine in the pain circuit**

<table>
<thead>
<tr>
<th>Normal case (Endogenous algesic)</th>
<th>With Morphine (Exogenous algesic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In normal cases, once a painful stimulus reaches the presynaptic part, <strong>P- Substance</strong> (a neurotransmitter responsible for the pain sensation) is released into the synaptic cleft to reach its postsynaptic receptor inducing thus a painful sensation. But due to the role of a modulatory neuron containing a natural algesic neurotransmitter called: “<strong>Enkephalin</strong>” once this latter is released it binds to its presynaptic receptors decreasing partially the exocytosis of <strong>P- substance</strong>. This leads to the partial inhibition of the pain feeling. Because Enkephalin could be degraded by specific enzymes. So the decrease in the pain sensation could last for a short period of time.</td>
<td>Morphine and Enkephalin have highly similar spatial configuration (shape). Thus, once it is injected, morphine binds to the receptors of Enkephalin on the neuron that secretes substance “<strong>P</strong>” and TOTALLY BLOCKS the exocytosis of the <strong>P</strong> substance. This leads to the total inhibition of the pain feeling. Because there is no specific enzyme that can digest morphine. So the decrease in the pain sensation lasts for longer period of time. Enkephalin is an agonist to Morphine.</td>
</tr>
</tbody>
</table>
Mode of Action of “Cocaine on Dopamine” synapses

<table>
<thead>
<tr>
<th>Normal case</th>
<th>With cocaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>In normal cases, dopamine (an endogenous chemical) is released for few seconds giving the person the pleasure feeling for short time after which dopamine is reabsorbed (recaptured) into the presynaptic neuron.</td>
<td>Cocaine (an exogenous chemical) blocks the recapture of dopamine which prolongs its effects by allowing its longer fixation on its receptors on the post synaptic membrane. This prolongs the pleasure feeling</td>
</tr>
</tbody>
</table>

**Cocaine is an agonist to Dopamine.**

Mode of Action of “Curare on Acetylcholine” synapses

<table>
<thead>
<tr>
<th>Normal case</th>
<th>With Curare</th>
</tr>
</thead>
<tbody>
<tr>
<td>In normal cases, Acetylcholine (Ach) is an excitatory endogenous neurotransmitter in the motor-end plate (skeletal muscles), leading to their contraction.</td>
<td>Curare (an exogenous chemical) and acetylcholine (Ach) have highly similar spatial configuration (shape). Thus, curare binds to the receptors of acetylcholine on the post-synaptic neuron, preventing the binding of acetylcholine. This leads to the muscle relaxation or even paralysis</td>
</tr>
</tbody>
</table>

**Curare is an antagonist to Ach.**

How does a drug amplify the action of a neurotransmitter?

• **Hypothesis 1:** the used substance inhibits the recapture of the neurotransmitter into the presynaptic terminal ex. Cocaine with dopamine.

• **Hypothesis 2:** the used substance facilitates the exocytosis of the neurotransmitter into the cleft ex.: Methamphetamine with dopamine.

• **Hypothesis 3:** the used substance facilitates the action of the enzyme that synthesizes the neurotransmitter.

• **Hypothesis 4:** the used substance inhibits the action of the enzyme that degrades the neurotransmitter.

• **Hypothesis 5:** the used substance binds to the receptor of the neurotransmitter and has a similar action to it ex.: Alcohol on GABA receptors.

• **Hypothesis 6:** the used substance facilitates the binding of the neurotransmitter to the receptor for a longer time.
UNIT IV: SCIENCE AND ECONOMY
Chapter 1: Biotechnology and immunology

Introduction:
- Chromosomes are located inside the nucleus of the human cell.
- Chromosomes are the carriers of genetic information and they are made up of chromatin (DNA & protein).
- Gene is a DNA fragment that codes for a certain characteristic such as synthesis of a certain polypeptide.

**Document 1: principle of biotechnology**

**Definition of transgenesis** (recombinant DNA technology/ Genetic engineering): is the process of introducing an exogenous gene – called a transgene— into a living organism so that the organism will exhibit a new property and transmit that property to its offspring.

**Steps of recombinant DNA technology applied on bacteria:**
1. **Extraction** of DNA from the cell.
2. **Cut** the DNA using restriction enzymes such that the gene of interest is obtained.
3. **Extraction of plasmid** (extra circular DNA) which is present in bacteria
4. **Cleavage** of plasmid by restriction enzyme.
5. **Ligation** (fusion) of the gene of interest in the cleaved plasmid using ligase enzyme such that a recombinant plasmid is obtained.
6. The recombinant plasmid is inserted into a bacterium. This process is called **transformation**.
7. **Gene cloning** by allowing the transgenic/recombinant bacterium to multiply.
8. **Purification** of the desired gene or protein after its synthesis.

**Why do we use Escherichia coli (E.coli)?**
1. Its genetics are the best known of any organism.
2. It is economically cheap.
3. It grows fast and can be manipulated genetically
4. It accumulates many different proteins.

**Note:** Transgenic organism is an organism whose genome has been altered (genetically modified) by adding an exogenous gene to its genome.

**Recombinant DNA technology can be used in many applications:**
1. Therapeutic Drug production
2. Vaccine production
3. Monoclonal antibodies
**Document 2: Recombinant DNA: therapeutic drugs**

**Insulin production:**
First the plasmid is extracted and then cleaved with restriction enzymes, then the insulin gene is isolated from a human cell and this gene is inserted into the plasmid using ligase enzymes. This plasmid is reintroduced into the bacteria (transformation), after that these Insulin producing bacteria are cultured for proliferation and the insulin produced by these bacteria is isolated and purified from the bacteria. At last insulin is administered to a patient.
Document 3: Recombinant DNA: vaccine production

Definition of a vaccine: it is mainly a protein (antigen) taken from the pathogen or an attenuated pathogen introduced in the body of living being.

Importance: B lymphocytes will secrete specific antibodies to protect the body against the live pathogen once it enters the body. So it helps the immune system to memorize this pathogen (by producing memory cells) and thus accelerates the immune response after the second contact with the same antigen.

There are 2 main types of vaccine:

<table>
<thead>
<tr>
<th>Peptide vaccine</th>
<th>Live virus vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proteins (antigens) are taken directly from the pathogen (virus or bacterium) and injected to the individual. (Old method).</td>
<td>1. Attenuation of harmful virus by eliminating the genes responsible for the harmful proteins (old method).</td>
</tr>
<tr>
<td>2. New method: Produced by DNA recombinant technique then injected to the individual.</td>
<td>2. New method: Injection of attenuated harmless virus which was genetically modified to have a virulent virus envelops.</td>
</tr>
</tbody>
</table>

Note: We can introduce the gene of the antigen in the genome of the plants so that the fruit contains the antigen and thus we obtain transgenic plants containing the vaccine (for babies).

A comparative table between peptide and live vaccines

<table>
<thead>
<tr>
<th>Type of vaccine</th>
<th>Peptide vaccine</th>
<th>Live virus vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>No risk of infection</td>
<td>Produce a complete immune response that lasts a life time</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Trigger a limited immune response</td>
<td>carries a risk of virus mutation to its original shape and causes disease</td>
</tr>
</tbody>
</table>

Note: We can introduce the gene of the antigen in bananas plants so that the fruit contains the antigen and thus we obtain transgenic plants containing the vaccine (for babies)
**Document 4: Production of monoclonal antibodies**

- An antigen has many simple parts of simple geometrical shape.
- Each part is called antigen determinant or epitope.
- Every bacterium is attacked by many different types of B lymphocyte each secreting different types of antibodies.
- Different Types of antibodies that originate from different clones of B-lymphocytes are called polyclonal antibodies that bind to different epitope.
- Group of one type of antibodies that originate from the same clone of B-lymphocyte is called monoclonal antibodies and it binds to single epitope.

- **Steps of monoclonal antibodies production:**
  1. Immunization or vaccination: injection of an antigen in the animal.
  2. Splenectomy: removal of spleen that contains our target B lymphocytes.
  3. Isolation of tumor cells (myeloma).
  4. Fusion of the two cells (myeloma and B lymphocyte) to obtain a hybridoma (it secretes the desired antibody and is immortal).
  5. Selections of hybridoma cells.
  7. Isolation of the desired antibodies.

- **Applications of monoclonal antibodies:**
  1. Pregnancy test: HCG hormone which is produced by the baby is detected in the urine of the mother.
  2. Detection of cancer.
Chapter 2: Biotechnology, agriculture and environment

Document 1: Searching for performing species

- **Definition of a species**: a group of organisms that share common characteristics and capable of cross breeding.

- **Species variability**: members of same species vary quantitatively and qualitatively. This variability depends on environment and genetic makeup of each species. The latter is taken into consideration in improvement of a species.

- **Improvement of a species can be done by**:

<table>
<thead>
<tr>
<th>1. Selection:</th>
<th>2. Hybridization / cross-breeding:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A process during which the best individuals will be selected then raised and reproduced to improve the species.</td>
<td>A process which occurs in both animals and plants. It is a cross between two different population or species to obtain new better variety.</td>
</tr>
</tbody>
</table>

**Note**: selection must be done for several generations.

**Note**: hybridization increases the economic value but limit the genetic value. Note: Heterozygote / hybrid vigor: the increased size, strength... of a hybrid as compared to either of its parents, such that the new generations differ from their parents by acquisition of new characters that are superior to the average of both parents.
Document 2: The transfer of gene

Transgenesis in plants

<table>
<thead>
<tr>
<th>Direct by electroporation:</th>
<th>Indirect by using agrobacterium:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject a protoplast (plant cell without cell wall) to a series of electric shocks, the DNA migrates to the nucleus and become integrated into the chromosomes.</td>
<td>From agrobacterium tumefaciens the Ti plasmid that is responsible for a form of root tumor in some plants was isolated and the tumor gene of this plasmid was removed. On the other hand an insecticide gene was isolated from bacillus thuringiensis that possesses a gene controlling the synthesis of a toxic protein against some insects, this gene was grafted in the isolated plasmid and then the resulting recombinant plasmid was reintegrated into the agrobacterium. This modified bacterium is used to infect a protoplast, after that the protoplast is cultured to get a young plant that develops into a plant that synthesize its own insecticide.</td>
</tr>
</tbody>
</table>

Advantages of transgenesis in plants:
1. Production of plants that are resistant to insects
2. Reduce the use of chemical insecticides that are harmful to health and environment.
3. Relieve the farmer from the cost of insecticides.

Transgenesis in animals:
1. Extract gene of interest.
2. Introduce the DNA in the nucleus of a fertilized animal egg.
3. Re-implant the egg into the uterus of a female.
4. Production of a transgenic animal if the new gene was integrated inside the chromosomes as a stable part.
5. The desired trait will be transmitted to next generation.

Document 3: Industrial breeding, a controlled production

Industrial breeding: Production of a great quantity of animals which has the following benefits:
1. Good quality for the consumer with lower prices.
2. Great profit to the breeder.

To breed successfully four factors are needed:
1. Appropriate place.
2. Genetic selection of productive breeds.
3. Control of reproduction (to have animals of same age at same physiological stage of development).
4. Balanced and rationed diet (to avoid excess weight of carcasses) at a reduced cost.

**Note:** index of consumption is the quantity of food needed by the animal to increase 1 Kg in its weight, so the aim is to increase body weight with low consumption index.

**Document 4: Animal food**

The aim of food research is to improve the nutrition of animals by the addition of the amino acids necessary for growth, at a reasonable cost, since food affects the quality and quantity of things produced.

**Document 5: The cost of progress**

A. **Pollution**: is the introduction of contaminants (pollutants) into the natural environment that causes adverse change in water, soil or atmosphere.

B. **Types of pollutants:**

<table>
<thead>
<tr>
<th>Hydrocarbons (from cars, factories, houses...)</th>
<th>Pollutant gases</th>
<th>Nitrates</th>
</tr>
</thead>
</table>
| They are used to provide energy.              | - Nitrogen oxide (NO and NO2): **Source:** cars and power stations. **Effects:** eye irritation in human and damage vegetation.  - Carbon dioxide (CO2): **Source:** motor exhausts. **Effects:** dizziness, headaches, and Greenhouse effects.  **Note:** green house effect allows taking in the solar radiations, and prevents the infrared radiations from getting out. This phenomenon causes an increase in the global temperature, which leads to melting of glaciers and rising of sea levels. | **Source:** excessive use of nitrate fertilizers. **Effects:**  - Nitrogen reaches the underground water in winter.  - Nitrate (NO3) when exceeds 25mg/l in drinkable water:  \[
\text{NO}_3^- \rightarrow \text{Stomach bacteria} \rightarrow \text{Nitrites (NO}_2\text{)} \\
\]  a) Nitrites can combine with hemoglobin and prevents fixation of oxygen leading to suffocation and death.  b) Nitrites can combine with food amine and produce carcinogenic nitrous derivatives. |
Document 6: The struggle against pollution

- Prevention of pollution and protection of the environment can be achieved by:
  1. Recycling.
  2. Plant forests and create green spaces in cities.
  3. Benefit from solar, wind and hydraulic energy.
  4. Use filters for factories and cars.
  5. Fight against: noise, pollution of fresh water and oceans, waste of mater and energy.
  6. Using biotechnology:

    Examples: develop bacteria that reduce iron and break up oxides such as magnesium oxide which is toxic to animals and plants or develop bacteria that transform the harmful ammonia into nitrogen.