Chapter III: Biology and Health

Introduction

Biology is the science that studies living organisms, their functions, their evolution, and their interactions with the environment. It is a vital tool for the prevention, diagnosis, and treatment of diseases in both animals and plants. Understanding the biological mechanisms of diseases helps us protect health, ensure food safety, and conserve biodiversity. Applied biology in health encompasses several disciplines: microbiology (the study of microorganisms), immunology (the immune system's response to infections), physiology (the functioning of organs), genetics (the predisposition to diseases), and biochemistry (the analysis of biological substances). These approaches are used to identify diseases, understand their causes, and develop practical solutions.

I. Biology in the Diagnosis of Animal Diseases

Animals, whether domesticated, farmed, or wild, are susceptible to infectious diseases (caused by bacteria, viruses, parasites, fungi) and non-infectious diseases (such as nutritional deficiencies, intoxications, metabolic or genetic disorders). Biology offers the essential tools to detect these diseases, understand how they work, and intervene effectively.

I.1. Identification of Pathogens

- **Bacteria:** *Salmonell*a, *Escherichia coli*, *Pasteurella*. Bacterial isolation involves culture on selective media and biochemical tests to determine the exact type.

- **Viruses :** *Avian influenza*, *rabies*, animal coronaviruses. Detection requires molecular tests, such as Polymerase Chain Reaction (PCR), or serological tests, such as Enzyme-Linked Immunosorbent Assay (ELISA).

- **Parasites**: helminths (intestinal worms), protozoa (*Trypanosoma*, *Toxoplasma*), ectoparasites (ticks, fleas). Identification is through microscopic examination of blood, feces, or skin samples.

- **Fungi**: dermatophytes causing skin infections (ringworm). Identification is performed using Sabouraud medium and microscopic analysis.

I.2. Analysis of biological indicators

- **Hematology**: measures red and white blood cells, platelets. Abnormalities can indicate infection, inflammation, or nutritional deficiency.

- **Blood biochemistry**: analysis of liver and kidney enzymes, plasma proteins, and electrolytes to detect organ dysfunction.

- **Examination of biological fluids**: urine, feces, milk, or respiratory secretions to identify pathogens or metabolic anomalies.

I.3. Practical applications

- Early diagnosis: enables detection of infections before severe symptoms emerge, helping to limit spread in livestock.

- Targeted treatment: antibiotics, antiparasitic, or antiviral drugs selected based on the identified pathogen.

- Prevention includes vaccination, proper nutrition, hygiene, and controlling vectors like ticks, mosquitoes, and flies.

- Epidemiological monitoring: tracking animal populations to prevent outbreaks.

II. Biology in the Diagnosis of Plant Diseases

Plants are affected by biotic stresses (fungi, bacteria, viruses, and insects) and abiotic stresses (nutrient deficiencies, pollution, and water stress). Plant biology helps identify these stresses, evaluate crop health, and develop preventive strategies.

II.1. Identification of Plant Pathogens

- **Fungi**: responsible for powdery mildew, fusarium wilt, and rust diseases. Detection by microscopic observation and culture on nutrient media.

- **Bacteria**: Agrobacterium, Pseudomonas. Diagnosis through culture and PCR. - Viruses: tobacco mosaic virus, potato virus. Detection by serological tests (ELISA) or PCR.

- **Insect vectors**: aphids, flies, scale insects. Biological studies and direct observation help control disease spread.

II.2. Analysis of Physiological and Biochemical Indicators

- **Soil analysis**: evaluates nutrients, pH, and microorganisms to prevent deficiencies or disease.

- **Plant tissue analysis**: chlorophyll, sugars, and enzymes to detect stress or infection.

- **Symptom monitoring**: yellowing, necrosis, or deformation to detect diseases early.

II.3. Practical Applications

- **Prevention**: selection of disease-resistant plant varieties.

- **Biological control**: use of beneficial microorganisms to limit pathogens.

- **Integrated pest management**: targeted application of chemicals only when necessary.

- **Productivity optimization**: maintaining healthy crops, increasing yields, and reducing economic losses.

III. Modern Biological Techniques for Diagnosis

Table 1: Techniques in Animal and Plant Health.

Technique	Animal Health Applications	Plant Health Applications
Optical microscopy	Parasites, bacteria, fungi	Fungi, bacteria, viruses
Microbial culture	Bacterial and fungal isolation	Fungal and bacterial isolation
PCR / qPCR	Rapid detection of viruses and bacteria	Rapid detection of viruses, bacteria, and fungi
ELISA	Detection of antibodies and antigens	Detection of antibodies and plant viruses
Genetic sequencing	Precise pathogen identification	Pathogen identification and selection of resistant varieties
Biochemistry and hematology	Metabolic and physiological analysis	Nutrient and enzyme analysis in plant tissues

IV. Case Studies Illustrating the Importance of Biology

- Animals: Early detection of salmonellosis in a poultry farm using PCR and bacterial culture, enabling targeted treatment and preventing egg contamination.
- Plants: Identified potato mosaic virus using ELISA, allowing for the removal of infected plants and limiting the spread.
- Public health: Detecting antibiotic-resistant bacteria in livestock to prevent transmission to humans.

Conclusion

Biology is crucial for understanding, diagnosing, and preventing diseases in animals and plants. It helps us:

- Identify pathogens, including bacteria, viruses, fungi, and parasites.

- Learn how diseases develop and spread in animals and plants.

- Implement preventive and treatment strategies such as vaccines, resistant crops, or good farming practices.

Modern techniques, such as PCR, ELISA, and molecular biology tools, enable faster and more accurate diagnosis. In animals, biology helps detect diseases early and breed healthier livestock. In plants, it allows for the development of disease-resistant crops and safer farming methods.

By employing biological methods, we can safeguard health, secure food supply, and maintain biodiversity while supporting sustainable, eco-friendly farming practices.