

## **HEREDITY AND EPIGENETIC MODULATIONS**

### **1. Review of the concepts of Genetics and Epigenetics**

#### **OUTLINE**

- Review of the concepts of Genetics and Epigenetics.
- Historical review of Epigenetics.
- Enzymes of epigenetic action.
- Epigenetic mechanisms in animal cells.

#### **LEARNING OBJECTIVES**

The student will be able to:

- Get to know the History of Epigenetics and how it began as an independent field of Genetics in the Biological Sciences.
- Understand and appreciate the importance and contribution of Epigenetics in addressing current challenges and questions in the field of modern Genetics and related disciplines

### **2. Heredity in Epigenetics**

#### **OUTLINE**

- Inheritance in Epigenetics.
- Transfer of epigenetic modifications to gametes and genetic improvement of animals.
- Genetic improvement studies on animal characteristics and their health.
- Genome/Epigenome-wide association studies (GWAS/EWAS) in animals.
- Examples of epigenetic differentiation of monozygotic twins.

#### **LEARNING OBJECTIVES**

The student will be able to:

- Explain the basic and critical characteristics of Epigenetic Science in relation to the classical view of the genetic code leading to the phenotype.
- Understand the inheritance of epigenetic characteristics in animals and humans.
- Understand the epigenetic parameters involved in the calculation of animal genetic improvement methods and the contribution of association studies throughout the genome/epigenome (GWAS / EWAS) in animals
- Understand the typical example of genetic variability in twins.

### **3. Heredity and epigenetic mechanisms of polymorphic sites and gene haplotypes**

#### **OUTLINE**

- Inheritance and epigenetic mechanisms on polymorphic sites and haplotypes.
- Inheritance of genetic alterations in the functionality of epigenetic enzymes and the consequences.

#### **LEARNING OBJECTIVES**

The student will be able to:

- Understand the heredity and epigenetic mechanisms of polymorphic locations and gene abnormalities.
- Understand the creation of genetic-epigenetic modifications.
- Understand the inheritance of genetic mutations in the functionality of epigenetic enzymes and their effects.

- Find the cooperation of genetic and epigenetic interactions, with the specificity of each individual due to polymorphisms and their different response to a chemical or drug.

#### **4. Transgenerational epigenetic inheritance**

##### **OUTLINE**

- Intergenerational epigenetic inheritance.
- The role of lifestyle, diet and metabolism in epigenetic inheritance.
- Interactions of the metabolic and epigenetic profile in mammalian cells.

##### **LEARNING OBJECTIVES**

The student will be able to:

- Understand biological phenomena, manifestation and inheritance of phenotypic alterations as a result of the combination of genetic and epigenetic changes.
- Understand on the one hand of the inheritance of non-DNA changes, induced by external influences, habits and environmental factors and on the other hand of the genetic profile.

#### **5. Epigenetic modulations in maintaining homeostasis in hematopoiesis and myogenesis**

##### **OUTLINE**

- Epigenetic formations in maintaining homeostasis in hematopoiesis
- Epigenetic configurations in the maintenance of homeostasis

##### **LEARNING OBJECTIVES**

The student will be able to:

- Realise the complexity of the cooperative action of the combined epigenetic modifications with chromatin positioning phenomena in the expression and regulation of hemoglobin and myoglobin genes, etc. and their variants.
- Realise the complexity of the cooperative action of the combined epigenetic and genetic factors in the diversity of diseases in hematopoietic and muscle tissue.

#### **6. Epigenetic toxicology in agrobiotechnology**

##### **OUTLINE**

- Epigenetic toxicology
- Toxicological effects in Agrobiotechnology.

##### **LEARNING OBJECTIVES**

The student will be able to:

- Understand that any environmental impact (eg diet, tobacco use, alcohol, etc.) is associated with a significant epigenetic effect on human cells, health and life expectancy.
- Understand the importance of induced epigenetic modulations by infectious agents, especially in populations of farmed organisms (e.g. farm animals, foodborne infections, climate, soil, groundwater, aquatic organisms, fish, etc.) for the hygiene benefit of both animals as well as humans.

#### **7. Inheritance of epigenetic imprinting mechanisms in Beckwith & Weidemann, Prader-Willi and Angelman syndromes**

##### **OUTLINE**

- General review of the impression on mammals.
- The peculiarity of epigenetic mechanisms in imprinting in Beckwith & Weidemann syndromes.

- The peculiarity of epigenetic mechanisms in imprinting in Prader-Willi and Angelman syndromes.

### **LEARNING OBJECTIVES**

The student will be able to:

- Comprehend the epigenetic mechanisms of imprinting in mammals and the type of inheritance.
- Understand the combined mechanisms of action of gene control, non-code RNAs and chromatin positioning in the complex control system of Beckwith & Weidemann syndrome.
- Understand the combined mechanisms of action of gene control, non-code RNAs and chromatin positioning phenomena in the complex control system of Prader Willi & Angelman syndrome

## **8. Epigenetic disease pathophysiology and new therapeutic approaches**

### **OUTLINE**

- Epigenetic effects on pathogen infection.
- Epigenetic effects on immune diseases such as arthritis, asthma.
- Epigenetic effects on heart disease.
- Epigenetic effects on eating disorders and metabolic disorders.
- Epigenetic effects on Alzheimer's disease and related diseases.
- Epigenetic effects on aging.
- Epigenetic genomics and Precision Medicine.
- Future applications of the epigenomic profile in health and performance of animals and humans.
- Precise optimization strategies in gene expression for adaptation and the welfare under current environmental "pressures".

### **LEARNING OBJECTIVES**

The student will be able to:

- Comprehend the epigenetic mechanisms in the pathogenesis of human diseases.
- Understand the combined mechanisms of action of gene control under the variety of disease cases.
- Know the possibilities of precision medicine when supported by the patient's epigenetic profile to applying therapeutic interventions of epigenetic modifiers designed on a case-by-case basis in diseases as well as the spectrum in research to creating and improving new drugs.

## **9. Epigenetics of cancer**

### **OUTLINE**

- Brief introduction to oncogenesis.
- Genetic review in cancer.
- Epigenetics in oncogenesis and cancer.
- Epigenetic therapeutic potential of interventions in cancer.
- Future trends.

### **LEARNING OBJECTIVES**

The student will be able to:

- Understand key changes in cancer cell.
- Understand and assimilate the epigenetic changes in the stages involved in cellular processes leading to the appearance of the transformed phenotype, from the onset of oncogenesis to the stage of cancer.
- Understand the need to use innovative therapies that complement the present by taking into account the epigenetic code in therapeutic interventions
- Understand the targeted action of new epigenetic drugs on specific cancers.

## **10. Epigenetic programming disorders**

### **OUTLINE**

- Epigenetic programming disorder and epigenetic changes in cloned animals.
- Epigenetic changes in assisted reproductive technologies in humans.
- Introduction to markers of induced pluripotent stem cells, iPSCs.
- Epigenetic potential in the therapeutic features of iPSCs.

### **LEARNING OBJECTIVES**

The student will be able to:

- Understand the spatiotemporal epigenetic changes in which the genetic component of the nucleus is not harmonized in the zygote and embryo formation during development of the cloned animal organisms.
- Understand the possible epigenetic changes in eggs / sperm / zygote formation in assisted reproductive technologies, which have been the subject of research and optimization.

## **11. Prions and epigenetics**

### **OUTLINE**

- Prions, their infectious entity and their transmission.
- Incorrect protein folding.
- Prions and epigenetics.
- Prevention / treatment.

### **LEARNING OBJECTIVES**

The student will be able to:

- Get to know Prions, their infectious entity and their transmission.
- Know the pathological processes in cells that lead to incorrect folding of proteins (Prions) and to encephalopathy.
- Know the epigenetic interpretation of the transmission and inheritance of Prions.
- Understand examples of Prions transmission such as Bovine Spongiform Encephalopathy (BSE) and Kuru (TSE) in humans.

## **12. Recent developments in epigenetic research**

### **OUTLINE**

- Recent developments in epigenetic research.
- Large epigenetic research programs.
- Generally about methods to studying epigenetic changes in DNA and histones.

### **LEARNING OBJECTIVES**

The student will be able to:

- Expand his horizons in relation to the latest developments in epigenetic research to improve the quality of life and the environment.
- Be introduced to the technology of studying epigenetic changes in DNA and histones.

### **13. Laboratory exercises**

Laboratory exercises aim to deepen the understanding of the concepts and applications presented in the theory. Specifically, the exercises will focus on Epigenetic analysis tools and techniques. Also, the student will work with his / her classmates to identify and interpret and or solve complex problems and questions of Genetics / Epigenetics known from the literature. Finally, he will be trained in writing scientific manuscripts and in searching, reporting and managing bibliography.