

# Course Content

## Unit 1: Maintaining Dynamic Equilibrium II

*Cells, tissues, organs, systems and ultimately organisms must maintain a biological balance despite changing external conditions. Homeostasis is the state of internal balance so critical to existence. It represents a dynamic equilibrium, displaying constant interactions and checks and balances both within organisms and between organisms and their environment. There are a variety of systems within living things responsible for the maintenance of this delicate balance and this unit will identify and introduce the role of some of the nervous (electrochemical) and endocrine (chemical) systems in humans.*

- 1.1 Analyze the nervous system and explain its structure and dynamics.
  - Explain the basic structure and function of the central nervous system. Include (i) brain and (ii) spinal cord.
  - Explain how the nervous system is protected. Include (i) skull, (ii) meninges and (iii) cerebrospinal fluid.
  - Explain the basic structure and function of the brain. Include (i) cerebrum, (ii) cerebellum, (iii) medulla oblongata, (iv) thalamus, (v) hypothalamus, (vi) midbrain, (vii) pons and (viii) corpus callosum
  - Describe the basic function of the peripheral nervous system. Include (i) autonomic – sympathetic, parasympathetic and (ii) somatic.
- 1.2 Explain how the nervous system helps to maintain homeostasis.
  - Identify requirements for a nervous response to occur. Include (i) sensory receptors (skin, eye, ear), (ii) impulse transmission (neurons), (iii) interpretation and analysis of impulses (brain, spinal cord) and (iv) effectors (muscle, gland).
  - Describe the structure of the typical neuron and explain the function of each part. Include (i) dendrite, (ii) cell body, (iii) axon, (iv) axon terminal and (v) Schwann cells (myelin sheath and nodes of Ranvier).
  - Describe the function of sensory neurons, motor neurons and interneurons.
  - Describe the transmission of an impulse along the length of a neuron. Include (i) ion distribution of the neural membrane (rest, depolarization, repolarization), (ii) threshold, (iii) action potential and (iv) all or none response.
  - Describe the transmission of an impulse across a synapse and the effects of neurotransmitters involved. Include (i) acetylcholine, (ii) noradrenaline, (iii) glutamate, (iv) GABA, (v) dopamine and (vi) serotonin.
  - Describe the critical role of cholinesterase in nerve transmission.
  - Identify the role of certain compounds to neuron function (oxygen, glucose, ATP, sodium ions).
- 1.3 Analyze homeostatic phenomena to identify the feedback mechanism involved.
  - Define reflex arc.
  - CORE LAB #1 The Nervous System and Reflex Responses.
- 1.4 Describe disorders linked to the nervous system and their effect on homeostasis of the system and the organism as a whole.
  - Include (i) Multiple Sclerosis, (ii) Alzheimer's Disease, (iii) Parkinson's Disease, (iv) Meningitis and (v) Huntington's Disease.
- 1.5 Analyze why and how technologies related to the treatment of nervous system disorders were developed and improved over time.

- Include the technologies (i) MRI, (ii) EEG, (iii) CAT Scan and (iv) PET Scan.
  - Describe the methods used to treat stroke and spinal cord injuries.
- 1.6 Describe how the use of prescription and non-prescription drugs can have a role in maintaining or disrupting homeostasis.
- Include (i) anesthetics, (ii) prescription drugs (OxyContin, Valium, Ritalin), (iii) illegal drugs (marijuana, ecstasy, cocaine) and (iv) legalized drugs (alcohol, nicotine, caffeine).
  - CORE STSE #1 Drugs and Homeostasis.
- 1.7 Explain how the eye as a sense organ helps maintain homeostasis.
- Describe the general structure and function of the eye. Include (i) lens, (ii) iris, (iii) retina, (iv) cornea, (v) choroids layer, (vi) fovea centralis, (vii) rods, (viii) cones, (ix) pupil, (x) blind spot, (xi) optic nerve, (xii) aqueous humour and (xiii) vitreous humour.
  - Trace the path of light through the eye and explain how the amount of light entering the eye is regulated.
- 1.8 Analyze and describe examples of disorders of the eye and where technologies for the correction of visual defects were developed based of scientific understanding.
- Include eye disorders (i) glaucoma, (ii) cataracts, (iii) astigmatism, (iv) myopia and (v) hyperopia.
  - Include treatments for eye disorders (i) corneal transplant, (ii) laser surgery, (iii) corrective lenses and (iv) lens replacement.
- 1.9 Explain how the ear as a sense organ helps maintain homeostasis.
- Describe the general structure and function of the ear. Include (i) pinna, (ii) tympanic membrane, (iii) ossicles (malleus, incus, stapes), (iv) Eustachian tube, (v) semi-circular canals, (vi) cochlea and (vii) auditory nerve.
  - Trace the pathway of sound through the ear.
- 2.0 Analyze and describe examples of disorders of the ear and where technologies for the correction of auditory defects were developed based of scientific understanding.
- Include (i) ear disorders (conduction deafness, nerve deafness) and (ii) treatment for ear disorders (Eustachian tube implants, hearing aids).
- 2.1 Evaluate, considering ethical issues, the consequences of medical treatments for visual and auditory disorders.
- Include (i) sense of exclusion and (ii) mandatory organ donation.
- 2.2 Explain how the endocrine system helps maintain homeostasis.
- Understand the general concept of a hormone and target cell or organ.
  - Compare how non-steroid and steroid hormones cause changes in target cells. Include (i) solubility in cell membrane, (ii) location of receptors and (iii) end result.
  - Identify the location and function of principal endocrine glands in the human organism. Include (i) pituitary, (ii) hypothalamus, (iii) pineal, (iv) thyroid, (v) parathyroid, (vi) adrenal, (vii) pancreas (Islets of Langerhans), (viii) thymus, (ix) ovaries and (x) testes.
- 2.3 Identify and describe the structure and function of important biochemical compounds, including steroid and non-steroid hormones.
- Identify the following hormones, their source gland and explain their general effect on the human organism. Include (i) melatonin, (ii) thyroxine, (iii) adrenaline, (iv) somatotropin (HGH-human growth hormone), (v) insulin and (vi) glucagon.
- 2.4 Analyze homeostatic phenomena to identify the feedback mechanisms involved.
- Describe representative positive and negative feedback loops. Include (i) hypothalamus-pituitary complex as a negative feedback control and oxytocin as positive feedback control.
  - Describe the regulation of blood sugar by controlled release of insulin and glucagon.

- 2.5 Describe disorders and treatments linked to the secretions of the endocrine system and their effect on the homeostasis of the system and the organism as a whole.
- Include (i) dwarfism, (ii) gigantism, (iii) hyperthyroidism, (iv) hypothyroidism and (v) diabetes mellitus.
  - CORE LAB #2 Identifying Diabetes Mellitus

- 2.6 Analyze examples of Canadian contributions to science and technology.
- Investigate the role played by Fredrick Banting and Charles Best in the discovery of insulin.
  - Debate the merits of developing and using life support technology, identifying questions that are scientific, technological and social in nature.

## **Unit 2: Reproduction and Development**

*This unit helps students to understand the principles of how living organisms reproduce and develop at both the cellular and individual levels. The primary emphasis is placed on human systems. Students should begin to appreciate the complexity and importance of reproductive technologies and be able to discuss and analyze from a variety of perspectives the relative risks and benefits these technologies create.*

- 1.1 Describe mitosis.
- Describe the events of interphase, mitosis and cytokinesis (the cell cycle).
  - Explain the importance of maintaining a constant number of chromosomes through the process of cell and organism reproduction.
  - Observe, identify and describe (using prepared slides of plant and animal cells) the events of the cell cycle. Include (i) growth, (ii) cytokinesis and (iii) chromosome behaviour.
  - CORE LAB #3 Observing the Cell Cycle in Plant and Animal Cells
- 1.2 Evaluate the physiological and ethical consequences of radiation therapy and chemotherapy in cell division.
- Describe their use and effectiveness.
  - Describe positive and negative aspects of these treatments.
- 1.3 Describe meiosis.
- Describe the events of meiosis (reduction division) and cytokinesis.
  - Explain the necessity of chromosome reduction during the production of sex cells.
  - Describe the crossing-over process and explain its role in helping randomize the gene combinations for sex cells.
- 1.4 Analyze and describe the function of spermatogenesis and oogenesis.
- Examine the process of spermatogenesis and oogenesis.
  - Explain why there is only one functional egg produced during oogenesis.
  - Describe and compare the structure of sperm and egg cells. Include (i) relative sizes, (ii) energy reserves, (iii) mitochondria, (iv) numbers produced, (v) motility and (vi) enzyme cap (acrosome).
- 1.5 Identify and describe examples of technologies that were developed based on cell division.
- Include (i) stem cell research, (ii) cell transplant, (iii) cancer treatment, (iv) spinal cord injury, (v) therapeutic cloning and (vi) reproductive cloning.
  - CORE STSE #2 Stem Cell Research.
- 1.6 Analyze natural reproductive strategies to interpret and explain their structure and dynamics.

- Distinguish between sexual and asexual reproduction.
- Define various types of asexual reproduction. Include (i) budding, (ii) binary fission, (iii) spore production, (iv) fragmentation and (vi) parthenogenesis.

1.7 Describe mitosis and meiosis within plant reproduction.

- Observe, identify and give the function of the basic structures of sexual reproduction in angiosperms (flowering plants). Include (i) pistil, (ii) stamen, (iii) pollen, (iv) ovules, (v) seed and (vi) fruit.
- Describe the process of sexual reproduction in flowering plants.
- CORE LAB #4 Reproductive Structures in Flowers.

1.8 Analyze and describe the structure and function of the human male reproductive system.

- Include (i) testis, (ii) scrotum, (iii) seminiferous tubules, (iv) epididymis, (v) sperm duct (vas deferens), (vi) Cowpers (bulbourethral) gland, (vii) seminal vesicle, (viii) prostate and (ix) urethra.
- Identify and state the functions of the principal reproductive hormones of the human male. Include (i) inhibin, (ii) follicle stimulating hormone (FSH), (iii) luteinizing hormone (LH) and (iv) testosterone.
- Explain the function and interactions among these hormones in maintaining the male reproductive system.

1.9 Analyze and describe the structure and function of the human female reproductive system.

- Include (i) ovary, (ii) follicles, oviduct (fallopian tube), (iv) fimbriae, (v) uterus, (vi) endometrium, (vii) cervix and (viii) vagina.
- Identify and state the functions of the principal reproductive hormones of the human female. Include (i) estrogen, (ii) progesterone, (iii) luteinizing hormone (LH) and (iv) follicle stimulating hormone (FSH).
- Explain the function and interaction among these hormones in the menstrual cycle.
- Research and evaluate the uses and effects of estrogen/progesterone treatment on the health of women. Include hormone therapy among menopausal women and the use of birth control pills.
- CORE LAB # 5 The Menstrual Cycle.

2.0 Research and describe the potential health risks on individuals and society associated with exposure to sexually transmitted infections.

- Include (i) HIV and AIDS, (ii) Chlamydia, (iii) hepatitis B, (iv) genital herpes, (v) syphilis and (vi) gonorrhea.

2.1 Explain and describe the use of reproductive technologies for humans.

- Identify the causes of human infertility. Include (i) blocked oviducts, (ii) failure to ovulate, (iii) endometriosis, (iv) damaged egg, (v) obstruction in the vas deferens or epididymis, (vi) low sperm count and (vii) abnormal sperm.
- Identify the technological solutions to human infertility. Include (i) artificial insemination, (ii) in vitro fertilization (IVF), (iii) in vitro maturation (IVM), (iv) surrogate motherhood, (v) superovulation using fertility drugs and (vi) embryo storage (cryopreservation).

2.2 Evaluate the design of birth control technologies and the way they function.

- Include (i) abstinence, (ii) birth control pills, (iii) Norplant (implant), (iv) Depo-Provera (needle), (v) IUD (intrauterine device), (vi) tubal ligation, (vii) diaphragm, (ix) spermicidal jellies and foams, (x) condom, (xi) vasectomy and (xii) rhythm method.
- Assess the effects of birth control technology on the population demographics of developed and underdeveloped countries.
- Debate the merits of funding solutions to human fertility problems versus human population control (China's one child rule, abortion of females in some developing countries).

2.3 Explain the process of fertilization and development in human reproduction.

- Trace the journey of sperm and egg from their origin until fertilization and implantation.
- Explain how fraternal and identical offspring are produced.
- Describe the following basic stages of embryonic development. Include (i) cleavage, (ii) morula, (iii) blastocyst (blastula), (iv) gastrula, (v) germ layers and (vi) neural development.
- Describe the function of the primary embryonic during the embryonic development of animals. Include (i) yolk, (ii) allantois, (iii) amnion and (iv) chorion.

2.4 Explain the process of development and birth in human reproduction.

- Describe the roles of the placenta and umbilical cord during pregnancy.
- Examine the effects of teratogens on the development of the embryo. Include (i) cigarette smoke, (ii) alcohol and (iii) prescription drugs.
- Describe the process of childbirth. Include (i) dilation stage, (ii) expulsion stage and (iii) placental stage.
- Identify chemical control hormones associated with implantation, birth and lactation. Include (i) progesterone, (ii) estrogen, (iii) oxytocin, (iv) prolactin and (v) human chorionic gonadotropin (HCG).
- Describe techniques used to monitor various stages of embryonic or fetal development. Include (i) ultrasound, (ii) amniocentesis, (iii) fetoscopy and (iv) CVS (chorionic villi sampling).

### Unit 3: Genetic Continuity

*Much of the structure and function of every living organism is determined by deoxyribonucleic acid (DNA). It is important to understand principles and fundamentals about DNA: what it is, how it works, how and for what purposes humans are manipulating it, and why this major area of scientific and technological endeavour has dramatic implications for humans and planet Earth.*

1.1 Demonstrate an understanding of Mendelian genetics.

- Define the term heredity and genetics.
- Explain Mendel's concept of unit characters and describe the unit theory of inheritance.
- Explain the meaning of the following terms (i) trait, (ii) P generation (parent generation), (iii) F<sub>1</sub> and F<sub>2</sub> generation (first and second filial generation), (iv) hybrid, (v) purebred, (vi) dihybrid, (vii) monohybrid, (viii) dominant, (ix) recessive, (x) gene, (xi) allele, (xii) homozygous, (xiii) heterozygous, (xiv) product rule, (xv) punnett square, (xvi) genotype and (xvii) phenotype.
- Explain how Mendel's experiments support (i) principle of dominance, (ii) law of segregation and (iii) law of independent assortment.
- Determine the outcome of monohybrid and dihybrid crosses.
- Explain the meaning of the following terms (i) incomplete dominance, (ii) co-dominance and (iii) multiple alleles.

1.2 Interpret patterns and trends in genetic data.

- Predict the outcome of monohybrid and dihybrid crosses for incomplete and co-dominance.
- Demonstrate the inheritance of traits governed by multiple alleles by predicting the genotypic and phenotypic ratios in crosses involving human blood types (ABO groups).
- Explain the significance of a test cross.
- Use a test cross to determine the unknown genotype of a dominant organism.

1.3 Summarize the main scientific discoveries that lead to the modern concept of the gene. Describe and illustrate the role of the chromosome in the transmission of hereditary information from one cell to another.

- Explain how the work of Gregor Mendel and Walter Sutton led to the chromosome theory of inheritance.
- State and explain the chromosome theory of inheritance.
- Describe Morgan's experiments with *Drosophila* and explain how his observations supported the chromosome theory of inheritance.
- Explain the concept of gene linkage (linked genes) and crossing-over.
- Outline, in general terms, the gene-chromosome theory of inheritance.
- Explain how the discovery of gene linkage affected man's understanding of Mendel's Law of Independent Assortment.
- State the Law of Independent Assortment in modern terms.
- Define sex-linkage.
- Explain why sex-linked defects are more common in males than females.
- Distinguish between genotypes and phenotypes in autosomal and sex-linked inheritance.
- Explain the influence of polygenic traits on inheritance.
- Predict the outcome of monohybrid and dihybrid crosses involving sex-linked traits.

1.4 Describe the contributions of the following to the understanding of the structure and function of DNA.

- Include (i) Mendel, (ii) Sutton Boveri, (iii) Levene, (iv) Griffith, (v) MacLeod, McCarty & Avery, (vi) Chargaff, (vii) Franklin & Wilkins, (viii) Watson & Crick and (x) McClintock.
- Describe the Watson and Crick double helix model of DNA.

1.5 Identify and describe the structure and function of important biochemical compounds.

- Compare and contrast the structure of DNA and RNA.
- Explain the semi-conservative model of DNA replication.
- Describe the four steps of DNA replication. Include (i) initiation, (ii) elongation, (iii) termination and (iv) proofreading and correction.
- CORE LAB # 6A DNA Structure and Replication

1.6 Explain the role of DNA and RNA (mRNA, tRNA, rRNA) in protein synthesis.

- Include (i) transcription and (ii) translation.
- Discuss the influence of hormonal and environmental factors on gene expression.
- CORE LAB # 6B Simulating Protein Synthesis.

1.7 Predict the effects of mutations on protein synthesis, phenotypes and heredity.

Describe factors that may lead to mutations in a cell's genetic information.

- Explain the meaning of mutation and what causes it.
- Explain what is meant by a gene mutation and predict, in general, its effect on protein synthesis.
- Distinguish between somatic and germ mutation and compare the inheritability of each.
- Distinguish between the two types of point mutations (gene mutations). Include (i) substitution – silent, mis-sense, nonsense, (ii) frameshift – insertion, deletion.
- Discuss how McClintock's jumping genes contribute to genetic variation.
- Distinguish among the different types of chromosomes mutations. Include (i) deletion, (ii) duplication, (iii) inversion, (iv) translocation, (v) nondisjunction (monosomy, trisomy).

1.8 Identify in general terms the impact of genetic diseases on the homeostasis of the organism.

- Describe several examples of human genetic diseases caused by chromosomal mutations. Include (i) Down syndrome, (ii) Turner syndrome, (iii) Klinefelter syndrome (XXY syndrome), (iv) Jacobs syndrome (XYY syndrome) and (v) Triple X syndrome.
- CORE LAB # 7 Karyotype Lab.

1.9 Pedigrees

- Draw and interpret patterns of inheritance shown on pedigree charts.

- Describe and identify on pedigree charts the following (i) autosomal recessive (Tay Sachs, PKU), (ii) co-dominant inheritance (Sickle Cell Anemia), (iii) autosomal dominant inheritance (Progeria, Huntington's), (iv) incomplete dominance inheritance (FH) and (v) x-linked recessive inheritance (color blindness, Muscular Dystrophy, Hemophilia).
- CORE STSE # 3 Genetics Research in Newfoundland and Labrador.

## 2.0 Genetic Counseling

- Discuss the importance of genetic counseling.
- Describe the various methods of detecting genetic disorders such as (i) amniocentesis, (ii) CVS (chorionic villi sampling), (iii) fetoscopy and (iv) genetic markers (linked marker and gene specific marker).
- Describe the various methods of treating genetic disorders such as (i) screening and prevention, (ii) surgery, (iii) environmental control and (iv) gene therapy.

## 2.1 Demonstrate and understanding of genetic engineering using knowledge of DNA.

- Define genetic engineering.
- Describe the tools and techniques in genetic engineering. Include (i) restriction enzymes, (ii) recombinant DNA, (iii) DNA amplification – bacterial vectors, viral vectors, polymerase chain reaction, (iv) gel electrophoresis and (v) DNA sequencing.

## 2.2 Explain the importance of the Human Genome Project and why it was initiated.

- Describe the Human Genome Project.
- Describe the major findings of the project.
- Analyze, from a variety of perspectives, the risks and benefits to society of applying the scientific knowledge gained through the Human Genome Project. Risks (i) privacy, (ii) financial, (iii) ethical Benefits (i) knowledge of predisposition to disease, (ii) analysis, prevention and treatment of disease.

## 2.3 Analyze from a biological, social, ethical and environmental perspective the risks and benefits of the development of GMFs and GMOs.

- Define GMOs and GMFs.
- Give examples of GMOs or GMFs and its major significance. Include (i) herbicide resistant plants, (ii) BST producing bacteria, (iii) golden rice, (iv) transgenic salmon, (v) insulin producing bacteria, (vi) PCB eating bacteria and (vii) oil eating bacteria.
- Identify and explain the major risks associated with GMOs and GMFs. Include (i) environmental threats, (ii) health effects and (iii) social and economic issues.
- Construct arguments to support or oppose the use of GMOs and GMFs in society.

## 2.4 Analyze from a biological, social, ethical environmental perspective the risks and benefits of cloning organisms.

- Define cloning.
- Use sheep as an example to describe the cloning process.
- Identify and explain the major benefits and risks associated with cloning.
- Identify and describe science-based careers related to the field of biotechnology. Include (i) cytogeneticist, (ii) medical geneticist and (iii) genetic engineer.

## Unit 4: Evolution, Change and Diversity

*Evolution is a concept in biology that links yesterday with today. This unit focuses on the history, importance and mechanisms of the process of evolution and how a change in the DNA blueprint creates new traits that propel evolution. Here we will build on what has been learned about mutations and genetic variability to show how this can lead to*

*changes in species based upon natural selection. This unit also outlines evidence and arguments pertaining to the origin, development and diversity of living organisms on Earth.*

1.1 Explain how knowledge of evolutionary theory evolves with new evidence.

- Define the terms evolution, adaptation and variation.
- Draw a timeline illustrating how early life forms evolved into the diverse array of organisms present on Earth today. Include the appearance of (i) single cells, (ii) marine worms, (iii) clams, (iv) fish, (v) dinosaurs, (vi) small mammals and (vii) modern mammals (humans).

1.2 Analyze evolutionary mechanisms such as natural selection and artificial selection.

- Explain the process of natural selection and artificial selection.
- Use the Peppered Moth story as an example of evolution and adaptation.

1.3 Describe historical and cultural contexts that have changed evolutionary concepts.

- Include the importance of peer review in the development of evolutionary knowledge.
- Describe the contributions of the following (i) Charles Lyell, (ii) Thomas Malthus, (iii) Alfred Wallace, (iv) Charles Darwin, (v) Jean Baptiste Lamarck and (vi) Georges Cuvier.
- Describe (compare and contrast) the theories put forth by Lamarck and Darwin.
- Explain why Darwin was unable to account for the mechanism of inheritance of traits in his theory.
- Illustrate how knowledge of Mendelian genetics and mutations supported Darwin's theory.
- Explain the modern theory of evolution and its importance to biological sciences.

1.4 Explain the role of evidence, theories and paradigms in the development of modern evolutionary theory.

- Describe current evidence that supports the modern theory of evolution. Include (i) fossil record, (ii) biogeography, (iii) comparative anatomy – homologous structures, analogous structures, vestigial structures, (iv) comparative embryology, (v) heredity and (vi) molecular biology.
- Discuss the relationship between the relative age of rock sediment and the relative age of fossils within the rock layers.
- Compare the processes and accuracy of the methods of dating fossils. Include (i) relative dating and (ii) absolute dating.
- THINKING LAB – Rocks of Ages.
- Perform half-life calculations.

1.5 Population genetics

- Define population genetics, gene pool and allele frequency.
- State the Hardy-Weinberg law and explain its significance in terms of the development of evolutionary theories.
- Perform calculations involving Hardy-Weinberg equilibrium.
- CORE LAB # 8 Population Genetics and the Hardy-Weinberg Principle.
- Describe conditions that have the potential to disrupt Hardy-Weinberg equilibrium. Include (i) mutations, (ii) genetic drift – bottle neck effect, founder effect, (iii) gene flow, (iv) non-random mating – inbreeding, assortative mating, (v) natural selection – stabilizing selection, directional selection, disruptive selection and (vi) sexual selection.

1.6 Analyze evolutionary mechanisms and their effects on biodiversity.

- Define speciation.
- Describe two general pathways that lead to the formation of a new species (transformation, divergence).
- Explain the conditions under which speciation may occur.
- Describe how geographic isolation may contribute to speciation.



- Demonstrate how biological barriers to reproduction may contribute to speciation. Include (i) pre-zygotic barriers – behavioral isolation, habitat isolation, temporal isolation, mechanical isolation, gametic isolation, (ii) post-zygotic barriers – hybrid inviability, hybrid sterility, hybrid breakdown.
- Describe adaptive radiation as a mechanism for speciation.
- Distinguish between convergent and divergent evolution and explain its occurrence in certain groups of organisms.
- Explain the process of coevolution.
- Compare the views on gradualism and punctuated equilibrium and discuss how evidence fuels the debate between them. Discuss ideas of (i) Gould and (ii) Eldridge.

1.7 Outline evidence and arguments pertaining to the origin, development and diversity of living organisms on Earth.

- Discuss (i) chemical evolution – Oparin Haldane theory, Miller Urey theory, (ii) heterotroph hypothesis, (iii) symbiogenesis, (iv) panspermia theory, (v) GAIA theory and (vi) intelligent design theory.
- STSE # 4 Extraterrestrial Life: Myth or Reality.