MIDDLESEX COUNTY COLLEGE
EDISON, NEW JERSEY

Course Title: **Heredity, Evolution & Society** Catalog #: **BIO 105**

Class Hours: 3 Laboratory Hours: 2 Credit Hours: 4

Department Chair: _____ Division Dean: _____ Date: 2007-2008

Prerequisite(s): Appropriate score on the College's Placement Test or MAT 013 and one year high school laboratory science or a 3 credit college level science course, with a grade of "C" or better.

Textbooks for Course:

Author	Title	Publisher	Copyright
M. J. Cummings	**Human Heredity: Principles and Issues 7th Edition**	**Thompson/ Brooks/Cole**	**2006**
C. Starr & R. Taggart	**Evolution of Life 11th Edition Diversity of Life 11th Edition**	**Thompson/ Brooks/Cole**	**2006**

Course Outline, **Laboratories**, **and Supplements**, by R.J. Furbee, Middlesex County College, Edison, NJ. 1998.

Biology Labs On-Line
FlyLab by Michael Palladino
EvolutionLab by Michael Palladino

Supplementary Materials
(1) General Purpose Classroom for lectures;
(2) Instructional Laboratory with 12 wireless laptop computers in the Biology Department **(LH 103)**

Catalog Description:
An introduction to classical and modern genetics and evolutionary theory. A survey on the historic and scientific developments leading to our current concepts of heredity and evolution. The individual and societal implications of the powerful ideas and technologies associated with modern genetics and evolutionary theory. Includes computer simulations, audiovisual materials and laboratory observations (without dissection). Recommended for non-science majors.

Course Objectives:

Students will:

1. Appreciate the materialistic nature of the scientific methods of data collection, interpretation and evaluation.

2. Know basic cell structures and functions.

3. Know the meaning of basic technical terms in genetics and evolutionary theory.

4. Understand the basic principles and concepts of classical and modern genetics.

5. Understand the basic principles and concepts of evolutionary theory.

6. Evaluate the inseparable contributions of nature (heredity) and nurture (environment) in determining observable traits.

7. Appreciate the importance of genetics and evolutionary theory in everyday life and to society. This includes a consideration of current ethical issues.

8. Formulate valid conclusions based on scientific data collection and evaluation.

9. Prepare and interpret charts and graphs.

10. Use computer simulations, Internet activities, videotapes, and laser disk information in studying genetics and evolution

12. Write lab reports presenting data, observations, results and conclusions in a clear meaningful fashion.

13. Distinguish the difference between science and non-science.

Behavioral Objectives

Students will:

1. Describe the scientific method and differentiate a hypothesis from a theory.
2. Discriminate between observable, objective data and subjective interpretation.
3. List basic cell structures and describe their functions.
4. List and explain the basic technical terms associated with classical and modern genetics.
5. List and explain the basic technical terms associated with evolutionary theory.
6. Describe mitosis, meiosis and gamete formation.
7. Summarize the theories of Mendelian and modern genetics.
8. Solve genetic problems using Punnett Squares and pedigree charts.
9. List the functions of proteins in cells and organisms.
10. Describe the basic method of cellular protein synthesis.
11. Summarize Darwinian and modern evolutionary theory.
12. Contrast the theory of natural selection with Lamarck's idea of the inheritance of acquired characteristics.
13. Describe the various genetic mechanisms that contribute to individual uniqueness.
14. Compare and contrast the contributions of nature (heredity) and nurture in determining observable traits in organisms..
15. Describe several genetic diseases in man that are associated with chromosomal abnormalities.
16. Describe several genetic diseases in man that are associated with inborn errors in metabolism.
17. Summarize several methods of diagnosing genetic diseases in man.
18. Describe the practices of prenatal diagnosis, genetic screening, genetic counseling and gene therapy. Be able to describe ethical considerations of these practices.
19. Describe and appraise recombinant DNA techniques and current applications.
20. Discuss the ethical implications of recombinant DNA research and applications.
21. Evaluate the concepts of Eugenics (selective breeding in humans), and Social Darwinism (survival of the fittest as it is misapplied to human society).
22. Describe the goals and progress of the Human Genome Project.
23. Describe the structure of DNA and how it replicates.
24. Describe the processes involved in protein synthesis.
25. Describe how mutations occur and their role in producing genetic variation.
26. Explain how science differs from "creation science" and "intelligent design."

COURSE OUTLINE

I. Introduction
   A. Purpose and objectives of the course
   B. Organic evolution
   C. Genetics
   D. "Creation science"
   E. Applied genetics
      1. Selective breeding
      2. Cloning of plants and animals
      3. Recombinant DNA/genetic engineering
      4. Embryo fusions
      5. Transgenic organisms
      6. Gene therapy
      7. Human genome project
      8. Conservation and biodiversity (optional)

II. Life
   A. Definition and characteristics of life (metabolism, reproduction, responsiveness, mutation, adaptability, evolution, unique biological molecules, and complex organization).
   B. Cell structure and function)
      1. Cell membranes
      2. Cell wall (plants)
      3. Nucleus
      4. Cytoplasm
      5. Nucleolus
      6. Ribosomes
      7. Golgi complex
      8. Mitochondria
      9. Lysosomes
      10. Chloroplasts (plants)
      11. Vacuoles
      12. Endoplasmic reticulum
      13. Chromosomes
      14. Microtubules (spindle)
      15. Centrioles (animals)
      16. Cilia (eukaryotes)
      17. Flagella
      18. Chromosome
   C. Differences between prokaryotic and eukaryotic cells
   D. Hierarchy of organization (cells through ecosystems)
   E. Classification
      1. Linnaeus
      2. Whittaker's Five Kingdoms
      3. Woese's Three Kingdoms
      4. Cladistics
   F. Hypotheses on the origin of life
      1. Special creation myths
      2. Cozmozoan (panspermia) hypothesis
      3. Oparin/Haldane (chemical/biological evolution) hypothesis
      4. Spontaneous generation

G. Time scale of evolution

III. Darwinism

A. Pre-Darwinian views

1. **Plato** (427-347 BC) his idea of perfect form or **Essentialism** was derived from the philosophical tradition that what we can see and measure in the world is merely the superficial and imperfect representation of an underlying reality or essence. Variation is superficial, unreal, and unimportant.
2. **Aristotle** (384-322 BC) classified living things and developed the Scala Natura that represented a discontinuous hierarchy of life. He distinguishes between descriptions of the world based on the supernatural (theologi) and descriptions based on natural causes (naturalistic thought).
3. **Buffon** (1707-1788) first true evolutionist, recognizing both the importance and ubiquity of variation, and suggesting, with reservations, an evolutionary process based on degeneracy and the inheritance of acquired characteristics.
4. **Erasmus Darwin** (1731-1802) C. Darwin's grandfather and a speculative evolutionist. His main theses were that the Earth's history was longer than specified by **Bishop Ussher's 6,000 years age of the earth** and that all life evolved from a common source.
5. **Lamarck** (1744-1829) advanced the first comprehensive theory of evolution and invoked the concepts of a "**CREATIVE FORCE**", "sentiment interieur" or “fluida” and the inheritance of **acquired characteristics**.
6. **Malthus** (1766-1834) Essay on the Principle of Population . How did this influence Charles Darwin and Alfred Russel Wallace?
7. **Cuvier** (1769-1832) Lamarck's opponent and a defender of special creation. He explained fossil remnants of extinct life forms with the theory of **CATASTROPHISM** which says that in the past, life on earth had been decimated or destroyed several times, as in the Biblical accounts of the flood, and new kinds of organisms somehow appeared after each catastrophe (migration & serial creation?). He was the founder of modern paleontology and comparative anatomy.
8. **Lyell** (1797-1875) provided an alternative to Catastrophism with Hutton's theory of **UNIFORMATARIANISM** which held that historical changes on the earth were NOT due to a series of catastrophies but to the same gradual changes as may be observed today--sedimentation, volcanism, erosion, etc.

9. **Wallace** (1823-1913) an outstanding biogeographer and evolutionist who in June of 1858 sent Darwin his essay entitled On the Tendencies of Varieties to Depart Indefinitely from the Original Type. This essay **forced Darwin to finally publish** his theory.

B. **Darwin's Theory** (Charles Darwin, born February 12, 1809-died April 19, 1882)
   1. Voyage of the Beagle (Dec. 27, 1831-Oct. 2, 1836) Why was this nearly 5 year voyage important in the development of Darwin's Theories?
   2. Reasons for Darwin's reluctance to publish

C. **The Origin of Species** (November 1859, first of six editions)

D. Evidence for the Theory
   1. Evidence from domestication
   2. Geographical distribution of species
   3. Comparative embryology, anatomy, and vestigial structures
   4. Geological succession and the incomplete fossil record
   5. Argument from taxonomy

E. Objections to the theory of natural selection
   1. Incipient organs/structures (St. George Mivert)
   2. Timescale of evolution (Lord Kelvin)
   3. Gaps in the fossil record (creationists)
   4. Blending inheritance (Flemming Jenkin)
   5. Argument from design and "excessive beauty" (Reverend Paley)

F. Post-Darwinian evidence
   1. Population Genetics
      a. Population (species) gene pool
      b. Factors involved in maintaining stability of the gene pool
         1) Random mating
         2) Isolation
         3) Large population size
         4) No mutation
         5) Lack of selection pressure
      c. Factors disturbing gene pool stability (causes of evolution)
         1) Mutation
         2) Gene flow (immigration/emigration)
         3) Natural selection
            a) Stabilizing
            b) Directional
            c) Disruptive
            d) Sexual
            e) Frequency dependent
         4) Genetic drift
            a) Founder effect
            b) Bottleneck
      d. New Species formation
   2. Recent paleontology (the growing fossil record)
      a. Continental drift and biogeography
      b. Radioactive dating
      c. Geological eras
   3. Comparative biochemistry/molecular biology
   4. Evidence from protective resemblance

a. Industrial melanism (peppered moth lab)
b. Mimicry

G. Current controversies in evolutionary theory
1. Punctuational evolution (S. J. Gould and N. Eldredge)
2. Selection for polymorphism
3. Importance of genetic drift and founder effect
4. Sexual reproduction

IV. Human Evolution
A. Man's antecedents (Primates, Hominoids and Hominids)
1. Prosimians (Tarsier, Lemur, Galago, and Loris)
2. Anthropoids (Monkeys, Apes, and Hominids)
3. Hominids (Ardipithecus, Australopithecus, and Homo)

B. Cultural evolution (non-Darwinian and **Lamarckian in nature**)
1. Tools (2.5 **million years before present--mybp**)
2. Oldest definite "campsite" (2 mybp)
3. Last definite signs of multiple species of coexistent **hominids** (approximately 1 mybp)
4. Cave drawings (1 mybp)
5. Definite signs of controlled fire (300-700 thousand + ybp)
6. Neanderthals disappear [cultural??] (30,000 ybp)
7. Representational art (35,000 plus ybp)
8. Mechanical devices like bows and spear throwers (30 thousand ybp)
9. Animal domestication (10-15 thousand ybp)
10. Agriculture (7-12 thousand ybp)
11. Urbanization (5-6 thousand ybp)
12. Recorded history (6 thousand ybp)
13. Metallurgy (5 thousand ybp)
14. Industrial revolution (220 ybp)
15. Publication of Darwin's Origin of Species (140 years ago)
16. Utilization of nuclear energy (54 years ago)
17. Discovery of DNA functions (about 50 years ago)

C. Multiregional (regional continuity) **vs** monogenesis (out of Africa) **vs** combination models of modern human origins

V. Biological Communication Between Generations
A. Cell division/cytokinesis
1. Mitosis
a. Interphase (Growth 1, Synthesis, Growth 2)
b. Prophase
c. Metaphase
d. Anaphase
e. Telophase

2. Meiosis (reduction division), gamete formation, crossing over, and nondisjunction
a. Diploid chromosome number

b. Haploid chromosome number
c. Fertilization (restoration of diploid number)

B. Mendelian genetics
1. Mendel's experiments
2. Statistical analysis of, and inference from the data
3. Dominant and recessive factors (elements or genes)
4. Particulate theory of inheritance
5. Phenotype
6. Genotype
7. Principle of Parental Equivalence
8. Principle of Segregation
9. Principle of Independent Assortment (dihybrid cross)

C. Genetics of sex
1. Sex chromosomes
   a. Evidence for the chromosomal theory of heredity
2. Sex determining systems (insects, fish, amphibians, reptiles birds, and mammals)
3. Sex-linked inheritance
   a. Hemophilia
   b. Red-green color differentiation
   c. Icthyosis
   d. Defective dentine (dominant & more common in females)
   e. Hypophosphatemia (dominant in females)
4. X inactivation
   a. Barr body formation and Lyonization
   b. Ectodermal dysplasia
   c. Tortoiseshell cats
5. Sex differentiation
   a. Sex determining region Y (**SRY**)
6. Genetic sexual disorders
   a. Testicular feminization (androgen insensitivity)
   b. Guevodoces (male pseudohermaphroditism)
   c. Chimeras and mosaics (true hermaphrodites)
   d. Turner syndrome [**XO**]
   e. Klinefelter syndrome [**XXY**]
   f. Metafemales [**XXX**] and Jacob syndrome [**XYY**]
7. Sex influenced and sex limited inheritance
8. Sex ratios
9. Parthenogenesis

D. Molecular genetics
1. Chemical structure of hereditary material
2. DNA replication
3. Protein synthesis
   a. Transcription (DNA → **all** RNAs)

b. Translation (messenger RNA → protein)

4. Cellular protein functions (be able to list several)
5. Unexpressed genetic information (Heterogeneous nuclear RNA, introns and exons)
6. Mutations
   a. Point mutations
      1) Sickle cell anemia
   b. Frame shift mutations
      1) Cystic fibrosis
   c. Mutation rates
   d. Somatic vs. reproductive cell mutations
   e. Cancer
      1) Viral causes
      2) Chemical causes
7. DNA repair mechanism
8. Natural and artificial causes of mutation
   a. Radiation
      1) Types of radiation
      2) Exposure levels
      3) Practical uses of radiation
   b. Chemicals
      1) Biological test for mutagenic and carcinogenic chemicals
         a) Ames test

VI. Gene Interactions
- A. Quantitative inheritance (polygenic/multiple factor hypothesis)
- B. Norm of reaction
- C. Expressivity
- D. Penetrance
- E. Delayed onset
- F. Codominance
- G. Epistasis
- H. Pleiotropy
- I. Chromosome structure
  1. Chromosome aberrations
     a. Causes
     b. Types
        1) Deletion
        2) Duplication
        3) Isochromosomes
        4) Inversion
        5) Translocation
        6) Fragile sites [fragile X syndrome]
- J. Mitochondrial heredity

VII. Nature (Heredity) and Nurture (Environment)
- A. Phenotypic variation
- B. Heritability
- C. Twin studies

D. Intelligence (What is it and how would you measure it?)
E. Mental retardation and mental disease
F. Personality and behavior
G. Disease susceptibility
    1. Sickle cell anemia and malaria
    2. Blood groups A and O (A appears more susceptible to stomach cancer, pernicious anemia and diabetes while group O individuals appear more susceptible to ulcers, smallpox and pituitary adenomas)
H. Sociobiology (optional)

VIII. Human Diversity
A. Blood type polymorphism
    1. ABO blood groups
    2. Rh positive and negative
B. Phenocopies- environmentally induced phenotype **NOT** characteristic of the organism's genotype under other environmental conditions.
C. Race
    1. Genetic classification (definition) of race
    2. 1952 United Nations statement on race

IX. Genetics of Man
A. History
    1. Family pedigree analysis
    2. A. Garrod and The Inborn Errors of Metabolism
    3. Cytogenetic techniques
        a. Karyotyping
        b. Chromosome staining and banding patterns
B. Selected hereditary diseases (possible examples to follow)
    1. Huntington disease
    2. Tay Sachs
    3. Cystic fibrosis
    4. Sickle cell anemia
    5. Albinism
    6. Glucose-6-phosphate dehydrogenase deficiency
    7. Phenylketonuria (PKU)
    8. Xeroderma pigmentosa
    9. Marfan syndrome
    10. Galactosemia

C. Chromosomal aberrations
    1. Aneuploidy (wrong chromosome number)
    2. Trisomies
        a. Down syndrome
        b. Edward syndrome
        c. Patau syndrome
    3. Deletions
        a. Wilm's kidney tumors in babies and children

    b. Cri Du Chat
  4. Translocations
D. Consanguineous mating
  1. Effects in man
  2. Social prohibitions
E. Diagnosis of genetic disease
  1. Family pedigree analysis
  2. Prenatal diagnosis
    a. Amniocentesis
    b. Chorionic villus analysis
    c. Fetoscopy/Embryoscopy
    d. Restriction Fragment Length Polymorphism (RFLP)
    e. Preimplantation embryo biopsy(optional)
    f. Gene probes (optional)
F. Genetic counseling
G. Genetics, law and bioethics
  1. Paternity suits
  2. Wrongful birth and wrongful life suits
  3. Forensic medicine and DNA fingerprinting
H. Management of the human gene pool
  1. Eugenics (program for improving mankind by positive or negative selective breeding)
  2. Euphenics (improvement of the individual phenotype by biological means)
  3. Euthenics (improvement in environmental quality in order to improve many phenotypes)
  4. Dysgenics (causing or perceived to be causing deterioration of hereditary qualities)
I. Politics, religion, evolution, and genetics
  1. Creationism
  2. Eugenics
  3. Lysenko
  4. Recombinant DNA technologies and cloning
  5. Patenting life forms