Course Syllabus for FISH/CMBL 7660 Fall 2008

Course title: Molecular Genetics and Biotechnology

Course number: FISH 7660/CMBL7660

Instructor: Dr. John Liu

Room: 303 Swingle Hall

Lecture: 8:00-9:15 a.m. Tuesdays and Thursdays

Lab (computer demonstrations, data base searching, and data management, bioinformatics introduction): To be arranged based on the schedule of the entire class. A total of 5-6 sessions will be called.

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Credit hours: 4 credits

Course Objectives: This is a course on genomics and genome analysis. In the genomics era, students, as the scientists in the post genomics era, need to understand how the big and complex genomes are analyzed; how the vast amount of genomic information is recorded, analyzed, and disseminated; how genomes are expressed and how their expression regulated; how genome-scale gene expression is analyzed; and how genome expression affect functions. As biology is going SYSTEMS BIOLOGY and PREDICTIVE BIOLOGY, future scientists need to understand how one gene's change affects the rest of the genome, and when one condition occurs, what consequences it may cause. Specifically, the course has the following objectives:

1. To acquaint students with science and technologies used to mark genomes. Specifically, the course will cover scientific concepts and technologies for various fingerprinting technologies including, but not limited to, allozyme analysis, mitochondrial DNA markers, restriction fragment length polymorphism (RFLP), random amplified DNA polymorphism (RAPD), amplified fragment length polymorphism (AFLP), microsatellites, expressed sequence tags (EST), sequence tagged sites (STSs), single nucleotide polymorphism (SNP), single strand conformation polymorphism (SSCP), heteroduplex analysis, Allele-specific oligo (ASO), and primer extension typing (PET).

2. To acquaint students with applications of DNA fingerprinting technologies in agricultural and medical sciences such as population analysis, forensics, molecular diagnosis, systematics, genetic disease testing, conservation biology, behavior correlation, and marker-assisted selection.

3. To acquaint students with genome analysis involving genetic linkage mapping, QTL mapping, radiation hybrid mapping, physical mapping, comparative mapping, and various other mapping methodologies.

4. To acquaint students with functional genomics. Transcriptome analysis, proteome analysis, microarrays, gene chips, and various methodologies used for the analysis of genome expression and function will be discussed.

5. To acquaint students with the next generation of genome technologies and their potential impact to agriculture.

Laboratory and Demonstrations (subject to update):

1. Demonstration: How to use internet to search molecular biology literature databases
2. Demonstration: How to use BLASTN programs for DNA analysis on Internet: identification of related sequences within a species, among species. Identification of SNP sites;
3. Demonstration: How to use BLASTX and BLASTP programs for protein analysis on Internet.
4. Independent analysis of DNA sequences to determine the structure of a gene with regard to introns, exons, potential promoters, open reading frame, starting and termination codons, and polyadenylation signals.
5. Independent analysis of DNA sequences for restriction sites, multiple alignment of sequences.
6. Search for molecular markers
7. Demonstration of linkage mapping software or other software concerning data management in genomics

Text book: Aquaculture Genome Technologies, (Liu ZJ ed.), Blackwell Publishing. Ames, USA, Oxford, UK, Victoria, Australia. 551 p.

Reference books:

1. Genome Analysis: Volume 4, Mapping Genomes, by Bruce Birren et al., 1999, Gold Spring Harbor Laboratory Press.
2. Genetics and Analysis of Quantitative Traits, by Michael Lynch and Bruce Walsh, Sinauer Associates, Inc. Publishers, 1998.
3. Molecular Biology of the Cell, 3rd ed. By Alberts et al. 1994
4. Genes VI, by Lewin 1997
5. Molecular Biotechnology, 2nd ed., by Click and Pasternak 1998
6. Molecular Biology of the Gene, 4th ed. By Watson et al.
7. Statistical Genomics, By Liu 1998
8. Bioinformatics, sequence and genome analysis, By David W. Mount, Cold Spring Harbor Press, 2001.

Reading list of papers will be distributed accordingly for each section of the course. Papers will be selected from journals such as Genome Research, Nucleic Acid Research, Gene, Animal Genetics, Marine Biotechnology, and others.

Grading: The course will have one midterm exam (30% of the grade) and one comprehensive final (50% of the grade). The remaining 20% will be graded on participation in class (10% of the grade) and laboratory (10% of the grade).

Students with special needs because of handicap or other reasons should make their needs known to the instructor in the first week of class.

Tentative Schedule and Outline of Course Content (subject to change as needed)

August 19	Background survey, Overview of the course, Introduction to genomics and biotechnology; Background review; Background review: From organisms to cells, nucleus, and chromosomes, the laws of Genetics; Genetic linkage and crossing over, the genetic material: DNA
August 21	Genomes and genome sizes, mutations as the source of genetic variations Restriction enzymes and their applications
August 26	Base pairing: the basis of molecular biology techniques; Hybridization techniques; PCR: deal with small biological samples and enhancing sensitivity, Real time PCR
August 28	DNA fingerprinting: Restriction fragment length polymorphism (RFLP)
September 2	DNA fingerprinting: Random amplified polymorphic DNA (RAPD)
September 4	DNA fingerprinting: Amplified fragment length polymorphism (AFLP)
September 9	DNA fingerprinting: Microsatellites;
September 11	DNA fingerprinting: Single nucleotide polymorphism (SNuPs), the ultimate way for differentiation of individuals. Detection of SNPs: allele-specific oligos (ASO), primer extension typing (PET), chip technology, Mass Spec, Pyrosequencing technology.
September 16	DNA fingerprinting: Single nucleotide polymorphism (SNuPs), next generation of technologies.

September 18 DNA fingerprinting: single strand conformation polymorphism (SSCP), DNA fingerprinting: Heteroduplex analysis; Next generation sequencing technologies

September 23 DNA fingerprinting: Mitochondrial and chloroplast DNA as markers; Isozymes: principles, variation, and Applications (Guest Lecture, Dr. Kucuktas)

September 25 Genetic linkage mapping: theories and practices

September 30 QTL mapping, Marker-assisted selection (Guest lecture?)

October 2 Physical mapping of the genome; BAC end sequencing

October 7 **Mid-term Examination**

October 9 Radiation hybrid mapping: mapping the genome without polymorphism

October 14 Molecular Diagnosis

October 16 Comparative mapping

October 21 Nutritional genomics, genome expression and metabolism of fat

October 23 Genome imprinting and Allele expression variations

October 28 Comparative gene mapping; Type I molecular markers; Expressed sequence tags (ESTs)

October 30 Gene expression and functions: microarrays, gene chips; MIAMI protocols and microarray data analysis

November 4 Functional Genomics

November 6 More on Functional genomics

November 11 Proteome and Protein sociology, gene networking.

November 13 Biotechnology: expression vectors; considerations for expression vector design

November 18 Genetic engineering: gene transfer; regulation and inheritance of transgenes

November 20 Biotechnology: production of recombinant proteins; Biotechnology: molecular diagnostics; Antisense technology and its applications

November 25 Thanksgiving Holiday

November 27 Thanksgiving Holiday

December 2 Environmental biotechnology

December 4 (Last day of classes) Biotechnology: Animal cloning; regulations and concerns. Conclusion of the course: perspectives in the post genomics era; GE3LS (genomics and economical, environmental, ethical, legal, and social issues)

December 12 Friday, 8:00 a.m. - 10:30 a.m. **Final Examination**