

## Tentative Schedule and Topics for Molecular Genetics: BY 311/511-2C – FALL 2007

**Course Objectives:** The objective of this course is to provide a broad overview of gene structure and function in prokaryotic and eukaryotic systems. Chromosome organization, regulation of transcription and replication, recombinant DNA technology and its applications, methylation and cancer, regulation of genes responsible for human diseases, gene therapy and its applications, and related topics will be discussed. This course is designed for junior and senior undergraduates, and for graduate students who have not had an equivalent course. This course will help students prepare for advanced level molecular genetics courses.

Lectures	Broad Topics	Reference Chapters
23 Aug.	Introduction; course description; class policies	(02;03; supplemental materials)
	Structure of a prokaryotic gene	
28-30	Structure of a prokaryotic gene	(02;03; supplemental materials)
	Structure of a eukaryotic gene	
04-06 Sept.	Prokaryotic genome organization	(02;03; supplemental materials)
	Eukaryotic genome organization	
11-13	Structure and composition of Nucleic acids	(02;03; supplemental materials)
	DNA structure and human genetic diseases	
18-20	Regulation of Transcription: Eukaryote	(03;11; 13; supplemental materials)
<b>25 Sept. (Tu)</b>	<b>TEST I</b>	
27 Sept.	DNA methylation and cancer	(12;17; supplemental materials)
2-4 Oct.	Structure/Function of tumor suppressor gene p53	(12;17; Supplemental materials)
09-11	Structure and regulation of <i>ob</i> gene	(17; supplemental materials)
	Structure and regulation of <i>BRCA1</i> ; <i>BRCA2</i> ; <i>dbc2</i> genes	(17; supplemental materials)
16-18	Human genome organization	(17; supplemental materials)
23-25	RNAi technology for gene silencing	(17; Supplemental materials)
	Principles and applications of gene therapy	(17; supplemental materials)
	Halloween genes	
<b>30 Oct. (Tu)</b>	<b>TEST 2 (Test 2 will also include selected topics from Test 1)</b>	
01 Nov.	Regulation of Transcription: Prokaryote	(10;11; supplemental materials)
06-08	Regulation of lactose operon and its applications	(10; supplemental materials)
13-15	Regulation of DNA replication	(06; supplemental materials)
20 Nov.	Bacteriophage $\lambda$ gene regulation and its applications	
27-28	Recombinant DNA Technology	(08; 09; supplemental materials)
04 Dec.	Bioinformatics	
<b>13 Dec. (Th)</b>	<b>Test 3 (Final Exam will also include selected topics from Test 1 and 2)</b>	
<b>Final Exam Time: 10:45 A.M. – 1:15 P.M.</b>		

**Instructor:** Asim K. Bej, Ph.D., Professor, Department of Biology; **Location:** Campbell Hall, Rm 251 (office); Rm 262 (lab); **Telephone:** 934-9857; **E-mail:** abej@uab.edu

# Gene Structure and Function: Prokaryote

## Prokaryotic gene components and their functions

Structure and function of Promoter, UP element; SD/RBS; Rules for the SD/RBS; ORF; Trailer sequence; Structural gene; Codon Table; Template and non-template strands; +1 nt transcriptional start; +1 nt of translational start; STOP codon; Start codon, etc.

## Prokaryotic chromosome organization

Nucleoid; Histone-like proteins and their role in chromosome organization; Experimental evidence showing the role of DNA-binding protein for chromosome organization; DNA supercoiling; DNA topoisomerase I and II; effects of antibiotics on topoisomerase I and II; Genes code for Topoisomerase I and II; Positive and Negative supercoil DNA; Mechanisms of action of topoisomerase enzymes; ATP requirement for the activity; mechanism of removal of DNA supercoiling; DNA supercoiling and gene regulation in bacterial pathogens

## Structure and composition of DNA

History of DNA structure discovery; structure and chemical composition of B-DNA, A-DNA and Z-DNA; Results of Rosalind Franklin's DNA crystallography; Chargaff's rules; Chromicity of DNA; Derivation of B-DNA structure by Watson and Crick from Rosalind Franklin and Erwin Chargaff's findings; Net charge of DNA and stabilization of DNA in salt buffer

## DNA Structure and Chemistry: Human Genetic Diseases

Discovery of Z-DNA and its characteristics; its role in human genetic diseases; Spermine, Spermidine, Putrescine; DIL and SLE; Type of mutations leading to Xeroderma Pigmentosum, Cockayne's syndrome, Bloom Syndrome; Fanconi anemia syndrome

## Prokaryotic Transcription Regulation

RNA polymerase structure and components; Sigma factor and its interaction with house-keeping genes and stress-responsive genes; Mechanism of Rho-dependent and Rho-independent termination and ATP requirement; role of GreA, NusA and NusG proteins in the regulation of prokaryotic transcription; Backtracking of RNA polymerase and transcriptional pause and termination; transcription /translation coupled in prokaryotic cells; process and enzymes involved in the degradation of mRNA

## Lactose operon

Genes structure and their function; promoter structures (P1 and P2 promoter system) and their function; Repressor protein structure and function; Molecular mechanisms of repression: repressor protein-mediated and catabolite regulatory process for regulation of lactose operon; big picture for the regulation of lactose operon closely tied with the utilization of lactose as a source for ATP (energy) production; alpha complementation of *lacZ*; *lacZ'* – alpha peptide, delta M15 mutation – omega peptide; various mutations on lactose operon genes resulting into their effects on lactose utilization in the cell; use of lactose operon in gene cloning and gene expression

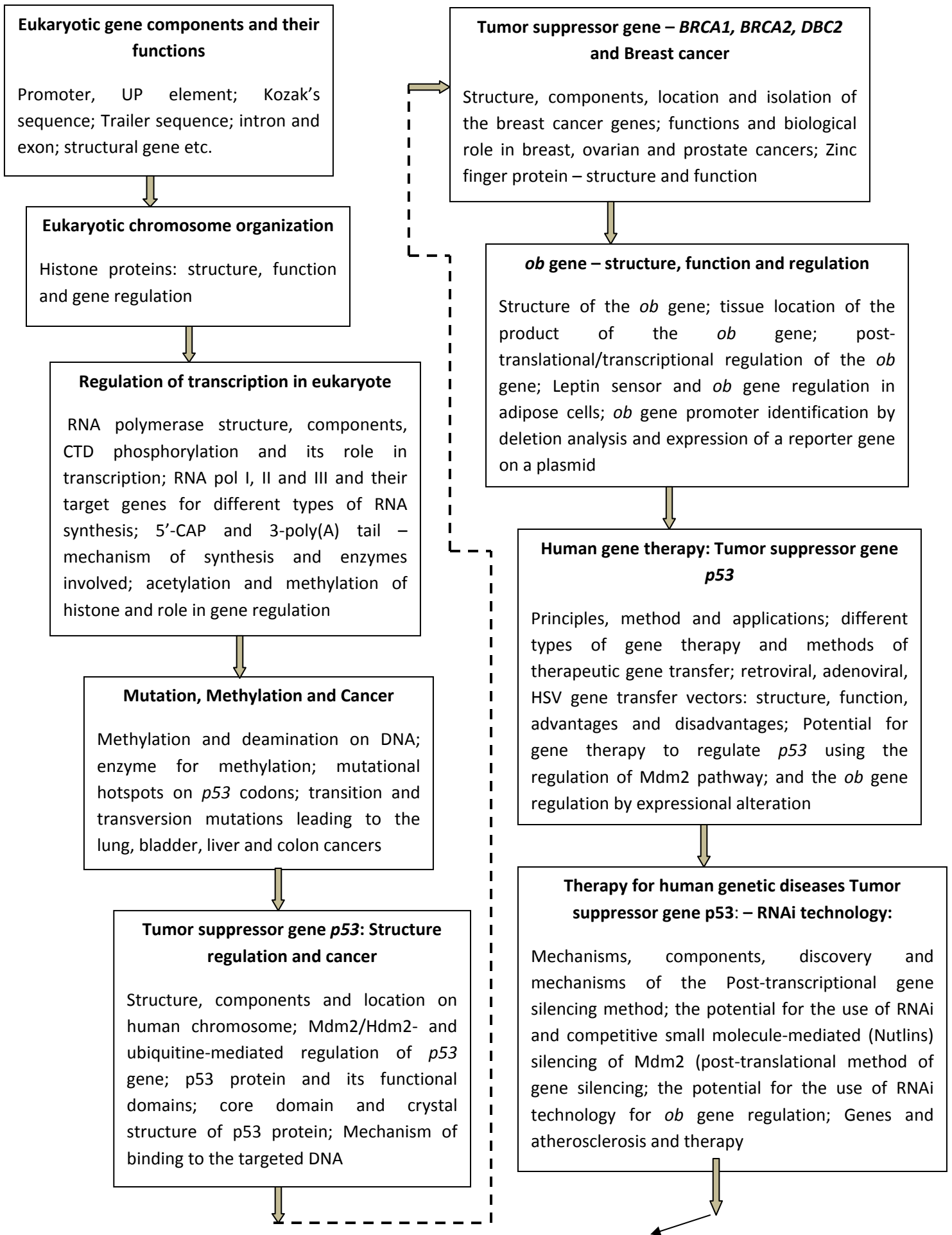
## Regulation of DNA Replication (*OriC*)

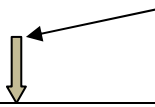
*OriC*; initiation by methylation on GATC; methylation enzymes; hemi-methylation and complete methylation; repeat sequences and role of DnaB, DnaA and DnaC proteins in the initiation of replication; bidirectional replication of *E. coli* chromosome; DNA polymerase I, II, III, IV and V – structures, subunits and their function; mechanism of DNA replication; termination of DNA replication – DNA sequences and proteins involved and mechanism; all enzymes involved in DNA synthesis and their role

## Bacteriophage Lambda

Genes (*cl*, *cro* etc.) and regulation; the use of lambda for gene cloning and gene library. Transduction: Generalized and specialized transduction and their applications

# Gene Structure and Function: Eukaryote





**Halloween Genes**  
Structure, function and regulation of Halloween genes in *Drosophila* embryonic development



**Human Genome Organization**  
History; Method for human gene sequencing and assembly; Human genome structure

**Recombinant DNA Technology and Bioinformatics**

**Gene Cloning and Expression**  
Plasmid vectors: expression vectors, promoter-probe vectors; *in-vitro* transcription vectors; translational and transcriptional gene fusions; Restriction endonuclease; other DNA-RNA modifying enzymes; principles of gene cloning; transformation; selection and screening of clones; Southern-blot DNA-DNA hybridization; Northern blot hybridization; western blot hybridization and their application in the studying the gene function



**Method of identification, structure, function analysis of promoter DNA fragment**  
Gel-mobility shift assay; DNase I protection assay; cloning of the putative promoter DNA and expression of a reporter gene; promoter strength (efficiency analysis; Sanger di-deoxy DNA sequence method); Automated sequencing method; Primer Extension and DNA sequencing for 5'-UTR analysis



**Bioinformatics**  
NCBI gene and protein database analysis; FLAT file analysis; retrieving gene sequences from GenBank; use of BioEdit software for gene analysis; BLAST sequence homology and alignment analysis

## Tentative Schedule & Course Information for Molecular Genetics: BY 511-2C – FALL - 2007

Students are required to complete the BY311 course material including all 3 tests. In addition, students are required to complete a 25-point term paper, and if possible, gain experience in nucleic acid methodologies from a molecular biology laboratory. Total possible points for the BY511 class =  $175+25=200$ .

Students are expected to select their term paper topics, which must be approved by the instructor.

Format for the Term Paper (1.5 space, ~10 pages excluding the title page and the References):

1. Title page
2. Objective
3. Approaches
4. Outcome
5. Discussion
6. References

Include flow-chart, diagram and table in the paper as necessary.

NOTE: Any indication of Plagiarism will result in a grade of zero.

Experience in nucleic acid methodologies: If possible the graduate students are expected to gain experience in the following simple and basic methodologies:

1. Identification of genetic strains of *E. coli* commonly used for recombinant DNA technology
2. DNA purification (chromosomal and plasmid)
3. Concentration and quality of purified DNA
4. PCR methodology
5. Gel electrophoresis
6. Plaque assay