

**TEXAS A&M UNIVERSITY-CORPUS CHRISTI  
GENOMICS, PROTEOMICS AND BIOINFORMATICS  
BIOL 4340.001**

**SYLLABUS**

**DATE:** Fall Semester 2007 (8/22 - 12/4)

**MEETINGS:** BH 113 M,W 2:00 - 3:15 PM

**INSTRUCTOR:** Dr. Kirk Cammarata (Office ST 317, Ph. x2468; Lab NRC 3227, Ph. x2145; Home Ph. 906-2401-till 10:30 PM only)  
[Kirk.cammarata@tamucc.edu](mailto:Kirk.cammarata@tamucc.edu)

**OFFICE HOURS:** [Subject to change pending advance notice]  
M 11:15 - 12:00  
T 8:30 - 9:30  
F 11:15- 12:00

***Please note that you are welcome to come by my office or lab at anytime, though you may wish to call first. I will be glad to help you if I am not busy.***

**COURSE DESCRIPTION:** An introduction to integrative biological study using genome-wide approaches and bioinformatics. The “-omics” technologies (Genomics, Proteomics, Metabolomics, etc.) will be surveyed for current and potential contributions to understand biological function at molecular, cellular, organismal and even ecosystem levels.

**PREREQUISITES:** Genetics (BIOL 2416) *and* either Cell Biology (BIOL 3410) or Biochemistry I (CHEM 4401) *or* Molecular Biology (BIOL/BIMS 3403) [or equivalent]

**REQUIRED TEXTS:** **Genomes 3**  
T.A. Brown (2006)  
Garland Science Publishing; ISBN 0-8153-4138-5

**Microarray Gene Expression Data Analysis: A Beginner's Guide**  
H. C. Causton, J. Quackenbush and A. Brazma (2003)  
Blackwell Publishing; ISBN 1-40510-682-4

**Additional Readings will be assigned in class.**

**OPTIONAL:** Genetics, Molecular Biology, Biochemistry or Cell Biology texts will be useful references

**ATTENDANCE:** Attendance is mandatory. Participation will be an important part of class

**The Course Goals are:**

1. To discover a new “systems” approach to biology in which organisms and even ecosystems are viewed from a molecular perspective.
2. To understand how the function of organisms can be understood at the levels of the genome, the transcriptome, the proteome and the metabolome.
3. To learn basic methodology associated with genomics, comparative gene expression studies, proteomics and metabolomics.
4. To understand the contributions of various genome projects.
5. To understand the role of bioinformatics in the application of the “-omics” technologies.
6. To survey basic methodology associated with sequence processing, comparative gene expression analysis, and data mining.
7. To review and appreciate the application of genomics and related technologies in medicine, agriculture and environmental studies.
8. To develop critical thinking and data analysis skills.

**LEARNING OUTCOMES AND COMPETENCIES:**

By the end of the course, students should be able to:

1. Conceptualize the function of organisms at the levels of the genome, the transcriptome, the proteome and the metabolome.
2. Describe the basic methodology associated with genomics, comparative gene expression studies, proteomics and metabolomics
3. Describe the utility of genome database projects in model and commercial organisms.
4. Describe basic methodology associated with sequence processing, comparative gene expression analysis, and data mining.
5. Describe the contribution and importance of bioinformatics in the application of the “-omics” technologies.
6. Describe applications of genomics technologies in medicine, agriculture and environmental science.
7. Critically evaluate the quality and utility of genomic data.

**EVALUATION:** (Tentative - subject to change; Grading on 10 % Scale)

Your final grade will be based on the percentage you earn out of the total possible points. Individual extra credit is not possible, but extra points may be built into exams or other assignments. Statistical manipulations, *if used* (at the Instructor's discretion), will be performed only once, at the end of the semester. A 10-point grading scale will be used:

**A = 90 - 100 %**

**B = 80 - 89.9 %**

**C = 70 - 79.9 %**

**D = 60 - 69.9 %**

**F = 0 - 59.9 %**

Mid-term Exam	=	150 pts
Final Exam	=	150
4 Quizzes @ 25 pts	=	100
Special Assignments	=	175
Class Participation	=	75
<b>TENTATIVE TOTAL</b>	<b>=</b>	<b>650</b>

The time schedule may require adjustment. Additional assignments may or may not be provided at the Instructor's discretion. Such assignments might include homeworks, group projects, reading assignments, quizzes, etc. *An assignment may be due during the last week of class (Study Week)*. Every attempt will be made to follow the time and evaluation schedules shown here. **It is the student's duty to attend each class session and be aware of all assignments, deadlines, etc.**

### **SPECIAL PROJECTS**

- 1. Microarray Data Processing:** Students will analyze source microarray expression data from the instructor using MagicTool software. Screenshots of the analysis results will be prepared with a brief explanation.
- 2. Microarray Data Mining Project:** Each student team will use one particular analytical algorithm from the "Gene-Linker Gold" Software platform to mine a microarray gene expression dataset. The students will learn and present the theory and application of that algorithm to the class, along with their findings, in a PowerPoint presentation.
- 3. Application of Genomics:** Each student will present to class, using PowerPoint, an application of genomics to some field of biology. A genomics textbook may serve as the starting point for the presentation, but the student is expected to present information garnered from other publications, including primary research articles. Web accessed resources may be used as well.

**Other Course Requirements:**

**1. All Exams are the property of the Instructor as they must be saved for course records.**

**2. ALL STUDENTS ARE REQUIRED TO SUBSCRIBE TO THE GENOMICS LISTSERV.**

To subscribe, send an e-mail to "[genomics-list-request@sci.tamucc.edu](mailto:genomics-list-request@sci.tamucc.edu)". Make sure that your e-mail address appears in the "From:" heading, and that the word "subscribe" is typed in the subject line. You will receive a subscription acknowledgement confirming that you have done everything correctly. To post messages to the listserv, send to "[genomics-list@sci.tamucc.edu](mailto:genomics-list@sci.tamucc.edu)". **Because of security concerns, you must post messages from the computer account that was used to subscribe to the listserv. You should use your official University email ([firstname.lastname@islander.tamucc.edu](mailto:firstname.lastname@islander.tamucc.edu)) for all correspondence.** At the end of class, please send an e-mail to "[genomics-list-request@sci.tamucc.edu](mailto:genomics-list-request@sci.tamucc.edu)" With "unsubscribe" in the subject heading. Please use this service to ask questions about class materials, dates, assignments, etc.

You are strongly encouraged to subscribe to the Opportunities Listserv using the same procedure: "[opportunities-list-request@sci.tamucc.edu](mailto:opportunities-list-request@sci.tamucc.edu)" This service provides notification of scholarships, research opportunities and science-related job opportunities.

**3. Attendance is required and counts towards your participation points. Assignments cannot be made up later if absent without a *recognized* excuse (see below).**

**4.** You should do the specified readings BEFORE coming to class for coverage of that topic. Lecture will consist of an overview, answering questions and problem-solving. The PPT notes may not be reviewed in comprehensive detail except in regard to specific questions. Quizzes will be used to make sure you stay on-track. You must take the responsibility for your education.

**5. Other Expectations:**

You are expected to attend all classes and labs in a timely manner. It is expected that you will take notes, ask/answer questions, and participate in group activities. Learning is more than spoonfeeding, memorization and regurgitation. While memorizing is an important first step, you should also be able to apply knowledge by linking data and synthesizing into useful concepts.

You are responsible for your own education. Take notes in class as some new information may be presented. Lecture notes from the instructor, when made available, do not represent everything you need to know. Read the book and handouts for further detail not covered in class, and to be prepared for laboratory. If you don't understand, then please ask, or see the instructor after class. **Don't allow yourself to fall behind. Be diligent and thorough on written assignments and examination answers.** If you

are not sure of an answer, at least try. For many people, putting anything down on paper clarifies their thinking and helps with recall. Also:

- Be aware of university-imposed deadlines (ie drop dates)
- Be aware of test times and dates, including changes
- Check your answers against a key as soon as possible. Check for clerical errors. The test score is not the end of the learning process. Review tests to determine why you missed an answer. Correcting your mistakes is an effective way to learn material (*reflective learning*).
- Work on all assigned homework problems in a timely manner. Seek tutorial help in the TLC or from the Instructor.
- Keep track of your progress in class.

**Exams** will comprise multiple choice questions, matching and short answer/essay-type questions. A take-home component may be included, and it may require computer access and analysis of data. Some questions typically require analysis and interpretation of data or experimental design to assess critical thinking skills. The **Final Exam will be held on Monday Dec 10 1:45 – 4:15 PM.**

**Outside reading** will be assigned and provided on reserve at the library or via WebCT. **PPT lecture** notes will be made available on WebCT. **Homeworks** may be assigned in class from the text or from handouts. You are encouraged to get together and work on problem-solving as a group. However, any assignments must be turned in individually and be written *in your own words, NOT COPIED from someone else.*

All assignments and examination answers must be legible to the Instructor. Illegible answers will receive a "0".

#### **Rules:**

All TAMUCC policies are in force and described in the TAMU-CC catalog and in the Student Handbook.

#### **Policy on Academic Dishonesty:**

Academic dishonesty, in all its forms, including plagiarism, is not tolerated. Students found responsible for violating this rule WILL be prosecuted to the fullest extent of University Regulations (see the current TAMU-CC catalog). The following procedures will be enforced:

- You must be prepared to present a photo ID at all examinations
- Different test forms may be prepared for a single examination. Follow instructions
- If you leave an examination room—for any reason—you must hand in your test and you will not be allowed to resume the examination. Attend to personal matters (e.g., rest room visits) before the examination.

**Attendance Policy:**

Attendance is the student's responsibility. You are responsible for the material covered in every lecture, even if it is not in the book, regardless of your attendance. **Nothing** missed during an **unexcused** absence can be made up. An excused absence allows us to make alternative arrangements to complete an assignment. Only **unavoidable** absences are excused. Routine events (non-emergency medical visits, parent-teacher conferences, household or auto repairs) should be scheduled to avoid conflicts with class. Plane tickets booked to conflict with class do NOT constitute an excusable absence. An acceptable excuse *must* be:

- from an appropriate source (doctor, dentist, funeral director) who states the nature of the event
- In writing, on official letterhead, and signed (it will not be returned)
- **presented prior to**, or within 1 week of, the absence

**Disabling Conditions:** The Biology Program complies with the Americans with Disabilities Act in making reasonable accommodations for qualified students with disabilities. If you suspect that you may have a disability (physical impairment, learning disability, psychiatric disability, etc.), *please contact the Disability Services Office as soon as possible* (located in Driftwood 101, 825-5816). Do not wait until it is too late ! Please obtain an accommodation letter from TAMU-CC *Disability Services Office* and then see the course instructor. It is important that you contact them in a timely fashion as it may take several days to review requests and prepare accommodations.

**Learning Resources:** A CD-ROM, *The Art of Genomes 3*, is packaged with your textbook and contains all of the textbook figures in both PPT and jpeg formats. These may be useful for preparation of your PPT class presentations. As a study tool, you could scroll through the figures and practice explaining each one.

The textbook has a number of features to facilitate your learning. Each chapter starts with a list of learning outcomes. Key Terms are highlighted in bold text and explained in an illustrated glossary at the back of the book. A list of abbreviations is in the front of the book.. A list of Further Readings can be found at the end of each chapter. Each chapter also has a "Technical Notes" section which focuses on the experimental techniques used in genomics. Each chapter ends with a series of multiple choice, short answer and in-depth problems. Answers to odd numbered questions are at the back of the book.

**An emphasis of the course is to stimulate you to integrate your knowledge and apply it to unfamiliar situations.**

There is also a publisher-based website associated with the textbook: [www.classwire.com/garlandscience](http://www.classwire.com/garlandscience) . This site contains links to additional resources from a variety of related textbooks.

Updated PowerPoint lecture notes, supplementary materials (eg readings, Study

Guides for exams, etc) and assignments will be posted on the WebCT site for this course (WebCT Help x2825).

### HELPFUL REFERENCES:

(All will be accessible in Dr. Cammarata's office or on reserve in the Bell Library, and can be used there. You may borrow overnight with permission of the instructor.)

- 1) Principles of Biochemistry  
Lehninger, Nelson and Cox (2000) 3<sup>rd</sup> Ed., Worth Publishers
- 2) Biochemistry, 2<sup>nd</sup> Ed.  
D. Voet and J.G. Voet (1995) John Wiley and Sons, Inc.
- 3) The Biochemistry of the Nucleic Acids  
R.L.P. Adams, J.T. Knowler, and D.P. Leader (1992) 11th. edition,  
Chapman and Hall
- 4) Genome: The Autobiography of a Species in 23 Chapters  
M. Ridley (1999) Fourth Estate Ltd.
- 5) Fundamental Concepts of Bioinformatics  
D.E. Krane and M.L. Raymer (2002) Benjamin Cummings
- 6) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins  
A.D. Baxevanis and B.F.F. Ouellette, Eds., Vol. 39, Methods of  
Biochemical Analysis, 2<sup>nd</sup> Ed. (2004) John Wiley and Sons, Inc.
- 7) Bioinformatics for Dummies  
J-M Claverie and C Notredame (2003) Wiley Publishing Inc. .
- 8) Molecular Biology of the Cell, 5<sup>th</sup> ed.  
B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts & J.D. Watson (2004)  
Garland Publishing
- 9) Molecular Cell Biology, 4<sup>th</sup> ed.  
H. Lodish, D. Baltimore, A. Berk, S.L. Zipursky, P. Matsudaira & J. Darnell  
(2004) W.H. Freeman & Co.
- 10) Structure and Mechanism in Protein Science  
A. Fersht (1999) W.H. Freeman and Co.
- 11) Structure in Protein Chemistry  
J. Kyte (1995) Garland Publishing, Inc.

- 12) Crystallography Made Crystal Clear  
G. Rhodes (1993) Academic Press, Inc.
- 13) Proteins: Analysis and Design  
R.H. Angeletti, ed. (1998) Academic Press, Inc.
- 14) 2-D Proteome Analysis Protocols  
A.J. Link, ed. (1999) Humana Press, Inc.
- 15) Introduction to Protein Architecture  
A.M. Lesk (2001) Oxford University Press
- 16) Biochemistry and Molecular Biology of Plants  
B.B. Buchanan, W. Gruissem, and R.L. Jones (2000) American Society of Plant Physiologists, Rockville, MD.
- 17) Principles of Genome Analysis and Genomics  
S.B. Primrose and R.M. Twyman (2003) 3<sup>rd</sup> Ed., Blackwell Publishing
- 18) Advanced Genetic Analysis: Finding Meaning in a Genome  
R.S. Hawley and M.Y. Walker (2003) Blackwell Publishing
- 19) Essential Genetics: A Genomics Perspective  
D.L. Hartl and E.W. Jones (2002) Jones and Bartlett Publishers
- 20) Genetics: Analysis of Genes and Genomes  
D.L. Hartl and E.W. Jones (2000) 5<sup>th</sup> Ed., Jones and Bartlett Publishers
- 21) Genetics: From Genes to Genomes  
L.H. Hartwell, L. Hood, M.L. Goldberg, A.E. Reynolds, L.M. Silver, and R.C. Veres (2004) 2<sup>nd</sup> Ed., McGraw-Hill
- 22) Discovering Genomics, Proteomics and Bioinformatics, 2<sup>nd</sup> Ed. A.M. Campbell & L.J. Heyer (2006) CSHL Press/Benjamin Cummings; ISBN 0-8053-4722-4
- 23) Essentials of Genomics PPT CD, P.N. Benfey & A.D. Protopapas (2005)  
Pearson Education, ISBN 0-13-047018-X
- 24) Molecular Biotechnology B.R. Glick & J.J. Pasternak (2003) ASM Press, ISBN 1-55581-224-4
- 25) Bioinformatics: Sequence and Genome Analysis, 2<sup>nd</sup> Ed. D.W. Mount (2004)  
CSHL Press ISBN 0-87969-687-7



**Computers:** Both web and PC based software and resources will be used in this course.

## **COURSE OUTLINE AND TOPIC SEQUENCE**

### **Genomics Introduction (B1; C pp1-6)**

- Course overview
- Introduction to a genomic perspective-scale and “Systems Biology”
- What is genomics ?
- Different fields of genomics – the “-omics” technologies
- Genome projects

### **Basic Review of Genetics, Information Flow Via the Central Dogma, and Molecular Methodology (B1, 2; Consult your reference textbooks if necessary))**

### **Genome Projects (B3, 4; Video)**

- DNA Sequencing
- Sequencing strategies and history of Human Genome Project (HGP)
- Mapping genomes
- Large-scale sequencing/High Throughput approaches
- Assembling genome sequences

### **Understanding/Interpreting Genome Sequences (B5)**

- Locating genes
- Bioinformatics I: Comparing sequences
- Determining functions: *In silico and experimentally*
- Annotation of genomes
- Databases

### **Functional Genomics: Understanding How a Genome Functions (B6)**

- Regulation of Gene Expression: Transcriptomics vs Proteomics vs Metabolomics
- Transcriptomics and DNA Microarrays (Causton et al. text)
  - Experimental design
  - Image processing
  - Data Analysis
  - Hands-on experience with MagicTool 2.0
  - Hands-on experience with GeneLinker Gold
  - Other techniques and applications of microarrays
- Proteomics: Protein Expression Profiling
  - Separation & Identification
  - 2-D gels
  - Automated Technologies: Mass Spec

Protein-Protein Interactions (Interactome)  
Metabolomics  
Integration into Gene Networks

**Comparative Genomics: Understanding the Structure and Evolution of Genomes  
(B7, 8, 9, 18, 19)**

Bioinformatics II: Comparing sequences  
The human genome  
Lessons from other genome comparisons  
    *E. coli*  
    *Buchnera*  
    Pathogenicity  
Acquisition of new genes  
    Transposable elements  
    Horizontal transfers  
    Duplications & repeated sequences  
    Introns  
Phylogenetics  
Evolution of humans  
Recent/ongoing evolution in humans  
SNPs, Disease and Pharmacogenomics

**IMPORTANT DATES:**

<b>Aug. 22</b>	<b>Classes begin</b>
<b>Sept 3</b>	<b>Labor Day (Campus Closed)</b>
<b>Sept 7</b>	<b>12<sup>th</sup> Class Day: Last day to drop w/o record entry</b>
<b>Oct 26</b>	<b>Last day to drop with a "W"</b>
<b>Nov 22-23</b>	<b>Thanksgiving Break (Campus Closed)</b>
<b>Dec 4</b>	<b>Last day of classes</b>
<b>Dec 10</b>	<b>Final Examination (1:45 - 4:15)</b>

**Week 4: Quiz 1**  
**Week 6: Quiz 2**  
**Week 8: Midterm Exam**  
**Week 10: Quiz 3**  
**Week 13: Quiz 4**  
**Dec 10: Final Exam**

**Projects Due: TBA**

**TENTATIVE SCHEDULE**

Please note that this schedule is subject to change. Changes will be announced

in class. It is your responsibility to attend class and be aware of changes.

<u>Week</u>	<u>Lecture</u>	<u>Date</u>	<u>Topic</u>	<u>Chapters</u>	<u>Notes</u>
1	1	8/22	Introduction to Genomics The Genomic Perspective Genome Projects	P 1 C pp 1-6 C&H: Foreword, Preface, p.1	
2	2	8/27	Complexity of Biological Problems; Case Study: Obesity	C&H 11	
	3	8/29	Genome Projects Large-Scale Sequencing Sequencing Approaches	C&H 1	Green Paper; Videos
3		9/3	<b>Labor Day Holiday</b> Mapping Genomes; Assembling		
	4	9/5	Working With Sequences: Bioinformatics I	C&N	
4	5	9/10	Working With Sequences: Bioinformatics II	C&N	
	6	9/12	HGP Sequences	C&H 1	<b>Quiz 1</b>
5	7	9/17	Applications of Genomic Information	C&H 2	
	8	9/19	Genomic Information	C&H 2	
6	9	9/24	Genomic Variations	C&H 3	
	10	9/26	Genomic Variations	C&H 3	<b>Quiz 2</b>
7	11	10/1	Expanded Central Dogma DNA Microarrays	C 1 C&H 4	
	12	10/3	Microarray Exptl Design	C 2; C&H 4	
8	13	10/8	Microarray Image Processing	C 3; C&H 4	
		10/10	<b>Midterm Examination</b>	C&H 1-5 C 1-4; P 1	

<u>Week</u>	<u>Lecture</u>	<u>Date</u>	<u>Topic</u>	<u>Chapters</u>	<u>Notes</u>
9	14	10/15	Microarray Data Analysis	C 4; C&H 4	
	15	10/17	Applications of Microarrays	C&H 5	
10	16	10/22	Applications of Microarrays	C&H 5	
	17	10/24	Grad Students Present Project #2		<b>Quiz 3</b>
11	18	10/29	The Proteome	C&H 6	
	19	10/31	Protein Structure & Function	C&H 6	
12	20	11/5	Protein Expression Patterns and Interactions	C&H 6	
	21	11/7	Protein Techniques	C&H 6	
13	22	11/12	The Metabolome	Assigned	
	23	11/14	Gene Circuits	C&H 7	<b>Quiz 4</b>
14	24	11/19	All Students Present Projects		
	25	11/21	<b>THANKSGIVING HOLIDAY</b>		
15		11/26	Integrated Genomic Circuits and Regulation	C&H 8	
	26	11/28	"Systems" Biology, Modeling Genome Circuits	C&H 9	
16	27	12/3	Students Present Projects: Applications of Genomics		
	28	12/10	<b>FINAL EXAM 1:45 – 4:15</b>		

\* B Brown text: Genomes 3

\* C Causton, et al. text: A Beginner's Guide to Microarray Data Analysis

**General Disclaimer:**

The Instructor reserves the right to modify the schedules and policies in this syllabus if and when necessary.