# General COVER SHEET FOR A NEW COURSE PROPOSAL

Submit 12 copies of the completed form with attachments to the Chair of the Curriculum Committee.

| **DESCRIPTION OF PROPOSED COURSE** | | | |
|---|---|---|---|
| Submitted By: Theresa M. Grana | | Date Prepared: | August 27, 2012 |
| Course Title: | Bioinformatics | | |
| Department/discipline and course number*: | | BIOL 444 | |

**This course number must be approved by the Office of the Registrar before the proposal is submitted.*

| Number of credits proposed: | 3 | Prerequisites: | BIOL 340, BIOL 341 | | | | |
|---|---|---|---|---|---|---|---|
| Will this be a ***new***, *repeatable* "special topics" course? (Do you want students to be able to take this new course more than once if the topic changes?) | | | | **NO** **X** | | **YES** | |

| Date of first offering of this ***new*** course: | | | Spring 2013 | | |
|---|---|---|---|---|---|
| Proposed frequency of offering of the course: | | | Every other year or every third semester | | |
| List the faculty who will likely teach the course: | | | Theresa Grana | | |
| **New Library resources** required? | **NO** | *X* | **YES** | | *Explain all resource needs in the attached rationale statement.* |
| **New space or equipment** needed? | **NO** | *X* | **YES** | | |

| **This new course will be (check all that apply):** | | | |
|---|---|---|---|
| Required in the major | | General Elective | |
| Elective in the major | X | General Education** | SI |

***AFTER the new course is approved, a separate proposal must be sent to the General Education Committee.*

**Catalog Description:** BIOL 444: *Bioinformatics* Prerequisites: Biology 340 and 341. An exploration of the rapidly growing genomics approaches to biological problems. Areas of study include genome sequencing, comparative genomics, functional genomics, and diversity. Students complete three research projects based on primary literature and utilize bioinformatics approaches to analyze original data. Class time is spent on discussions, on student presentations of research project results, and in collaborative work.

| **COURSE HISTORY** | | | | | | |
|---|---|---|---|---|---|---|
| Was this course taught previously as a topics or experimental course? | **YES** | X | | **NO** | | |
| **Course Number and Title of Previous Course** | **Semester Offered** | | | **Enrollment** | | |
| BIOL 471V | Fall 2009 | | | 13 | | |
| BIOL 471V | Spring 2011 | | | 8 | | |
| | | | | | | |

| X | **CHECK HERE** if the proposed course is to be ***equated*** with the earlier topics or experimental offerings. This means that students who took the earlier "topics" course will only be able to take the new course if they made a C- grade or lower in the earlier course. |
|---|---|

***NOTE:*** If the proposed course has not been previously offered as a topics or experimental course, **explain in the attached course justification** why the course should be adopted even though it has not been tried out.

**REQUIRED ATTACHMENTS:**

1. **Rationale statement** (Why is this course needed? What purposes will it serve? Resources needed?)
2. **Major Program Impact** (Explain how the new course affects major requirements. If major requirements have been changed recently, how will this course affect prior major requirements?)
3. **Sample Syllabus**

**Department Chair Signature:** Andrew Dolby **Date:**

CCC Chair: Bradley Hansen Date Sep. 19, 2012

2 September, 2012

**Rationale statement** for BIOL444: *Bioinformatics*

The Department of Biological Sciences seeks to have *Bioinformatics* established as a 400-level elective, offered every other year, or every three semesters. Bioinformatics has been offered successfully as an upper-level topics course. This course was developed in response to how biology has changed over the past 15 years, and a primary reason why I was hired by the department was specifically to add bioinformatics to the biology curriculum.

*Why Bioinformatics should be offered to college students:*

Bioinformatics is a broad and growing area of study that involves using computers to access and interpret the vast amounts of biological data present in online databases, such as the data generated in the Human Genome Project. Because bioinformatics is rapidly developing and relatively new, it is not covered adequately in most undergraduate textbooks and courses. However, researchers use bioinformatics in nearly every area of modern biology, including studies of diversity, evolution, and medical genetics. The impact and utility of bioinformatics makes it an important area for undergraduate students to study.

*Why Bioinformatics should be offered at UMW:*

*Bioinformatics is increasingly offered in the modern biology curriculum:* Most colleges offer a bioinformatics course. Some offer bioinformatics degrees (see http://www.nslijgenetics.org/bioinfotraining/). If we do not offer bioinformatics, we may lose good students to bioinformatics programs at Virginia Commonwealth University or other regional universities.

*The topic of this course is not covered in other courses:*

This course focuses on genomics, a topic not covered in detail in any other UMW course. One other course, BIOL443: *Biology and Biochemistry of Proteins*, spends some time on protein bioinformatics, but does not cover genome bioinformatics at all. (Another course, BIOL125,126: *Phage Hunters I & II*, introduces genomics to a small group of freshmen, but it cannot be taken by biology majors for credit if they have completed the introductory course BIOL121,122: *Biological Concepts*. Also, *Phage Hunters* is academically designed for freshmen, not juniors and seniors.)

*Preparation of our students for graduate school:* A strength of the biology major at UMW is the breadth of courses offered. Bioinformatics adds to this strength. Several students who have taken the topics course with me are now enrolled in bioinformatics graduate programs.

*The course format is a capstone-like experience for Biology majors:*

Bioinformatics has been a great learning experience for my students and for me. It is a small, project-based course that involves collaboration, group discussions, and student presentations. Many students choose to attend small liberal arts universities for the same reasons why the bioinformatics course is a great learning experience: small class size, immersion in primary literature, exploration of current research, extensive time for discussion, review and application of biology fundamentals, and a chance to develop as a creative and critical thinker. Bioinformatics allows students to build upon what they have learned in other courses and extend their research skills.

(I plan to apply for SI status for this course due to its speaking-intensive format.)

2 September, 2012

**Resources:** No new resources are needed for the class as most students use their own laptops to access bioinformatics databases during class. In addition, for data analysis heavy days, we can continue to use the Jepson 108 computer lab. When the Convergence Center is complete, a dedicated classroom computer lab for this course would be beneficial.

**Past enrollment:**

Optimal enrollment for this course is 12 students. Because it was offered after two semesters rather than three and because most students are unaware of what bioinformatics is, the enrollment was a bit low the second time. Overall, as an advanced, research project-based course, the enrollment level has been appropriate.

**Major Program Impact:**

This course would be an elective in the biology major. As an elective in the major that has been taught in two of my four previous years at the University, the course would not have an impact on the requirements of the biology major.

2 September, 2012

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# BIOINFORMATICS

**BIOL444**

*http://bioinformatics.umwblogs.org/*

**Spring 2011/Working syllabus for 2013**
Jepson 313
MWF 2-2:50 PM
3 credits

Theresa Grana, PhD
tgrana@umw.edu, x1196
Office Hours MW3-4, R1-3, F9:30-10:30
or by appointment; Jepson 436

## Learning Objectives

By the end of this course you will:

Understand how biological information is encoded in a genome and how genomes are studied.

Be able to accurately and efficiently extract genetic and genomic data from public databases, taking in to consideration the limitations of available data.

Have developed approaches to solving biological problems using Bioinformatics.

Employ good science & computing practices, including maintaining an online record of your work, managing files, and backing up your work.

Effectively communicate with others about complex biological problems and work collaboratively with others.

Read and interpret primary literature in bioinformatics.

Critically evaluate your own experiments and those of others.

Work in areas outside of your own areas of expertise in biology and computing, gaining the knowledge and skills you need as you go along. Be willing to use trial and error to figure out how different bioinformatics software works.

Be comfortable with the open-ended nature of biological problems. (Choose to leave the museum and journey to new places with many paths and opportunities.)

## About The Course: Bioinformatics

Bioinformatics is a huge and rapidly growing field that influences every area of biology and medicine. The definition of bioinformatics is a subject of contention, but we will consider it to be the use of computers to characterize living things at a molecular level. Paramount to our work in bioinformatics is use of the various online databases that house biological information, including the National Center for Biotechnology Information (NCBI) databases.

This course will not be a survey of all the areas of bioinformatics. We will focus on solving current biological problems in the sub-discipline of genomics. Since we will focus on problems, you are expected be self-motivated to find ways to answer the questions we focus on. We will work together to make sure all the resources needed are available.

Because this course is designed to be a stepping-stone to graduate level work, your projects will be more similar to independent research experiences than most courses.

This course will involve three original research projects. Because of that, it will feel like research. You will at various times be: frustrated, working really hard, excited, bored, struggling to learn. You will also find that breakthroughs come suddenly and you will become better at handling complex problems by the end.

Like practicing researchers, you are expected to document your work and communicate your findings with others.

## Class expectations

This is an upper-level course. You are expected to be self-motivated to complete your work at a continuous, steady pace.

You are expected to participate during class. Non-participation includes use of your computers and cell phone for non-class activities during class and failure to prepare for class ahead of time.

You are expected to contribute to making the course effective for everyone in the class.

***Honor Code & Collaboration Policy***

Abide by the UMW Honor Code.

You are welcome to collaborate during many aspects of this course. Some course work will *require* group work.
When in doubt, ask your instructor for clarification. However:

- You must do your data analysis separately from other students (beyond sharing how to use a particular program or database).
- You must acknowledge outside sources and collaborators. Give credit to classmates that help you! Then if your collaborators mislead you, we'll know the source of the confusion. For citations, Zotero is strongly recommended.

You are expected to treat others with respect at all times. Part of working in a real-world environment is collaborating with others, even when they are difficult to work with.

## Texts and Materials

Required: a custom textbook for background knowledge. It is available only in the UMW bookstore, where it is listed as 'Biology Selected Material, Custom, Raven ISBN: 9781121041806.' This book consists chapters (13, 16, 17, 18, 23, 24, 26, 27) from *Biology, Ninth Edition* by Raven, Johnson, Mason, Losos, and Singer.

Bioinformatics is not covered by any current undergraduate text. The field changes too quickly.

You will find your work more efficient if you own your own laptop and bring it to class. A computer can be provided for you if you do not own a laptop. We will sometimes meet in Jepson 108, the computer lab.

Grades, pdfs of original articles, and class slides, & announcements will be posted on Blackboard. Additional online resources include the course website and numerous public databases and programs.

You will generate your own course materials in the form of an online Course Notebook (see below).

## How The Class Will Go

The course is divided into five units. For each unit, we will spend about a week or more learning about an important area of genomics. We will then build upon the background with readings from the primary literature. Journal Clubs and outlines will aid your understanding of the primary articles.

For three of the units, each student will develop and complete an individualized project extending from the paper we analyzed together. Students will analyze data from either the primary literature or unpublished data from Dr. Zies lab. This will give you experience in bioinformatics data analysis, scientific thinking, use of databases, and various sets of bioinformatics software.

During this class we will all learn from each other. This is not a class where everything we need to know is outlined in advance. It will sometimes be disorganized because we are doing something entirely new. Biology is messy. Getting used to uncertainty is part of maturing as a biologist.

Data in databases is updated continuously. Online software that we plan to use may suddenly be updated or unavailable. Your instructor cannot see into the future and so will be unable to anticipate these changes. We must all be adaptable. You will not be penalized for changes that are made in the course along the way.

## Course Notebook

A major part of the documentation of your work will involve keeping an online Course Notebook. This is included as part of the course for several reasons: it is how practicing bioinformatics researchers keep track of their work, it will serve as documentation of what you've learned, it will allow you to access your work on any computer.

The technology we will use for the notebook is umwblogs. You will create an individual user page and make blog entries at least once per week.

Your umwblogs website will have two functions. 1) Reflections on your learning. Each week you will answer questions such as:

What have I learned?
What isn't clear to me (yet)?
What should I spend time on next?

During the semester you should develop the ability to think deeply about your learning, figuring out what you don't know and need to spend more time on. You will be graded on your reflections.

The following guidelines will apply: You must submit one reflection each week with the category 'Reflection' appended to it. This category will cause it to feed into my blog. Each week will start on Sunday at 12:01 AM.

You will earn 12 points for each on time submission and no points for late submissions. The instructor will read and comment on how to improve your reflections, if needed.

2) For each project you will also make a separate Page on your blog where you will record what you have completed. On the page you should place your project title, a very basic outline of your method, and a short description of your findings. You should also list what didn't work. Because you will also present your work in an oral presentation or write a report, this website does not have to be detailed. Its main purpose is to help me gauge where you are in your work and where I can possibly be of help to you.

**Accommodations:** The Office of Disability Resources has been designated by the University as the primary office to guide, counsel, and assist students with disabilities. The disability resources office can be reached at 654-1266. If you need accommodations for this class make an appointment with me to discuss your approved accommodation needs. Please bring your accommodation letter with you to your appointment. All information will be kept confidential.

## Attendance policy

Class attendance and getting to class on time will affect the class participation grade. Missing class too often will adversely affect your grade beyond the class participation score due to the collaborative nature of course activities. Students who miss more than 6 of the class meetings will receive a maximum 50% for participation.

## Grading

There will be no tests in this class. Thus, your grades depend on your day-to-day work, class participation, and projectes.. Manage your time to complete your projects on time.

## Grading Scale

| | | | | | |
|---|---|---|---|---|---|
| A | 100-94 | B- | 83-80 | D+ | 69-67 |
| A- | 93-90 | C+ | 79-77 | D | 66-60 |
| B+ | 89-87 | C | 76-74 | F | < 60 |
| B | 86-84 | C- | 73-70 | | |

## Midterm grade policy

A score of 70% or below or poor attendance will be reported as a 'U' (unsatisfactory) at the mid-semester report.

Participation grades depend on your attitude, course contributions, original thoughts, timeliness, classmate's perceptions of your ability to work to others, and contributions to the class. Texting during class or lab is completely inappropriate and will not be tolerated. I will take off participation points.

*Components of Grades*

| **Activity/Assignment** | **Points** |
|---|---|
| Participation (9 points/week, 15 weeks ) | 135 |
| Course Notebook (12 points/week, 14 weeks + 5) = | 173 |
| Quizzes (15 points x 4) = | 60 |
| Lander Summary | 20 |
| Project 1 - HIV Data Analysis | |
| Markham Paper Outline | 20 |
| Markham Journal Club | 25 |
| HIV Presentation & Discussion | 20 |
| Comments for Classmates' Presentations | 10 |
| Your Research Paper | 30 |
| Altshulter Journal Club | 25 |
| Altshulter Summary | 20 |
| Project 2 - Microarray Data Analysis | |
| Merrell and Eckdahl discussion | 10 |
| Merrell Outline | 20 |
| Eckdahl Summary | 20 |
| Minute Talks | 15 |
| Microarray Analysis and Conclusions | 30 |
| Project 3 - Studies of Diversity | |
| Turnbaugh Diversity Project Paper | 30 |
| Turnbaugh Diversity Project Presentation | 40 |
| Total: | 673 |

| Week | | | Tentative Course Schedule | Assignments Due |
|---|---|---|---|---|
| 1 | M | Jan 10 | Introduction to Bioinformatics | |
| | W | Jan 12 | UMW Blogs, genetics and chromosome structure review | read p. 1-6, 11-15 |
| | F | Jan 14 | UMW Blogs Advanced Skills Sequencing | set up your Blog, read p. 41-46, 49-54 |
| 2 | M | Jan 17 | Martin Luther King Day - no class | |
| | W | Jan 19 | Sequencing & Base Calling, Sequence Assembly | Quiz 1 - Genetics; |
| | F | Jan 21 | *Speaking Center – Class Discussions* | read p. 6-10, 66-72 |
| 3 | M | Jan 24 | Annotation of Genomes, NCBI Databases *Good, Bad, and Ugly of PowerPoint* | read p. 72-75, begin Lander 2001 Article |
| | W | Jan 26 | **Class Discussion** of Lander Article/ Scientific Literature: context, interpretation, argument (stance) *Demonstration of Journal Clubs* | Lander Article Assignment |
| | F | Jan 28 | Class Exercise: Phage Genome Sequencing, Annotation, & Finishing | read p. 149-150 |
| 4 | M | Jan 31 | Tree Topology | Quiz 2 - Genome sequencing |
| | W | Feb 2 | Systematics and the Phylogenic Revolution | read p. 86-100 |
| | F | Feb 4 | Multiple Alignments, HIV Project Introduction | |
| 5 | M | Feb 7 | Tree Building | Quiz 3; read p. 100-101, 144-148, 151-154 |
| | W | Feb 9 | More on the HIV Project, Journal Club, and the Bioquest HIV Problem Space | Outline of Markham Paper |
| | F | Feb 11 | Markham Paper Journal Club I | **Presentations** |
| 6 | M | Feb 14 | Markham Paper Journal Club II | **Presentations** |
| | W | Feb 16 | Work on Project Questions & Explore Software | Project Questions |
| | F | Feb 18 | Work on Project in Class, Data loaded? | |
| 7 | M | Feb 21 | Project Presentations | **Presentations** |
| | W | Feb 23 | Project Presentations | **Presentations** |
| | F | Feb 25 | Project I Wrap-up | |
| 8 | | | Spring Break! | |

| | | | | |
|---|---|---|---|---|
| 9 | M | Mar 7 | Comparative Genomics Between Species | read p. 75-78, 104-118 |
| | W | Mar 9 | Genome Evolution, Analysis, Dot Plots | |
| | F | Mar 11 | NCBI Genome Workbench Software | |
| | | | | |
| 10 | M | Mar 14 | UCSC Databases, Introduction to Altshulter Article | Genome WB data |
| | W | Mar 16 | **Discuss** Altshulter Article: *Genetic mapping in human disease* | read Altshulter Article |
| | F | Mar 18 | **Journal Club Altshulter Article** | **Presentations** |
| | | | | |
| 11 | M | Mar 21 | **Journal Club Altshulter Article** | **Presentations** Altshulter Article Summary |
| | W | Mar 23 | Control of Gene Expression, review, Microarray Data Analysis | read p. 18-38, p. 46-48, 78-82, 114-116 |
| | F | Mar 25 | Techniques and Applications in Functional Genomics, Discuss Enard Article | read Enard Article |
| | | | | |
| 12 | M | Mar 28 | Microarray Data Analysis, clustering | read Merrell article |
| | W | Mar 30 | Microarray Data Analysis, Merrell article discussion | Outline of Merrell article |
| | F | Apr 1 | **Discuss** Eckdahl and Merrell articles | Read Eckdahl article |
| | | | | |
| 13 | M | Apr 4 | Introduction to Zies Lab Microarray Project | Eckdahl summary, Quiz 4 |
| | W | Apr 6 | Microarray Data Analysis in Class, Introduction to Minute Talks | |
| | F | Apr 8 | **Minute Talks** | Microarray Conclusions |
| | | | | |
| 14 | M | Apr 11 | Break: TED talk by J. Craig Venter, a bioinformatics celebrity. Videos: minimal Genome, synthetic biology, Sorcerer II (introduces diversity) | |
| | W | Apr 13 | The Tree Life, DNA Barcodes, MOTUs, Final Project Introduction | read 123-124, 127-141 |
| | F | Apr 15 | Work on Final Project: Diversity | read Turnbaugh paper |
| | | | | |
| 15 | M | Apr 18 | Work on Final Project: Diversity | |
| | W | Apr 20 | **Final Project Presentations** | **Presentations** |
| | F | Apr 22 | **Final Project Presentations** | **Presentations** |
| | | | | |
| 16 | M | Apr 25 | Final Paper Project due at 6:00 p.m., Jepson 436 | |