Undergraduate Curriculum Change Memo

Date: 03/07/2022

From: Charles Spencer, Department of Biological Sciences

Through: Bruce Cushing, Department of Biological Sciences

Through: Robert Kirken, College of Science

To: Committee Andrew Fleck, Chair University Undergraduate Curriculum

Subject: Addition of a new course – Introduction to Bioinformatics **BIOL 4300**

With the advance in technology, biological datasets are becoming increasingly large and complex. We have offered a new UG course in Bioinformatics to introduce students to these topics. The course has been offered three times as a BIOL 4395 new course with increasing enrollment each year, demonstrating the desire for a course such as this. We now propose to add this course to the catalog for permanent offering with a unique course number. This course will be listed as electives in all of our degree plans and may be added as a required course as we redesign some of our degree plans.

CURRICULUM PROPOSAL

APPROVAL PAGE

Proposal Title: Introduction to Bioinformatics

College: Science **Department: Biological Sciences**

DEPARTMENT CHAIR- Charles Spencer

I have read the enclosed proposal and approve this proposal on behalf of the department.

Charles T Spencer
2022.03.07 14:45:01
-07'00'

3/7/22

Signature **Date**

COLLEGE CURRICULUM COMMITTEE CHAIR – Nancy Marcus

I have read the enclosed documents and approve the proposal on behalf of the college curriculum committee.

N. Marcus

3-21-22

Signature **Date**

COLLEGE DEAN – Robert Kirken

I have read the enclosed documents and approve the proposal on behalf of the college. I certify that the necessary funds will be allocated by the college in support of this proposal.

Robert Kirken

3/21/22

Signature **Date**

Syllabus for Introduction to Bioinformatics BIOL 4300

BIOL 4395 Lectures: Mondays: Asynchronous on Blackboard
Wednesdays: Quinn Hall 206: In-person/Synchronous 4:30 pm - 5:50 pm
Lab/Homework Assignments: Online

Course Description:
The objective of this course is to teach how computational techniques can help with solving biological problems. Students will learn to efficiently use multiple genomics and bioinformatics tools, that are freely available, for the analysis of DNA, RNA and protein sequences and structure. No programming skills are necessary for this course. This interdisciplinary course would be helpful for students in the department of Biology, Computer Science, Mathematics and Chemistry who aspire to go to either graduate school or medical school, or plan to work in the Bioinformatics industry that has experienced exponential growth within the last decade.

Course Goals:
With successful completion of this course, students will:

1. Gain knowledge about the current genome sequencing techniques.
2. Understand how bioinformatics is related to biology and medicine.
3. Gain knowledge about DNA, RNA and protein sequences and structures.
4. Learn to gather and use information UCSC and ENSEMBL genome browser.
5. Be able to perform pairwise and multiple sequence alignments.
6. Gain knowledge on searching multiple sequence databases.
7. Be able to perform phylogenetic analysis.
8. Be able to predict genes.
9. Be able to analyze RNA and protein structures.
10. Learn how to design and analyze primers.

Instructor:

Dr. Sourav Roy
BRB 2.172(Office)
sroy1@utep.edu
Office hours: By appointment

Teaching Assistant
TBA

Course Resources:
The Recommended **textbook** for this course is **Essentials of Bioinformatics by Jin Xiong.** The course will be coordinated through a Blackboard course connection (access via **my.utep.edu**). Blackboard will provide an online syllabus, course calendar, course bulletin board, and some supplemental web sites and notes for lectures. Grades will also be presented through Blackboard.

Grades

This course will employ a variety of teaching methods according to the type and content of material presented. The class is composed of quizzes, assignments and exams for this course. Applicable core concepts taught previously will be assessed throughout the length of this course. Note that the points for a given graded event (assignment, quizzes, exams, etc.) will be weighted and adjusted per the percentage allocations as noted in the table below.

Quizzes: Most lectures will have an open-book, open-notes quiz at the end of the lecture.

Online Exams: Two online exams (45 mins each) will be composed of a combination of multiple-choice, true or false, matching, and/or short answer questions. Mid-term will have questions from materials covered in lecture and lab until the mid-term. Final exam would consist of questions from material covered after the mid-term.

Lab/Homework Assignments: Students will be given assignments for each lab section; they will use the bioinformatics tools (they will learn how to use these in the lectures) to complete the assignments. Their participation in these sections, as well as their demonstrated understanding of the readings' content and significance, will be assessed through their performance in the lab sections.

Assessments	Points	Percentage of Grade
Quizzes	50	25
Homework Assignments	50	25
Midterm Exam	25	25
Final Exam	25	25
Total	200	100

COURSE POLICIES

Class participation:
You are expected to attend the in-person or synchronous sessions, be prepared to answer questions about the assigned readings or other materials.

E-mail and Blackboard:
You are required to provide the teaching team with a UTEP e-mail address and check your UTEP e-mail and Blackboard daily. We will use your UTEP e-mail to contact you and you will use your UTEP e-mail to contact us as well. Do not use Blackboard for e-mail.

Dropping the course:
Students may drop the class and receive a W (withdrawal) on their transcript prior to April 1st, 2022. You must consult the instructor prior to dropping. Due to the University's six-drop rule, dropping the course may not be in your best interest. After April 1st, a drop will result in an F on your transcript. Receiving either a W or an F in any course may prevent you from meeting the satisfactory Academic Progress requirements necessary to receive financial aid.

Student Conduct:
Each student is responsible for notice of and compliance with the provisions of the Regents' Rules and Regulations, available at http://www.utsystem.edu/bor/rules/homepage.htm. All students are expected to behave as courteous, responsible adults. We will have frequent

discussions and students are expected to tolerate and respect the opinions of others.

Cellular and electronic devices:

Cell phones and other electronic and recording devices must be turned off during class time to minimize classroom disruptions and protect the integrity of test-taking situations. This means you cannot make calls, send text messages, or use social media during class. You may use your laptop or tablet to take notes in class, but this privilege will be revoked if the devices are used inappropriately.

Students who fail to follow this rule may incur disciplinary action up to and including dismissal from the class and upon repeated offenses, the course.

Final Exam:

[From the online Schedule of Classes] "Exemption from final examination may not be given." Final examinations will take place during the final examination period. It is the policy of the university not to administer a second final examination in the course. It is also university policy that students shall not have more than two final examinations in a single day. In the unlikely event that the examination schedule results in a student having three final examinations on a single day, the faculty member upon the request of the student shall reschedule the second of that student's three examinations."

Academic Integrity:

All graded assignments must be entirely the work of the individual student. "Plagiarism" means the appropriation, buying, receiving as a gift, or obtaining by any means another's work and the unacknowledged submission or incorporation of it in one's own academic work offered for credit, or using work in a paper or assignment for which the student had received credit in another course without direct permission of all involved instructors. (from the Regents' Rules and Regulations) Plagiarism is a serious violation of university policy and will not be tolerated. All cases of suspected plagiarism will be reported to the Dean of Students for further review.

Disability accommodations:

If you have or suspect you might have a disability and need an accommodation you should contact the Center for Accommodations and Support Services (CASS) at 747-5148 or at cass@utep.edu or go to Room 106 Union East Building. Students are responsible for providing any CASS accommodation letters and instructions.

Campus Carry:

Persons holding a Concealed Handgun License can lawfully carry their handgun into a UTEP classroom as long as the gun remains concealed. Open carry remains prohibited on campus. In other words, none of us should see (or be able to tell that there is) a gun at UTEP. Call the University Police at 747-5611 or dial 911 if you see any individual on campus with a handgun or other type of weapon. For more information on campus carry, see [http://sa.utep.edu/campuscarry/]; for more information on overall campus safety, see [http://admin.utep.edu/emergency].

Military Statement:

If you are a military student with the potential of being called to military service and /or training during the course of the semester, you are encouraged to contact us no later than January 27.

*** Disclaimer: This syllabus may be changed as necessary at the discretion of the instructor.

Course Outline

Jan 19. Basics of genomics and bioinformatics:
Session 1 : Synchronous
Central Dogma (DNA –> Transcription –> RNA –> Translation -> Protein)
Describe gene and genome.
What is genomics?
What is Functional genomics and Comparative genomics?
Describe proteome.
What is proteomics?
Describe homologs, orthologs and paralogs
What is bioinformatics?

Week of Jan 24: Introduction to biological databases:
Session 2: Asynchronous
What is a database?
Types of databases
Biological databases
Pitfalls of biological databases
Information retrieval from biological databases
Session 3: Synchronous
What are sequence databases?
Different types of sequence formats – FASTA, GENBANK, EMBL etc.
Major sequence databases
How to retrieve sequences from different databases
Sequence matrices
How to search for unknown gene using BLAST
How to search for unknown protein sequences using InterProScan

Week of Jan 31. Human genome and browsers:
Session 4 Asynchronous
Genome sequencing methods
Sequencing of the Human genome
Genome browsers
Session 5 Synchronous
How to navigate and use the UCSC genome browser
ENSEMBL browser

Week of Feb 7. Pairwise Sequence alignment:
Session 6 Asynchronous
What is sequence Alignment?
Global alignment and local alignment
What information can be gathered from sequence alignment
Methods of pairwise sequence alignment
Session 7 Synchronous
Scoring matrices and gap penalties in sequence alignment
Pairwise alignment with Blast2seq

Week of Feb 14. Multiple Sequence alignment:
Session 8 Asynchronous
Methods of multiple sequence alignment
Structural or evolutionary alignment?
How to align multiple sequences
Session 9 Synchronous

Global multiple sequence alignment with CLUSTAL Omega, T-COFFEE
Local multiple sequence alignment

Week of Feb 21. Sequence polymorphism:
Session 10 Asynchronous
Overview of molecular evolution
Origins of polymorphisms
Types of polymorphisms
Session 11 Synchronous
SNP discovery methods
Genotyping
The international haplotype map project

Week of Feb 28. Review and Midterm
Session 12 Asynchronous
Review
Session 13 Online
Midterm

Week of March 7. Phylogenetic analysis:
Session 15 Asynchronous
Relation between phylogenetic analysis and multiple sequence alignment
Methods for phylogenetic prediction
Genome complexity and phylogenetic analysis
Methods of phylogenetic prediction
Session 16 Synchronous
Phylogenetic trees: reliability and uses
Forms of tree representation
Phylogenetic programs
Building phylogenetic trees – Phylogeny.fr

Week of March 14: Spring Break

Week of March 21. Gene finding/prediction:
Session 17 Asynchronous
Introduction
Prokaryotic and Eukaryotic gene prediction
Open reading frame and its reliability
Gene prediction methods
Gene prediction Programs
Session 18 Synchronous
Exon, intron, UTRs, promoters
Gene prediction with GeneMark, GENSCAN

Week of March 28: Promoter and regulatory element prediction:
Session 19
In-class/Take-home assignment
Session 20 Synchronous
Promoter and regulatory elements in Prokaryotes
Promoter and regulatory elements in Eukaryotes
Prediction Algorithms

Week of April 4. RNA sequences: prediction and analysis of structures:
Session 21 Asynchronous
Basics of RNA secondary structure

Features of secondary and tertiary structure
RNA folding: Sequence and base pairing patterns
Free energy determination
Levels of prediction (pseudoknot free; nested pseudoknots; pseudoknotted with nested pseudoknots)
Session 22 Synchronous
Methods for predicting RNA secondary structure
RNA secondary structure prediction and analysis with MFold and IPKnot

Week of April 11. Principles of protein structure:
Session 23 Asynchronous
Description of protein structure
Amino Acids
Peptide Formation
Dihedral Angles
Structure and sequence similarity
Analyzing an active site
Session 24 Synchronous
Protein structural visualization
Molecular viewers: POLYVIEW-2D and Swiss PDB Viewer
Protein structure comparison
Protein structure classification
Prediction of protein secondary structure from amino acid sequences

Week of April 18. Primer designing:
Session 25 Asynchronous
Primers and their uses
Basics of primer and oligo designing
Optimal size
Melting Temperature
GC content
Session 26 Synchronous
Self-complementarity
Hairpin Structures
Mis-priming
Primer designing using Primer3 and OligoAnalyzer 3.1

Week of April 25. Genomics and Proteomics:
Session 27 Asynchronous
Challenges for genome analysis
Comparative genomics
Functional classification of genes Genomes
Functional genomics approaches
Posttranslational modification
Protein–Protein interactions
Session 28 Synchronous
Importance of rigor and reproducibility in scientific research. Dr. Aguilera (guest lecture)

Week of May 2. Review and Final Exams:
Session 29. Asynchronous
Review for final exam.

Session 30. Online
Final Exam: May 5

COURSE ADD

All fields below are required

College : Science **Department :** Biological Sciences

Rationale for adding the course:
Bioinformatics is used in all biology related fieds these days and the exposure to Bioinformaticsis extremely necessary for students graduating with a degeree in Biological Sciences. As such, there is no course at the Univeristy at the undergraduate level that introduces undergraduate students to bioinformatics in biological systems.

All fields below are required

Subject Prefix and # BIOL 4300

Title (29 characters or fewer): Introduction to Bioinformatic

Dept. Administrative Code : 0430

CIP Code 26 .1103 .00

Departmental Approval Required ☒Yes ☐No

Course Level ☒UG ☐GR ☐DR ☐SP

Course will be taught: ☐ Face-to-Face ☐ Online ☒ Hybrid

How many times may the course be taken for credit? (Please indicate 1-9 times): 1

Should the course be exempt from the "Three Repeat Rule?" ☐Yes ☒No

Grading Mode: ☒Standard ☐Pass/Fail ☐Audit

Description (600 characters maximum):
This course will teach how computational techniques can help with solving biological problems. Students will learn to efficiently use multiple genomics and bioinformatics tools, that are freely available, for the analysis of DNA, RNA and protein sequences and structure. This interdisciplinary course would be helpful for students in the department of Biology, Computer Science, Mathematics who aspire to go to either graduate school or medical school, or plan to work in the Bioinformatics industry that has experienced exponential growth within the last decade.

Contact Hours (per week): 3 Lecture Hours Lab Hours Other

Types of Instruction (Schedule Type): Select all that apply

☒ A	Lecture	☐ H	Thesis
☐ B	Laboratory	☐ I	Dissertation
☐ C	Practicum	☐ K	Lecture/Lab Combined
☐ D	Seminar	☐ O	Discussion or Review (Study Skills)
☐ E	Independent Study	☐ P	Specialized Instruction
☐ F	Private Lesson	☐ Q	Student Teaching

Fields below if applicable

If course is taught during a part of term in addition to a full 16-week term please indicate the length of the course (ex., 8 weeks): 16-weeks

TCCN (Use for lower division courses) :

Prerequisite(s):		
Course Number/ Placement Test	**Minimum Grade Required/ Test Scores**	**Concurrent Enrollment Permitted? (Y/N)**
BIOL 1306	**C or better**	**N**

Corequisite Course(s):

Equivalent Course(s):

Restrictions:	
Classification	

Major	

THE UNIVERSITY OF TEXAS AT EL PASO

Bioinformatics Program

March 29, 2022

Dear Sourav,

Thank you for sending me your proposal for the addition of a new undergraduate course BIOL 4300 (Introduction to Bioinformatics) and its syllabus. I fully support the proposal as this course is a very appropriate and timely addition to our undergraduate curriculum at UTEP. It does not conflict with any of the existing graduate level bioinformatics courses. I expect this new course will enhance our undergraduate students' interest and encourage them to pursue graduate studies in bioinformatics.

Sincerely,

Ming-Ying Leung, Ph.D.
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Director, Bioinformatics Program
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