Phase I: Preliminary Report NIBLSE Survey – May 8, 2016

This Phase I Preliminary report is established from the online bioinformatics survey recently distributed by NIBLSE group. The responses to the survey have been summarized by using both the Qualtrics software output for the survey and some limited SPSS tables. For some questions, the Qualtrics software provided the best visual, and for some questions the SPSS table organized the output for better understanding. For a Phase II analysis, the SPSS file will mainly be used to look at more targeted relationships, such as contrasting responses from 2 and 4 year institutions. However, for that phase some targeted questions for consideration will need to be developed before the SPSS runs are undertaken to be more focused in the analysis.

For this Phase I overview, some brief notes of potential interest areas upon this first "look" at the survey have been added in blue type.

Since the survey had some significant branching and optional responses associated with it, there were some inconsistencies in how the question numbering occurred between survey number, the Qualtrics output numbering, and the SPSS numbering. The results themselves were consistent, but the question numbering has been reordered in the report to make for a more coherent review process with an additional designation of the main sections identified by a letter (A-W) with a number for each sub-question in that section (1-7) to have additional letter-number designations, such as A1, B1, B2, C1, C2, etc., to permit better group conversations on the responses.

The response summaries now follow, with some the comments added in blue text that occur before each question's result table or graph.

A. RESPONDENT INFORMED CONSENT PAGE

A1. A total of 1,259 participants reached the informed consent page. A total of 1,243 respondents answered this question that they agreed to participate in the survey (99%) and 1% (N=16) of those potential participants declined to participate in the survey. The sample size for each question on the survey is later included in the overview notes for each question.

Last Modified: 05/06/2016

A1-Q1. Dear Life Sciences Educator. The Network for Integrating Bioinformatics into Life Sciences Education (NIBLSE; "nibbles") is a National Science Foundation Research Coordination Network for Undergraduate Biology Education (RCN-UBE) devoted to establishing bioinformatics as essential to the undergraduate life sciences curriculum. To that end, we are asking the community to help us determine core bioinformatics competencies for the undergraduate curriculum. We are asking you to complete a short, anonymous survey if you are in one or more of the following groups: Educators who teach undergraduate life sciences at a 2-year or 4-year college, university, or technical school. Educators who supervise graduate students and who expect, or would like to expect, graduate student familiarity with bioinformatics. Biologists and/or bioinformaticians who teach/provide training in bioinformatics as part of their work at a

company or organization, but not as part of a for-credit course at a college or university. The survey should take you approximately 15 minutes to complete. We invite you to read more about our activities and other ways to contribute and provide feedback at our project website or contact us at the address below. Thank you in advance for your input. NIBLSE Leadership Team: Mark Pauley (mark@niblse.org), University of Nebraska at Omaha Elizabeth Dinsdale, San Diego State University William Morgan, College of Wooster Anne Rosenwald, Georgetown University Eric Triplett, University of Florida This survey is covered by IRB 161-16-EX. The survey administrator will disassociate any linked or uploaded files from your survey response before sharing these with the research team. For questions about the survey, please contact Mindy McWilliams. NIBLSE is supported by NSF Award #1539900. NIBLSE is a proud partner of QUBES: https://qubeshub.org/

#	Answer		Response	%
1	I agree to participate.		1,243	99%
2	I do not agree to participate.		16	1%
	Total		1,259	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.01
Variance	0.01
Standard Deviation	0.11
Total Responses	1,259

B. RESPONDENT VIEW OF INTEGRATING BIOINFORMATICS

B. Note (View of Integrating Bioinformatics): Of those who agreed to participate (n=1,243), a total of 1,221 respondents provided responses to the first question on their view of integrating bioinformatics into undergraduate life sciences. Within this group, 95% (n=1,160) indicated that they "…think bioinformatics should be integrated into undergraduate life sciences education." The remaining 61 respondents (5%) "do not think bioinformatics should be integrated into undergraduate life sciences education." See the figures below.

B1. Q2. To begin the survey, please select the statement that best describes your view of bioinformatics in undergraduate life sciences education.

#	Answer		Response	%
1	I think bioinformatics should be integrated into undergraduate life sciences education.		1,160	95%
2	I do not think bioinformatics should be integrated into undergraduate life sciences education.		61	5%
	Total		1,221	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.05
Variance	0.05
Standard Deviation	0.22
Total Responses	1,221

C. RESPONDENT DEMOGRAPHIC TABLES (From SPSS Tables)

C. Notes (Respondent Demographics): Of the 1,259 overall respondents, 47.1% were female and 49.4% were male, and 3.5% declined to say. Race was primarily listed as White (80.8%), with Asian at 6.2%, and Black as 3.3%, and 9.2% not wanting to say. For ethnicity, 4.1% were Hispanic or Latino, and 86.3% listing ethnicity as not Hispanic or Latino. The majority of respondents (87.2%) listed a Ph.D. for their highest level of education. Specific demographics are illustrated below in the following charts.

C1. Q. 29 Sex

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	502	39.9	47.1	47.1
	Male	527	41.9	49.4	96.5
	Rather not say	37	2.9	3.5	100.0
	Total	1066	84.7	100.0	
Missing	System	193	15.3		
Total		1259	100.0		

C2. Q. 30 Race

Race

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	American Indian or Alaska Native	2	.2	.2	.2
	Asian	66	5.2	6.2	6.4
	Black or African American	35	2.8	3.3	9.7
	Native Hawaiian or Other Pacific Islander	3	.2	.3	10.0
	White	858	68.1	80.8	90.8
	Rather not say	98	7.8	9.2	100.0
	Total	1062	84.4	100.0	
Missing	System	197	15.6		
Total		1259	100.0		

C3. Q. 31 Ethnicity

Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hispanic or Latino	42	3.3	4.1	4.1
	Not Hispanic or Latino	889	70.6	86.3	90.4
	Rather not say	99	7.9	9.6	100.0
	Total	1030	81.8	100.0	
Missing	System	229	18.2		
Total		1259	100.0		

C4. Q. 33 Highest Degree Earned

Highest earned degree. If "other," please explain.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	B.S. (or equivalent)	8	.6	.7	.7
	M.S. (or equivalent)	112	8.9	10.5	11.2
	Professional degree (e.g., M.D.)	10	.8	.9	12.2
	Ph.D. (or equivalent)	932	74.0	87.2	99.3
	Other, please explain:	7	.6	.7	100.0
	Total	1069	84.9	100.0	
Missing	System	190	15.1		
Total		1259	100.0		

D. RESPONDENT INSTITUTIONAL CONTEXTS

D. Notes (Institutional Contexts): More than 1000 of the respondents (generally N=1056), answered contextual questions about their institution. A good mix of institutions were represented with 17% identifying at being at an associate college, 22% at a baccalaureate college, 19% at a masters granting institution, 35% at a doctoral level, and 7% were unsure or didn't know the level. For the minority-serving context, 34% identified their institution as minority serving, 39% identified that their institution was not classified as minority-serving, and 28% were unsure or didn't know how to answer that questions. The total number of students at the institutions were relatively equally distributed between less than 5,000 students (32%), between 5,000 and 15,000 students (33%), and more than 15,000 students (33%).

D1. Q35. What is the Carnegie classification of your institution?

#	Answer		Response	%
1	Associate's College		176	17%
2	Baccalaureate College		230	22%
3	Master's (Small, Medium, Large)		205	19%
4	Doctoral University (High, Higher, Highest Research Activity)		369	35%
5	Don't know		76	7%
	Total		1,056	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	2.94
Variance	1.52
Standard Deviation	1.23
Total Responses	1,056

D2. Q36. Is your institution classified as minority-serving?

#	Answer		Response	%
1	Yes		355	34%
2	No		407	39%
3	Don't know		294	28%
	Total		1,056	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.94
Variance	0.61
Standard Deviation	0.78
Total Responses	1,056

D3. Q37. What is the total number of students (undergraduate and graduate) at your institution?

#	Answer		Response	%
1	< 5,000 students		334	32%
2	5,000 - 15,000 students		347	33%
3	> 15,000 students		343	33%
4	Don't know		31	3%
	Total		1,055	100%

Statistic	Value
Min Value	1
Max Value	4
Mean	2.07
Variance	0.76
Standard Deviation	0.87
Total Responses	1,055

D4. Q38. What is the total number of undergraduate students at your institution?

#	Answer		Response	%
1	< 5,000 students		385	37%
2	5,000 - 15,000 students		337	32%
3	> 15,000 students		290	28%
4	Don't know		40	4%
	Total		1,052	100%

Statistic	Value
Min Value	1
Max Value	4
Mean	1.99
Variance	0.79
Standard Deviation	0.89
Total Responses	1,052

E. RESPONDENT DEPARTMENT NAME

E. Notes (Department Name): A mix of department names were represented by the respondents as their host department, with most focused on 1) biology or biological sciences, 2) sciences, mathematics, and computer science, 3) and more specific departments such as plant science, genetics, animal, and marine sciences.

E1. Q39. What is the name of your department/unit (e.g., Department of Biology, Biochemistry Department, School of Interdisciplinary Informatics)?

Text Response
botany/zoology
Biology
Department of Biology
Life sciences
Thomas H. Gosnell School of Life Sciences
Department of Biology
Natural Sciences
Physiology
Department of Biological Science
School of Life Sciences
Department of Biology
Department of Biological Sciences
Department of Biology
School of Biological Sciences
Department of Biology
Biology
Biology
Biological Sciences
Biology Department
Math, Computer, and Natural Sciences
Department of Science, Technology and Mathematics
Department of Biology
BIOMEDICAL SCIENCES
Arts and Sciences
Cell and Molecular Biology
Biology
Department of Biology
Biology Department
Center for Learning Innovation, University of Minnesota Rochester
Chemistry and Biochemistry
Biology
Math and Computer Science
Biological Sciences
Department of Ecology and Evolutionary Biology
Department of Biological Sciences
Biology
Department of Biology
Biology
Dept. of Biology
Math and Science
Department of Biological Sciences
Department of Biology
Biochemistry
Math and Science
Department of Biological Sciences

Biology
Department of Natural Sciences
Division of Science
Biology
Biological Sciences
Biology
Department of Biology
Biology
Department of Biology
Biology
GSOLS
Department of Biology
Biology Dept.
Division of STEM
Department of Biology
Genetics
Biological Sciences
Biology
Biology
Ecology and Evolution
Department of Biology
Department of Biology
Department of Biology
Biological sciences
ZOOLOGY
Animal Science
Biology
Biology
Dept of Biology
Biology
Marine Science
Biology
Biology
SEM
Department of Life Sciences
biological sciences
Department of Biology
Biological Sciences
Biology
Plant Sciences
Department of Biology
Department of Biological Sciences
Department of Biology
Biological Sciences
Genetics and Biochemistry
Biology
Department of Natural Sciences
Biology
Department of Biology
Systems Biology and Bioinformatics Graduate Program
Biological Sciences

Biology
Natural and Forensic Sciences
Department of Biology
STEM
Biology with Computer Science affiliation

Statistic	Value
Total Responses	1,028

F. RESPONDENT DEPARTMENT SIZE

F. Notes (Department Size): A nice mix of department sizes were represented by the 1,057 respondents, with 26% of the respondents having less than 10 full time faculty, 38% having 10-20 full time faculty, 18% having 21-30 full time faculty, 9% having 31-40 full time faculty, 3% having 41-50 full time faculty, and 4% having more than 50 full time faculty. The number of students in the department were also nicely mixed with 9% of the respondents having less than 50 students, 13% having 51-100 students, 37% having 101-500 students, 23% having 500-2,000 students, and 6% having more than 2,000 students. A total of 12% of the respondents were unsure of didn't know on the number of students in the department.

F1. 40. How many full-time faculty are in your department/unit? (Do not include part-time faculty or adjuncts.)

#	Answer		Response	%
1	< 10		271	26%
2	10 - 20		398	38%
3	21 - 30		190	18%
4	31 - 40		94	9%
5	41 - 50		32	3%
6	> 50		39	4%
7	Don't know		33	3%
	Total		1,057	100%

Statistic	Value
Min Value	1
Max Value	7
Mean	2.50
Variance	2.19
Standard Deviation	1.48
Total Responses	1,057

F2. 41. How many undergraduate students are in your department/unit (all majors)?

#	Answer		Response	%
1	< 50		98	9%
2	51 - 100		140	13%
3	101 - 500		389	37%
4	501 - 2000		242	23%
5	> 2000		59	6%
6	Don't know		128	12%
	Total		1,056	100%

Statistic	Value
Min Value	1
Max Value	6
Mean	3.39
Variance	1.90
Standard Deviation	1.38
Total Responses	1,056

G. TEACHING CONTEXT

G1. Notes: (Teaching Context 4 and 2 year colleges). Of the 1,259 respondents that answered the question about their teaching context, a total of 80.8% taught at a 4-year college or institution, and 18.3% at a two-year college or technical school. Only 1.7% worked in a company or organization that was not part of a for-credit course at a college or university.

G1. Q57

Please select the statement below that best describes you.

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	I teach at a 4-year college or university.	923	73.3	80.0	80.0
	I teach at a 2-year college or technical school.	211	16.8	18.3	98.3
	I teach/provide training in bioinformatics as a regular part of my work at a company or organization, but not as part of a for-credit course at a college or university.	20	1.6	1.7	100.0
	Total	1154	91.7	100.0	
Missing	System	105	8.3		
Total		1259	100.0		

G2. Notes (Teaching Context Bioinformatics Integration): A total of 53.5% of the 1,259 respondents taught in the life sciences, and had no bioinformatics in their teaching, as shown below in the first of the following tables. A total of 24.1% taught undergraduates majoring in the life sciences and include substantial bioinformatics in their teaching. Only 12.2% actually taught a dedicated bioinformatics course. A total of 10.3% supervised graduate students and expect these students to have familiarity with bioinformatics.

G2. Q1

Please select the statement below that best describes your current teaching of bioinformatics con...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I teach dedicated bioinformatics course(s) to undergraduates majoring in life sciences or closely related disciplines.	136	10.8	12.2	12.2

	I teach undergraduates majoring in life sciences or closely related disciplines and include substantial bioinformatics (more than one lecture/lab section) in my teaching.	269	21.4	24.1	36.2
	I teach undergraduates majoring in life sciences or closely related disciplines and DO NOT currently include substantial bioinformatics (more than one lecture/lab section) in my teaching but will/would like to do so in the future.	598	47.5	53.5	89.7
	I supervise graduate students in the life sciences or closely related disciplines and expect, or would like to expect, graduate student familiarity with bioinformatics.	115	9.1	10.3	100.0
	Total	1118	88.8	100.0	
Missing	System	141	11.2		
Total		1259	100.0		

H. LEVEL OF COURSES

H. Notes (Level of Courses): For respondents who taught a dedicated bioinformatics course, most of the dedicated courses were at the higher level within the educational experiences for the students with 78% checking that they had a course at the senior level, and 67% checking that they had one at the junior level, 22% at the sophomore level, and 11% at the freshman level *(checking all that applied).* Similarly, for courses with bioinformatics content, most of that content was at the upper levels with 73% having such content at the senior level, 67% at the junior level, and 43% at the sophomore level, and 26% at the freshman level (again checking all that applied).

H1. Q5. What is the level of the dedicated bioinformatics course(s) you teach? (Check all that apply.)

#	Answer		Response	%
1	Freshman		13	11%
2	Sophomore		27	22%
3	Junior		82	67%
4	Senior		96	78%

Statistic	Value
Min Value	1
Max Value	4
Total Responses	123

H2. Q6. What is the level of the courses with bioinformatics content that you teach? (Check all that apply.)

#	Answer		Response	%
1	Freshman		58	26%
2	Sophomore		95	43%
3	Junior		149	67%
4	Senior		163	73%

Statistic	Value
Min Value	1
Max Value	4
Total Responses	222

I. SHARING RESOURCES

I. Notes (Sharing Resources): When asked about sharing resources for an online reposition of bioinformatics syllabi, 34% said that they would be willing to share their own syllabi and assessments, a total of 51% said maybe, and just 15% said no, they would not share.

I1. Q9. As part of our work, we are building an online repository of bioinformatics syllabi and content assessments. Would you be willing to share your

syllabus/syllabi and/or content assessment(s) with us so they could be added to this repository?

#	Answer		Response	%
1	Yes		132	34%
2	Maybe		202	51%
3	No		59	15%
	Total		393	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.81
Variance	0.45
Standard Deviation	0.67
Total Responses	393

J. LEVEL FOR INCLUDING BIOINFORMATICS CONTENT

J. Notes (Level for Bioinformatics Inclusion): When asked about what level of courses that they would like to see bioinformatics content included, there was roughly an equivalent preference for the freshman (51%), sophomore (54%), junior (50%), and senior (48%) levels.

J1. Q10. What is the level of the courses you teach in which you would like to include bioinformatics content? (Check all that apply.)

#	Answer		Response	%
1	Freshman		270	51%
2	Sophomore		284	54%
3	Junior		265	50%
4	Senior		253	48%

Statistic	Value
Min Value	1
Max Value	4
Total Responses	527

K. BARRIERS TO INCLUDING BIOINFORMATICS CONTENT

K. Notes: (Preventing Bioinformatics Content Inclusion): A total of 517 respondents noted barriers to development and/or implementation of bioinformatics content. Some of the more common responses related to the following areas: 1) lack of personal or general faculty knowledge and expertise, 2) difficulty in finding space in an existing or overloaded curriculum and knowing what to remove, 3) faculty colleagues who don't understand the need for such curriculum additions, 4) aging or difficult access to computing or other institutional resources, 5) large classes or difficulty in organizing activities for large numbers of students, 6) lack of anticipated student prerequisites, 6) difficulty in finding the personal or faculty time to undertake such significant revisions in the curriculum.

K1. Q11. What is preventing you from including bioinformatics content in these courses?

Text Response
Too much other core content to teach.
survey course, I teach limited < 1 lecture and some examples throughout class, don't see how I could find time in existing curriculum to incorporate more
Ideas on what to do, time in which to implement it
Lack of awareness of resources to help my integrate bioinformatics effectively - e.g. modules or prepared active-learning exercises.
Textbook
Determining which coding to teach in which context and coordinating with others and dealing with other priorities
This is not currently part of our departmental learning outcomes.
knowing how to integrate it and the start up costs to teaching math and computing.
Lack of time to change the lab, which is where I see it being integrated. I have taught a class using the Integrated Microbial Genomes Annotation Collaboration Toolkit (IMG-ACT) and would like to integrate some of those activities into a micro class for majors.
Lack of personal expertise in the field and no buy in from colleagues (and even strong opposition from colleagues)
other course requirements
The course demand and low enrollment risks
Time needed to restructure the course to include bioinformatics
I have retired from active teaching, but remain interested in curriculum development.
time in the course, knowledge of the best resources, time to update instructions as quickly as the online resources change their interfaces
Content knowledge (my own), students' unfamiliarity/discomfort with bioinformatics tools, implementation strategies
lack of prepared activities for use in the classroom tied to specific course objectives
My own lack of confidence with methods & techniques. I am not a molecular or computational biologist, so doing QPCR or high throughput sequencing is beyond my skillset. I do teach basics of molecular biology, we do PCR and cloning in lab, and I teach basic stats, but not the sophisticated material I'd consider to be bioinformatics.
Time Poor quality, and outdated exercises.
I include a little bioinformatics but not more than one lecture. The courses are not geared to just bioinformatics and there are other issues to discuss
Lack of time and background knowledge obtained in prior coursework.
Good text, knowledge of best practices and time.
Currently the major course that I teach is so full of other "required" material. I'll need to offer an elective to substantially discuss Bioinformatics.
My own lack of training. I am older and have been teaching introductory classes for a long time. I do not have experience in bioinformatics, or interest in computer science.
access to good exercises
Course is already very content heavy, so adding more time to any topic is very difficult.
Good resources that are at the freshman level.
I really have no background in this subject.
I don't have the background to teach it.
Lack of easy access to programs that are easy to use
time
not enough time in the semester, my lack of expertise in software

Knowledge of Bioinformatics tools, large class sizes, appropriate starting point to introduce students to topic.
Limited time; Lack of knowledge about bioinformatics; lack of suitable active learning exercises
Time and resources
time available for covering the material
time and difficulty incorporating new topics into existing courses
I do include one lecture/lab- the students don't like it- so I don't do more-- plus there is so many other things I need to teach.
lack of background/preparation
not enough background myself and limited time and resources.
I am a new faculty in my university at the moment. However, I am determined to influence the courses I am assigned and teach as times go on, with substancial bioinformatics content
Technical resources
students have very poor background for the courses and lots of time needs to be devoted to the fundamentals.
Easy access to well-structured, existing exercises that I can test-run myself and then modify for my needs.
I think it's resistance to change.
More info. Needed.
Syllabus content provided to me upon hire
Time and expertise. I feel I have to cover a lot of other material and/or reteach concepts before I can cover bioinformatics. As bioinformatics was not something I learned about as an undergrad or graduate student, I have to teach myself first before I feel comfortable teaching someone else. I am picking up programming and statistics courses to do this.
Haven't developed the course yet.
Currently limited access to data sets, project or software for bioinformatics projects.
Sufficient access, level of studnet taking the classes
I do one bioinformatics activity in my genetics class and some in molecular biology. I would incorporate more but feel I do not have enough time in my course.
My own lack of expertise.
course content and time constraint
time, materials for integrating the content, materials that put bioinformatics into a context that a typical undergraduate can understand
Not having computer and monetary resources
I teach General Biochemistry in a completely flipped active class - all "lectures" are online narrated by me PowerPoints. It would be good to get some degree of bioinformatics in the class activities. One lab does 16S sequencing and basic Blast search.
content requirement
no training in the area
Contextual knowledge. Students lack it, therefore, they can't intelligently engage bioinformatics. There is a lot of misinformation, such as hCG (a primate-specific hormone) in mice. Its a transgenic mouse, but students don't make that connection.
lack of resources/time/money
I have no training in it, so I can only teach how to use the on line resources that I am aware of and those are limited
Current course content is full. Students have insufficient computer science background.
Time and Knowledge

limited personal knowledge; time; students do get this info in other classes
On campus resources and sufficient understanding/training in bioinformatics.
Not really excited about bioinformatics
Lack of training
time needed to devote to other topics in the one biostats course we have
past course-taught more bioinformatics; current course-need more course structure
Time
It is not included in the text book I am currently using and also my personal lack of knowledge on the subject.
No expertise at our small college. With my advising, 1 student recently entered a bioinformatics graduate program.
I'm not familiar enough with it myself in order to implement it in teaching.
Students have not taken any statistics class and lack very basic statistical and experimental design concepts; they have - for the overwhelming part - no experience in even reading primary scientific & peer-reviewed literature, or exploring scientific databases. They have problems interpreting data. Some have no experience with Excel.
Time and my unfamiliarity with bioinformatics.
There are several bioinformatics courses offered in our program. Since I teach Molecular Biology, which covers a broader topics, it is difficult for me to allocate more than one class specifically for bioinformatics.
The course I teach is Directed Research, a senior capstone class. I would like to integrate bioinformatics in to each student's project, but lack the expertise. I am a microbiologist by training.
Departmental content developers do not feel that incoming and current students are adequately prepared to be successful at Bioinformatics courses.
I don't have time to sort through the mountains of info and develop curriculum.
It is not part of those courses.
Lack of clear, brief useful tutorials or exercises. Lack of knowledge about what tools are used and are actually useful. (My research program doesn't rely on bioinformatics.)
not in the current curriculum
My lack of knowledge of what is available and applicable to my courses and my lack of experience/expertise with bioinformatics.
My lack of clarity about which topics could/should be included as "bioinformatics." Do we consider investigative assignments using BLAST analyses as such?
lack of training
Time, knowing what other material to cut to include the bioinformatics content.
No time. Syllabus is full and I usually don't get everything covered without adding new components.
We teach biology using a 1 semester system and this is not enough time. We would like the university to increase the credit fro 3 to 4 so that we can increase the time in class lecture. Budget cuts in the WIsconsin system are hingering this progress.
Time Plus, I agree that I don't have much experience in bioinformatics.
pre made lab exercises that I think would be effective.
I do not have sufficient training in bioinformatics to teach it effectively.
General biology I includes many other topics that need covering.
Time during the semester and lack of integration of the material in the text I use.
No formal training.
Caution. . . not interested in too much pedagogy at this level.
May be knowing ways to integrate bioinformatics into the lectures and problem sets.
Time and resources
course has not been modified for a long time, but it is huge and requires departmental

committments to do so
lack of time/ priority
I mostly teach environmental sciences, ecology, and teaching methodologies. I'm not sure it is appropriate in some of these classes.

Statistic	Value
Total Responses	517

L. COURSES AT THEIR INSTITUTION WITH BIOINFORMATICS CONTENT

L. Notes (Classes at their Institution with Bioinformatics Content): When respondents were questioned about whether there were bioinformatics courses that students in the life sciences routinely take, a total of 40% said yes, 42% said no, and 18% were unsure (Don't know). When asked about other courses at the institution (outside of their area) with bioinformatics content, a total of 62% answered yes, 28% answered no, and 9% were unsure (Don't know). In addition, when asked if more bioinformatics courses were needed at the institution, a total of 64% of the respondents said yes, 17% said no, and 19% didn't know.

L1. Q12. Are there undergraduate courses with bioinformatics content at your institution that life sciences students routinely take? If "yes," please encourage those teaching these classes to complete the survey (forward the solicitation e-mail).

#	Answer		Response	%
1	Yes		271	40%
2	No		284	42%
3	Don't know		119	18%
	Total		674	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.77
Variance	0.53
Standard Deviation	0.73
Total Responses	674

L2. Q13. Aside from the course(s) you teach, are there other undergraduate courses with bioinformatics content at your institution that life sciences students routinely take? If "yes," please encourage those teaching these courses to complete this survey (forward the solicitation e-mail).

#	Answer		Response	%
1	Yes		244	62%
2	No		110	28%
3	Don't know		37	9%
	Total		391	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.47
Variance	0.44
Standard Deviation	0.66
Total Responses	391

L3. Q14. In your opinion, are additional undergraduate courses with bioinformatics content needed at your institution?

#	Answer		Response	%
1	Yes		606	64%
2	No		159	17%
3	Don't know		184	19%
	Total		949	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.56
Variance	0.64
Standard Deviation	0.80
Total Responses	949

M. BARRIERS TO COURSE DEVELOPMENT AND IMPLEMENTATION

M. Notes (Barriers to Development and Implementation): A total of 371 respondents noted barriers to development and/or implementation of bioinformatics content and coursework integration. Some of the more common responses related to the following areas: 1) lack of personal or general faculty knowledge and expertise, 2) difficulty in finding space in an existing or overloaded curriculum and knowing what to remove, 3) faculty colleagues who don't understand the need for such curriculum additions, 4) aging or difficult access to computing or other institutional resources, 5) large classes or difficulty in organizing activities for large numbers of students, 6) lack of anticipated student prerequisites, 6) difficulty in finding the personal or faculty time to undertake such significant revisions in the curriculum.

M1. Q15. Optional: Please describe briefly; include any barriers to development and/or implementation.

Text Response
Lack of knowledge on the part of the faculty, inertia from using old curricula
We can't find qualified faculty. Qualified faculty are those who have a computer scientist level understanding of computers and a biologist level understanding of biology, and focus on computers for the sake of answering biological questions. We find many who have one of the three requirements, but not all three.
Not yet developed
Deciding as a department on outcomes and which courses will take time and leadership in order to bring forth changes.
see above - still a debate about whether data analysis should be taught in excel or R
insufficient faculty to offer a general bioinformatics course
Lack of faculty professional development in genomics/bioinformatics content and use of associated technologies (especially computational skills); lack of faculty recognition about the importance of genomics/bioinformatics across biology curriculum
The main issue is not having specialized and dedicated faculty with the proper mathematical and computational training.
time and opposition to the idea of bioinformatics as an important skill for undergrads
We are too busy teaching other courses and its hard to add a new one. Also, our faculty aren't formally trained in bioinformatics.
It is hard to include bioinformatics when we are always pressed for time on the content we do have. The question always is: What do I remove to fit this into the curriculum?
Additional course would be offered as an elective and may face low enrollment barrier to run regularly. Also, prerequisite courses may hinder enrollment of a more diverse group of students.
The various biology majors at my institution have few elective units for students to fulfill with bioinformatics courses. So until existing major requirements are reduced we risk starving the existing courses for bioinformatics by adding new ones.
we have recently hired someone who will bring additional expertise in this area into our department, and I think this will reduce barriers greatly
The biology curriculum is overloaded. Every faculty members believes his or her specialty is necessary for all students so there isn't room for my specialty.
faculty with expertise to teach these courses
Lack of appreciation for bioinformatics by older faculty members (e.g., blatantly passing over the chapters in the intro textbook that integrate genomics/bioinformatics into the genetics part of the intro curriculum because they are too "niche"); lack of colleagues who use bioinformatic in research; lack of money to hire new faculty in this new type of area.
Faculty with the proper training, number of hours that students need to take to graduate
We do not have enough faculty expertise to offer these courses.
Hands on projects in bioinformatics are technically challenging for our student population.
learning curve of coding and scripting, institutional roadblocks on courses shared between departments
We don't have the expertise in our faculty.
Lack of well thought out biological sciences curriculum has led to courses being offered that faculty want to teach as opposed to what is best for students.
Too few faculty members; not enough time to fit in bioinformatics courses.

We are on the (10-week) quarter system so there is little flexibility to add to existing courses. We barely have enough faculty to cover our existing curriculum so we'd have to cut out some classes to make room and there would be general resistance to that.
We currently don't have anyone who feels qualified to build an entire course around the topic, and, frankly, modifying an existing course requires time that we currently don't have to donate. There is definitely an "activation energy" barrier.
Our computer facilities are aging and poorly maintained. The students are disinclined to move beyond their phones to work on projects.
Curriculum is already overloaded in biology degree programs and courses.
insufficient student interest, insufficient instructor expertise and time
We lack some faculty expertise
Some faculty members are not familiar or comfortable with bioinformatics content. At my institution, we all teach a heavy load and collaborating on curriculum development tends to take a couple years before content is ready.
We need to have our students doing statistics and bioinformatics much earlier
We don't have the faculty within our department to teach a dedicated course. Students may not have the computational background to take such a course.
see above
Large classes, little recognition for development of or teaching new courses.
currently teaching loads don't allow us to offer very many elective courses
It is in the works!
getting new faculty lines approved
I suspect that having faculty integrate some bioinformatics assignments in their courses is more work that most faculty want to do.
Faculty lack specific training in bioinformatics and don't have the resources (personnel or funds) to spend on software and equipment.
Not enough students are registering for bioinformatics classes.
Financial
students who do not have strong background in molecular biology and genetics find difficulties in a) interpreting results generated by bioinformatic tools, b) appreciating the power of bioinformatics
I suppose it's mainly lack of funding for higher institutions.
More information is needed on the topic.
Students have fear or math and programming that killed my department's first attempt at this. No one wanted to take the classes. I think that integrating bioinformatics concepts in traditional biology curricula first would make offering a course like this more appealing.
Knowledge on the part of the professors, and low number of faculty to teach required courses
Platform hosting, standardized interface.
Limited resources for incorporating bioinformatics into classroom setting
Faculty interest and expertise.
Time and money.
I haven't had time to develop a bioinformatics course since developing my own skills during a recent sabbatical leave. I expect to offer a course for the first time in 2017-2018.
Concepts of bioinformatics should be included in core courses to help students build competency. Upper level courses should also teach some bioinformatics most appropriate to the subject matter. (It should be integrated,not necessarily separate).
Time
change is happening slowly
Faculty member who taught courses left
The computer infrastructure is really weak.

There are no good ways to re-tool for those of us who are interested. All workshops at Cold Spring Harbor are in the middle of the semester and the Yale course in June (computational immunology, which is best suited for my field) is impossible to get into if you are not a student/postdoc at a research institution. I'll keep looking and applying, but I am starting to feel excluded from the process
Too few faculty to add additional courses.
We need a course devoted to bioinformatics, and especially genomic-level approaches. Barriers include staffing and expertise.
small institution/small department, therefore limited opportunities
Staffing sufficient to teach both courses required for the major and teach classes that are "wanted."
Just the lack of faculty interested
I teach a Genomics course where we use bioinformatics tools to analyze data and perform original research through the Genomics Education Partnership. However, we don't have a course where students develop bioinformatics tools themselves, so we need a true bioinformatics course in addition to the Genomics course.
Faculty buy-in for curriculum revision of biology major related courses.
Lack of knowledge on the subject.
Pre-med requirements drive enrollments too much.
Separation of departments; not enough seats in the bioinformatics courses currently offered to handle all of our majors.
Our faculty are expected to maintain funded research programs so teaching and developing new programs are not top priority.
time, conversation about integrated curricula
A lot of unfamiliarity with the techniques and, therefore, hesitance to teach the subject. I only teach bioinformatics as part of the SEA PHAGES in silico curriculum.
It takes time to educate ourselves about bioinformatics beyond any limited amount we may use in our small research programs, but with all the other duties and responsibilities we have to put our time into, from planning, teaching, and assessing our courses, to advising, to diversity issues, to student recruitment and student retention activities, to communication with the omnipresent email/texts, oh, and somewhere in there we are supposed to do some research. Basically, there are more priorities than there is time. It is difficult to make time to educate ourselves in any substantial way.
Lack of faculty experience with field (only dedicated faculty is from Comp. Sci. and focuses on big data broadly, not necessarily specific biological/biochemical questions and combining bioinformatics with hypothesis-driven wet bench work).
we lack any content on -omics analysis as none of the faculty are trained in this.
Time. Our students have a set curriculum that prevents additional such course offerings.
varying os platforms, discomfort with unix command line, general unfamiliarity with computing
Knowledge and expertise
One of the lab components (in freshman biology class) is to generate molecular portfolio for the assigned protein. In this students are asked to download sequence in faster format for the assigned accession number. Identify conserved domain. Find the information about corresponding gene, and associated features. etc....
not likely to be popular for students to take
faculty to teach the course(s). i am essentially a single-person discipline, primarily teaching cell biology and genetics courses. i have recently added a bioinformatics course, but am pretty much stretched to my curricular limit!
Many of my "bench science" colleagues see laboratory skills as necessary and sufficient for our students, and view bioinformatics as an elective that just fills the schedule/adds

needed units to graduation.
We have just approved a course on Biostatistics that may include bioinformatics. When I think of bioinformatics I think of huge data bases...largely from genetics and molecular biology
Currently the biggest barrier is faculty knowledge. Only two of use use bioinformatics in our research. Many of the others are willing but lack training.
Not valued enough by faculty (yet) to make it a required part of undergraduate education.
time to fit into curriculum, availability of computers, faculty/graduate students with expertise are limited
Faculty with expertise and interest (e.g. use it in their research) whose courses would be accessible to all science majors
We don't have anyone with bioinformatics experience at our institution.
Course design is time consuming and any assistance with course modules would be beneficial
Training and technology.
Lack of professors with training in this area
lack of inclusion by faculty, trained prior to its explosion
Lack of dedicated computer labs. There is only one such lab at my institution and I have to limit my use of this classroom to evening classes.
Lack of facilities and full-time faculty with the knowledge and skills to teach the courses. Most faculty here are part-time and have very little input in curriculum.
I think bioinformatics content should be more infused in core bio courses
Introductory programming classes
I have thought about this a lot. I am planning on just doing a short "paper version" of bioinformatics concepts with my microbiology students (sophomores). The current software has too high of a learning curve for an activity that will only cover one lab.
access to computer labs
expertise and faculty workload; reliant on many adjuncts with current class offerings; hard to imagine finding time to develop let alone teach such a course
we have some courses but not enough students take them. We are limited by class size constraints
Time and availability to teach. Also, expertise of other faculty in such areas.
I offered to develop such a course collaborating with a CSci/Math prof who does bioinformatics research, but we were not able to get releases from our current courses to offer the new course.

Statistic	Value
Total Responses	371

N. CERTIFICATE OR MINOR FOR BIOINFORMATICS CONTENT

N. Notes (Certificate or Minor): When asked about having an undergraduate bioinformatics certificate or minor at the institution, of the 1,064 respondents to the question, 79% answered no, and 12% answered yes, with 9% not knowing or unsure. A variety of certificate and minor names and websites were provided by the 78 respondents who had answered a further optional question that had requested additional institutional information on the name of the certificate or minor.

N1. Q16. Is an undergraduate bioinformatics certificate or minor offered at your institution?

#	Answer		Response	%
1	Yes		125	12%
2	No		842	79%
3	Don't know		97	9%
	Total		1,064	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.97
Variance	0.21
Standard Deviation	0.46
Total Responses	1,064

N2. Q17. Optional: Please give certificate or minor name, department/unit in which it's offered, and website URL (if available).

Text Response
Bioinformatics emphasis in the computer science department
School of Life Sciences, bioinformatics analysis, https://www.rit.edu/science/programs/minor/bioinformatics-analysis
In process of being approved.
http://catalog.mst.edu/undergraduate/degreeprogramsandcourses/bioinformaticsminor/#text
Quantitative Biology Minor offered by Department of Biology http://www.wlu.edu/biology-department/about-the-department/biology-minor-requirements#QuantitativeBiologyminor
https://www.rit.edu/science/gsols/
http://www.dal.ca/academics/graduate_programs/computational-biology-and-bioinformatics.html
Bioinformatics and Computational Biology (both a major and a minor are available)
Quantitative and Computational Biology certificate available to any undergraduate major.
The Bioinformatics Minor for non-CS majors - Computer of Information Sciences
Minor Bioinformatics, info found on UF Undergraduate catalog http://microcell.ufl.edu/bioinfo3/
Minor in Bioinformatics http://drexel.edu/coas/academics/departments-centers/biology/degrees/
Bioinformatics minor http://catalog.minotstateu.edu/undergraduate/collegeofartsandsciences/departmentofbiology/#minorstext
http://cbb.unl.edu
http://biology.umbc.edu/undergrad/undergraduate-programs/binf/
Many of our students do a computer science/biology major and take a few courses. Not really a bioinformatics certificate.
Computer science department
We have a biomedical informatics degree and minor but it is very focused and not appropriate for many students who are interested in the broader area of bioinformatics.
It's under development now.
https://science.iit.edu/programs/undergraduate/bioinformatics
somewhat related to Bioinformatics: Minor name: Computational Science Minor Department: Mathematical, Information & Computer Sciences URL: http://www.pointloma.edu/mics-programs/computational-science-minor
Bioinformatic minor CREATED IN 2012, from the Microbiology and Cell science Dpt http://microcell.ufl.edu/bioinfo3/
Computer Science and College of Health Sciences
Computer Science majors have been able to choose a specialization in Bioinformatics, but I am not sure that this is still offered. (Department of Computer Science, University of New Orleans)
Biology B.S. with specialization in Quantitative Biology and Bioinformatics http://www.stonybrook.edu/commcms/biology/current/schedule.html
Bioinformatics minor. Jointly administered by Biology, Computer Science, and Statistics Depts.
http://catalog.mst.edu/undergraduate/degreeprogramsandcourses/bioinformaticsminor/#text

Molecular Biology, Biochemistry, and Bioinformatics Program, Bioinformatics Track http://www.towson.edu/fcsm/departments/molecularbio/
Minor in bioinformatics; cooperative program between biology and computer science but listed under computer science for administrative purposes. http://northcentralcollege.edu/majors/bioinformatics
Minor in Bioinformatics, Department of Math and Computer Science
Quantitative Biology Program: http://biology.hunter.cuny.edu/index.php?option=com_content&view=article&id=162:2013-10-24-16-39-38&catid=12:bioteaching Bioinformatics Option in Biological Sciences: http://www.hunter.cuny.edu/qubi/biology-majors
There is a quantitative biology track within the undergraduate biology major.
Bioinformatics
http://www.udmercy.edu/catalog/undergraduate2012-2013/programs/eng-sci/bioinformatics-minor/index.htm It is a minor offered by our Math and Computer Science Department. Most Biology Major do not want to participate.
http://biology.umbc.edu/undergrad/undergraduate-programs/minors/
Bioinformatics track within the Biology major
Bioinformatics major within Dept of Biological Sciences
Certificate of Study in Bioinformatics. The certificate is currently on hold due to lack of institutional support that resulted in two critical courses in the certificate program being suspended. http://www2.humboldt.edu/biosci/programs/Certificate%20of%20Study%20in%20Bioinformatics.htm
Bioinformatics Certificate
http://www.dyc.edu/academics/schools-and-departments/programs-and-degrees/minors.aspx
Major in Bioinformatics, major and minor in genomics with heavy bioinformatics content.
http://bioinformatics.uncc.edu
Department of Health Informatics
Bioinformatics major within the Dept. Biological Sciences, run by Dr. Charles Hauser: https://www.stedwards.edu/undergraduate/bioinformatics
Mathematical Biology Minor - shared between Biology, Mathematics and Computer Science -- http://mathbio.truman.edu/home/mathbio-minor/
Undergraduate Minor in Genomics and Bioinformatics, Department of Biology, https://www.uttyler.edu/biology/undergraduate/files/bioinformaticsminorweb.pdf
http://lifesciences.vcu.edu http://lifesciences.vcu.edu/academic-programs/
http://bioinformatics.byu.edu
Computer Science
http://degreesearch.arizona.edu/major/biology-bioinformatics-emphasis
http://www.juniata.edu/academics/departments/biology/research/genomics-certificate.php
Bioinformatics minor via Biology/Computer Science Departments
Minor in Bioinformatics, Department of Biology, this is a new minor that is currently under final review for approval effective fall 2016.
Biology department
http://www.rowan.edu/colleges/csm/departments/bioinformatics/programs/
I am the founder head of a B.S. in Bioinformatics program that was established at Ramapo College of New Jersey in 2002. It is part of the School of Theoretical and Applied Science http://bioinformatics.ramapo.edu/index.html The program also offers a Minor in Bioinformatics
Minor in Bioinformatics offered by Mathematics and Computer Science Department

Minor in the Computer Science department
Interdisciplinary Graduate Program in Informatics http://informatics.grad.uiowa.edu/bioinformatics/
it is an interdisciplinary concentration in Bioinformatics offered through the Biology, Chemistry, and Computer Science departments http://www.worcester.edu/Bioinformatics-Program/
specialization in quantitative biology and bioinformatics, undergraduate biology program, stony brook university
In theory one is available, but in reality not. Given required curriculum, and disallowing 'double-counting" of courses, students are unable to obtain minor - problem!
Translational Genomics Certificate
Bioinformatics, School of Theoretical and Applied Science, http://www.ramapo.edu/catalog-2015-2016/tas/bioinformatics/
Computational Science concentration (satisfied with biology electives and my computational biology course)
Our Program in Bioinformatics and Computational Biology offers both a major and a minor. http://www.wpi.edu/academics/bcb/ugrad-minor.html
http://courses.cornell.edu/preview_program.php?catoid=26&poid=12977
Biotechnology department
Minor in Bioinformatics is in the final stage of approval. It is open to all students but will be administratively housed in the Department of Biology
Minor in Dept of Math and Computer Science
Biological Sciences major, concentration in Computational Biology
http://www.fandm.edu/bioinformatics
Bioinformatics offered in the computer and informatics department
HHMI Genomics Certificate
Bachelor of Science in Biology, Bioinformatics track
http://unomaha.smartcatalogiq.com/en/2015-2016/Undergraduate-Catalog/Undergraduate-Degree-Programs-and-Certificates/Information-Science-and-Technology/School-of-Interdisciplinary-Informatics
http://web.uconn.edu/mcb/undergraduate/bioinformatics_minor.html
http://www.uh.edu/technology/programs/minors/engineering-technology/bioinformatics-in-biotechnology-and-biomedical-sciences/
Bioinformatics Minor
Biotechnology Major, Bioinformatics option, SEBS; Rutgers, The State University of NJ

Statistic	Value
Total Responses	78

O. MAJOR FOR BIOINFORMATICS CONTENT

O. Notes (Bioinformatics Major): When asked about having an undergraduate bioinformatics major at the institution, of the 1,066 respondents to the question, 84% answered no, and 7% answered yes. A variety of names, additional information and websites were provided by 59 respondents answering an additional optional question, that had requested additional institutional information or websites.

O1. Q18. Is an undergraduate bioinformatics major offered at your institution?

#	Answer		Response	%
1	Yes		93	9%
2	No		896	84%
3	Don't know		77	7%
	Total		1,066	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.98
Variance	0.16
Standard Deviation	0.40
Total Responses	1,066

O2. Q19. Optional: Please give name, department/unit in which it's offered, and website URL (if available):

Text Response
Bioinformatics major and is located in the Biology department (http://bioinformatics.byu.edu/)
School of Life Sciences, bioinformatics, https://www.rit.edu/science/programs/bs/bioinformatics
BS and BS/MS in Bioinformatics taught in the School of Life Sciences
Bioinformatics and Computational Biology
https://www.rit.edu/science/gsols/
Bioinformatics and Computational Biology (both a major and a minor are available)
http://www.canisius.edu/bioinformatics/
Bioinformatics major (with multiple concentrations); Center for Biological Complexity in the School of Life Sciences at VCU. http://www.csbc.vcu.edu/bioinformatics-programs/
http://catalog.minotstateu.edu/undergraduate/collegeofartsandsciences/departmentofbiology/#bsinbioinformaticstext
http://biology.umbc.edu/undergrad/undergraduate-programs/binf/
BS in Bioinformatics offered by Computer Science department. http://catalog.njit.edu/undergraduate/computing-sciences/computer-science/bioinformatics-bs/
https://science.iit.edu/programs/undergraduate/bioinformatics
http://bioinformatics.byu.edu/
Bioinformatics Major with the Interdisciplinary Science Program
Bioengineering
Computer Science and Engineering (crosslisted with Biology). http://cse.csusb.edu/programs/bioinformatics/
As above.
Bioinformatics, Department of Math and Computer Science https://www.fontbonne.edu/academics/departments/mathematics-and-computer-science-department/bioinformatics-major/
Biological Sciences, Chemistry, Computer Science, Mathematics, Statistics http://www.hunter.cuny.edu/qubi/qubi-home
Mathematical and Computational Biology (joint major offered by biology, math and CS departments) https://www.hmc.edu/biology/programs-and-courses/#math-bio
http://biology.umbc.edu/undergrad/undergraduate-programs/binf/
Unfortunately the major was discontinued because of lack of cooperation between the several component disciplines.
Department of Natural Sciences and Bioinformatics, Soongsil University, Seoul, South Korea http://bio.ssu.ac.kr/
http://www.biology.pitt.edu/undergraduate/academic-programs/bioinformatics
BS and MS in Bioinformatics http://www.rowan.edu/colleges/csm/departments/bioinformatics/index.php http://rowanu.com/programs/72
It is through computer science and is more a computer science degree than biology. http://programs.eku.edu/academics/computer-science
Biology-Interdisciplinary Computation: http://www.colby.edu/catalogue/requirements/bi/ Offered through Biology and Computer Science
Not one department. Supervised by genomics program but pulls from multiple departments.

https://www.stedwards.edu/undergraduate/bioinformatics
Unfortunately, our entire website is undergoing a revision and nothing up there (at the moment) is very reliable, contact me in the fall for updated links and information on the major and minor
http://www.sbu.edu/academics/schools/arts-and-sciences/departments-majors-minors/bioinformatics
BS Computational Biology (Biological Sciences Department)
http://lifesciences.vcu.edu/academic-programs/
http://biology.byu.edu
Bioinformatics
Degree offered http://undergrad-catalog.buffalo.edu/academicprograms/programs/bioinfo_about.html
molecular biology and bioinformatics https://www.uwp.edu/learn/programs/molecularbiomajor.cfm
Rochester Institute of Technology, Gosnell School of Life Sciences (GSOLS), Bioinformatics
I am the founder head of a B.S. in Bioinformatics program that was established at Ramapo College of New Jersey in 2002. It is part of the School of Theoretical and Applied Science http://bioinformatics.ramapo.edu/index.html
Biology department - bioinformatics.byu.edu
BSc Bioinformatics, Dept. of Computer Science,
College of Engineering, Biomedical Engineering, Bioinformatics Track http://www.engineering.uiowa.edu/bme/undergraduate-program/bme-tracks/bioinformatics-track-bme
specialization in quantitative biology and bioinformatics, undergraduate biology program, stony brook university
Biological Sciences Department, Bioinformatics Program https://www.stedwards.edu/undergraduate/bioinformatics
Bioinformatics, School of Theoretical and Applied Science, http://www.ramapo.edu/catalog-2015-2016/tas/bioinformatics/
http://undergrad-catalog.buffalo.edu/archive/1415/academicprograms/bioinfo.shtml
Université de Montréal, dept. of biochemistry
http://www.wpi.edu/academics/bcb/ugrad-requirements.html We are in the process of upgrading our website...
http://courses.cornell.edu/preview_program.php?catoid=26&poid=12977
https://science.iit.edu/programs/undergraduate/bioinformatics
It's a concentration for computer science students
Rensselaer Polytechnic Institute, Department of Biological Sciences http://www.rpi.edu/academics/interdisciplinary/bioinformatics.html
Biology
Iowa State University Bioinformatics and Computational Biology BCBio https://bcbio.las.iastate.edu/
New major, starting in Fall 2016. Offered jointly between the departments of Biological Sciences and Mathematics, Statistics, and Computer Science at Marquette University.
Computer and information Science engineering dept
We offer a Bioinformatics concentration within our Biological Sciences major in Natural Sciences
Bachelor of Science in Bioinformatics from College of Arts and Science http://unomaha.smartcatalogiq.com/en/2015-2016/Undergraduate-Catalog/Undergraduate-Degree-Programs-and-Certificates/Arts-and-Sciences/Bioinformatics/Bachelor-of-Science-in-bioinformatics-BSBI Bachelor of

Science in Bioinformatics in College of Information Science & Technology http://unomaha.smartcatalogiq.com/en/2015-2016/Undergraduate-Catalog/Undergraduate-Degree-Programs-and-Certificates/Information-Science-and-Technology/School-of-Interdisciplinary-Informatics
luc.edu/bioinformatics

Statistic	Value
Total Responses	59

P. BIOINFORMATICS TRAINING NEEDED

P. Notes (Training Needed): A large number of respondents identified the low level of their bioinformatics knowledge and minimal training though out the survey responses. On the direct question answered by 1,069 respondents about their current level of bioinformatics training, 10% mentioned that they had no training, 45% identified that they had no formal training or were self taught, and 22% identified that they had a short workshop or bootcamp. At the graduate level, 14% of the respondents identified that they had completed a graduate course, and 5% had a graduate degree in bioinformatics.

P1. Q34. Which of the following best describes your level of bioinformatics training?

#	Answer		Response	%
1	No training/experience		103	10%
2	No formal training (self-taught)		477	45%
3	Short workshop/bootcamp		234	22%
4	Some undergraduate courses		31	3%
5	Undergraduate certificate		0	0%
6	Undergraduate degree		5	0%
7	Post-graduate certificate		12	1%
8	Graduate courses		150	14%
9	Graduate degree		57	5%
	Total		1,069	100%

Statistic	Value
Min Value	1
Max Value	9
Mean	3.47
Variance	6.29
Standard Deviation	2.51
Total Responses	1,069

Q. BIOINFORMATICS TRAINING OFFERED

Q. Notes (Training Offered): Very few respondents appeared to offer bioinformatics training at their institutions, with just a handful of responses (n=9) to these four related questions on the training that they had provided at their institution. A follow-up SPSS table combining the four questions also is included to provide a more systematic overview of respondents linkage between the four questions to better describe their training approaches.

Q1. Q20. Briefly describe the format of the bioinformatics training (e.g., boot camp, short course, etc.) you most commonly provide.

Text Response
Bootcamp -> 2 to 5 day workshops that focus on specific bioinformatics content
2-day workshop
One or two day on-site hands-on training, mostly with NGS datasets
Mentor interning undergraduates in research lab
Short course, with a variable hands-on part
short course small group consultation
Short course
Short course, one on one
3 hour short courses, 4-6 day boot camps, weekly open coding hour, weekly 1 hour tutorials

Statistic	Value
Total Responses	9

Q2. Q21. Briefly describe your audience for this training.

Text Response
Graduate students, post docs, profs, etc.
Graduate students, postdocs, pre-tenure researchers
Grad students, faculty, staff. Hardly ever undergraduates
High school/Undergraduate students come for summer internships to our research lab to learn basic techniques of biotechnology.
Biologists and technicians from my University Hospital and nearer public Institutes
Wet-lab biologists (colleagues) students (graduate, postdocs transitioning to new fields)
PhD students, postdocs, senior researchers
Grad students, postdocs
graduate students, postdocs, faculty

Statistic	Value
Total Responses	9

Q3. Q22. In your opinion, what are the biggest bioinformatics needs of those taking your training?

Text Response
They have the data but really have no idea how to process it.
Data management best practices and automation, computing on shared HPC environments, practices for reproducible computational research
Overcoming the initial learning curve.
familiarity with bioinformatics tools
Both theoretical and practical knowledge of tools which could improve their working activity likely is the most important.
foundational understanding of a programming language
Genomics analysis skills
Basic skills, UNIX navigation and basic R.
statistics, project organization

Statistic	Value
Total Responses	9

Q4. Q23. What reasons do your students provide as to why they are taking your training (e.g., professional advancement, have a research problem they need to solve, have been tasked with teaching a course in bioinformatics)?

Text Response
They have a research problem they need to solve.
Research problem that is made challenging by having a large volume of high-dimensional data
Hope or fear. Fear of being left behind if they don't learn this stuff; or hope that they will actually be able to gain insight from their data.
Professional advancement
Professional advancement on topics which strictly relate to their day-by-day activity
have a research problem they need to solve bioinformatics skills are marketable
Research problem
Research problem or general interest in learning more
have or will have research problems they need to solve

Statistic	Value
Total Responses	9

Q5.

Additional SPSS Table Note: The following table provides responses that are linked by respondent, with the rows representing the respondent and the four columns representing the question asked.

Q20 - Briefly describe the format of the bioinformatics training (e.g., boot camp, short course, etc.)...	Q-21 Briefly describe your audience for this training.	Q-22 In your opinion, what are the biggest bioinformatics needs of those taking your training?	Q-23 What reasons do your students provide as to why they are taking your training (e.g., professional...
Bootcamp -> 2 to 5 day workshops that focus on specific bioinformatics content	Graduate students, post docs, profs, etc.	They have the data but really have no idea how to process it.	They have a research problem they need to solve.
2-day workshop	Graduate students, postdocs, pre-tenure researchers	Data management best practices and automation, computing on shared HPC environments, practices for reproducible computational research	Research problem that is made challenging by having a large volume of high-dimensional data
One or two day on-site hands-on training, mostly with NGS datasets	Grad students, faculty, staff. Hardly ever undergraduates	Overcoming the initial learning curve.	Hope or fear. Fear of being left behind if they don't learn this stuff; or hope that they will actually be able to gain insight from their data.
Mentor interning undergraduates in research lab	High school/Undergraduate students come for summer internships to our research lab to learn basic techniques of biotechnology.	familiarity with bioinformatics tools	Professional advancement
Short course, with a variable hands-on part	Biologists and technicians from my University Hospital and nearer public Institutes	Both theoretical and practical knowledge of tools which could improve their working activity likely is the most important.	Professional advancement on topics which strictly relate to their day-by-day activity
short course small group consultation	Wet-lab biologists (colleagues) students (graduate, postdocs transitioning to new fields)	foundational understanding of a programming language	have a research problem they need to solve bioinformatics skills are marketable
Short course	PhD students, postdocs, senior researchers	Genomics analysis skills	Research problem
Short course, one on one	Grad students, postdocs	Basic skills, UNIX navigation and basic R.	Research problem or general interest in learning more
3 hour short courses, 4-6 day boot camps, weekly open coding hour, weekly 1 hour	graduate students, postdocs, faculty	statistics, project organization	have or will have research problems they need to solve

tutorials			

R. CONTENT TOPIC AND COMPETENCY UNDERSTANDING FOR UNDERGRADUATES

R. Notes (Topical and Competency Understanding): When asked about the importance of 15 different topics associated with bioinformatics and their inclusion into the life sciences curriculum, most all of the 15 topics received responses ranging toward the high end of the scale (3 - moderately to 5 - extremely important). The two most important needs were identified as knowing how to access genomic data (4.24), and understanding the role of computation and data mining (4.13). Further, the score means for all 15 topics ranged from 2.86 to 4.24 (out of 5). When asked in a follow-up questions which topics were missing, a total of 175 respondents also identified that they thought that one or more topics were missing from the list, and gave a wide range of suggestions were made about additional topics or skill sets.

R1. Q24. In your opinion, how important is it for undergraduates majoring in life sciences or closely related disciplines to...

#	Question	Not at all important	Slightly important	Moderately important	Very important	Extremely important	Total Responses	Mean
1	Understand the role of computation and data mining in hypothesis-driven processes within the life sciences?	2	29	180	418	380	1,009	4.13
2	Understand computational concepts used in bioinformatics, e.g., meaning of algorithm, bioinformatics file formats?	26	150	372	304	155	1,007	3.41
3	Know statistical concepts used in bioinformatics, e.g., E-value, z-scores, t-test?	12	70	196	366	359	1,003	3.99
4	Know how to access genomic data, e.g., in NCBI nucleotide databases?	7	55	141	285	516	1,004	4.24
5	Be able to use bioinformatics tools to analyze genomic data, e.g., BLASTN, genome browser?	8	76	176	295	444	999	4.09
6	Know how to access gene	20	168	340	300	148	976	3.40

	expression data, e.g., in UniGene, GEO, SRA?							
7	Be able to use bioinformatics tools to analyze gene expression data, e.g., GeneSifter, David, ORF Finder?	25	193	348	273	134	973	3.31
8	Know how to access proteomic data, e.g., in NCBI protein databases?	22	132	264	327	244	989	3.65
9	Be able to use bioinformatics tools to examine protein structure and function, e.g., BLASTP, Cn3D, PyMol?	18	165	311	291	201	986	3.50
10	Know how to access metabolomic and systems biology data, e.g., in the Human Metabolome Database?	38	238	347	247	101	971	3.14
11	Be able to use bioinformatics tools to examine the flow of molecules within pathways/networks, e.g., Gene Ontology, KEGG?	27	228	368	234	118	975	3.19
12	Be able to use bioinformatics	38	251	340	232	109	970	3.13

	tools to examine metagenomics data, e.g., MEGA, MUSCLE?							
13	Know how to write short computer programs as part of the scientific discovery process, e.g., write a script to analyze sequence data?	146	267	270	172	125	980	2.86
14	Be able to use software packages to manipulate and analyze bioinformatics data, e.g., Geneious, Vector NTI Express, spreadsheets?	51	202	300	278	145	976	3.27
15	Operate in a variety of computational environments to manipulate and analyze bioinformatics data, e.g., Mac OS, Windows, web- or cloud-based, Unix/Linux command line?	67	210	289	254	161	981	3.24

Statistic	Understand the role of computation and data mining in hypothesis-driven processes within the life sciences?	Understand computational concepts used in bioinformatics, e.g., meaning of algorithm, bioinformatics file formats?	Know statistical concepts used in bioinformatics, e.g., E-value, z-scores, t-test?	Know how to access genomic data, e.g., in NCBI nucleotide databases?	Be able to use bioinformatics tools to analyze genomic data, e.g., BLASTN, genome browser?	Know how to access gene expression data, e.g., in UniGene, GEO, SRA?	Be able to use bioinformatics tools to analyze gene expression data, e.g., GeneSifter, David, ORF Finder?	Know how to access proteomic data, e.g., in NCBI protein databases?	Be able to use bioinformatics tools to examine protein structure and function, e.g., BLASTP, Cn3D, PyMol?	Know how to access metabolomic and systems biology data, e.g., in the Human Metabolome Database?	Be able to use bioinformatics tools to examine the flow of molecules within pathways/networks, e.g., Gene Ontology, KEGG?	Be able to use bioinformatics tools to examine metagenomics data, e.g., MEGA, MUSCLE?	Know how to write short computer programs as part of the scientific discovery process, e.g., write a sc	Be able to use software packages to manipulate and analyze bioinformatics data, e.g., Geneious, Vector NTI Express, spreadsheets?	Operate in a variety of computational environments to manipulate and analyze bioinformatics data, e.g., MacOS, Windows, web- or cloud-

													ript to analyze sequence data?		based, Unix/Linux command line?
Min Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Max Value	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Mean	4.13	3.41	3.99	4.24	4.09	3.40	3.31	3.65	3.50	3.14	3.19	3.13	2.86	3.27	3.24
Variance	0.67	1.00	0.94	0.88	0.99	1.01	1.04	1.12	1.10	1.05	1.03	1.09	1.54	1.22	1.35
Standard Deviation	0.82	1.00	0.97	0.94	0.99	1.01	1.02	1.06	1.05	1.03	1.02	1.04	1.24	1.11	1.16
Total Responses	1,009	1,007	1,003	1,004	999	976	973	989	986	971	975	970	980	976	981

R2. Q25. If there are bioinformatics competencies you feel are missing in the above, please describe them here.

Text Response
Ability to use a high performance computer cluster. Background in NGS. Ability to code large scale algorithms.
None
Be able to dissect existing source code and create some (but in an incredibly transparent language like html)
Integrating fundamental biological knowledge with data analysis skills.
R
Protein structure database (PDB), software to visualize, analyze, and compare protein structures: VMD, PyMol etc.
Manage an independent bioinformatic analysis project
I'm honestly not sure if constructing phylogenies based on sequence data is considered part of bioinformatics, but if it is, then I would say this an important thing for students to know about and experience, even if they can't do the whole process on their own.
phylogenetics; taxa divergence estimates; identify and view genomic variants using genome browsers (e.g. NCBI Variation Viewer)
It is important to be able to devise algorithms to ask novel questions of the data.
You don't mention using cloud-based, free platforms like iPlant or Galaxy...I feel that these are the best time investment for students in terms of learning software/platforms.
Be comfortable working in statistical environments such as R or SPSS.
Use for building phylogenetic trees
Modeling and proficiency in R are important. Bioinformatics per se as opposed to computational biology with theoretical inputs (from population genetics/evolution and from biophysics) will decline in importance going forward.
RNA Seq Data Analysis
NO
molecular phylogeny
Understanding the uses and limits of computational vs bench data.
understand methodology for obtaining bioinformatic data understand variety of applications for bioinformatic data (population genomics, ecology, etc beyond traditional molecular biology subfields)
fundation to teach oneself
use of bioinformatics in evolution and ecology
NON-GENMICS DATA!!! Bioinformatics is NOT just genomics data- and this is a HUGE disservice in educaction. ALL large data - GIS data, environmental data, synthesis data, are all critically important- and all but missing from most considerations of bioinformatics. I am soooo tired of bioinformatics now becoming synonymous with genomic data. You are totally missing the boat on the breadth of things that people need to know
General coding skills. Computer science courses should be a part of undergraduate biology curiculum
Basic phylogenetic comparison
data base development
Poor survey design. Too many choices for this national survey. I am tempted to stop here.
Comparative genomics, including or perhaps especially among microbes. How to detect

horizontal gene transfer.
be able to develop basic understanding of the science behind the validity of large pools of data
I, personally, am missing all of them
Most of them (I'm a field-based ecologist).
This is not my area of expertise.
Analyse phylogenetic data
your choice of software examples is badly off in a few instances in the table above. for metagenomics Mega/muscle?? a general tool and an aligner respectively? Geneious as typical example of software package -- maybe you meant commercial, gui based etc.
I emphasize alignment and phylogenetics as well.
I currently work with metagenomic and metatranscriptomic data using a Mac and Linux. I lack almost all of the other "omics" competencies.
Some familiarity with how bioinformatics data relate to experimental data derived from crystallography, NMR, circular dichroism, and other physico-chemical techniques.
There is NO mention of phylogenetic construction, and I think that's a CENTRAL use of the data as it puts everything else in an evolutionary perspective.
All of the above. But I would love to have those taught here.
relational database use, metadata analysis
I dont think it is important to know how to use tools. I think that bioinformatics students need to know how to write code to chain together existing tools, or to write new ones. Most problems require some programming.
None seem to be missing
There are no competencies missing. I answered moderately important for most of these because not all life sciences majors need these tools, though for the ones who do, the answer changes to very important. What students at this level really need is an appreciation of the opportunities and limitations associated with bioinformatics. This is information that is sorely lacking in virtually all of the life sciences. And it must start early and be reinforced throughout their classes.
Using R to build graphs based on genomics data and make sense of these graphs (scatter plots, heat maps, density plots etc...) Finding SNPs / variation and understanding the effect of SNPs on gene function
The entire issue is that there are too many computational competencies required for students to do basic work and understand the concepts--the goal at this level.
Understand the limitations and error rates associated with data acquisition technologies
NA
understanding evolutionary underpinnings of the bioinformatics methodologies
I think the questions miss the main point: these skills would be very valuable for the small subset of students who specialize in this area, but few would be relevant for the majority of (bio) students. The question does not allow that dichotomy, so all the answers aren't really appropriate.
It appears that you are defining bioinformatics very narrowly. What I teach and what students need is broader, maybe closer to what you would call statistics and computer science, or data analytics.
The above list is very difficult to respond to since level of importance depends on lot on research subfield. I work on genomic DNA data but not gene expression or protein data. While I view the former as most important to me, I also know that the later topics would be very important for people carry out research in those areas.
These are all aimed at molecular research tools. What about natural history collections? Perhaps you are using the warped view of "life sciences" as being narrowly defined as molecular biology, or biomedical research. Had some questions been about tools for

acquiring and analyzing a broader range of bioinformatics, some of my responses might have been more strongly positive.....
you are already well beyond my own competencies!
I am learning programming for Python, Java, R, and others on my own. I plan to begin working on a bioinformatics or data science certificate program (online on Coursera) this summer. I have looked for a fellowhip to retrain in bioinformatics (my Ph.D. is in Biochemistry), but most are for current college students.
To understand the use of data, esp. homologous sequences (synapomorphies) to discover and understand relationships among taxa.
All of them except for how to access Metabolomics and System Biology
Be able to use bioinformatics tools to model phylogenetic relationships.
integration of bioinformatics software and real life knowledge of molecular biology, ability to develop new software to solve existing problems
Writing software
Programming in R or the ability to use bioconductor tools.
The ability to develop and test a computational hypothesis.
I feel like this effort might be too little to late. There certainly is a balanced need for learning bioinformatics but it can't come at the expense of Biology or the phenotype.
None missing
none that I can think of
Shell scripting. Regular expressions.
It is more important for students to learn general approaches (e.g. how to write a script or operate in Unix or Linux) than to learn specific programs or tools (at the undergraduate level)
Understand science as a way of knowing. Understanding the differences between frequentist and Bayesian inference. Understanding probability. Understanding Hypothesis testing.
Multiple sequence alignment Phylogenetics
applications to taxonomy (DNA barcoding) & systematics (trees) as these inform evolutionary biology and biodiversity research
my institution has a large number of pre-health professions students (med, dental, PA school) - it would be useful to include some healthcare-related bioinformatics content for these students
They need to know how the different omics fit together.
Understanding of false discovery rate
Phylogenetic analysis is a crucial competency that is often overlooked in traditional bioinformatics curricula. It is essential. Nothing in comparative biology can be done without considering and inferring phylogenies.
unix, python, command line driven analysis
phylogenetics, and ecological analyses!!!
At the present time in our University, there are five departments that offer a certificate in bioinformatics at the GRADUATE level. I think it is important for undergraduates to understand the growing importance of metadata analysis and the tools that are utilized; but aside from independent study in a particular area, coursework here is focused on general computer literacy and competence in general statistical analysis.
Scientific programming. This is already often and will become universally indispensable.
lost our Dept of Computing including faculty, phased out for lack of student interest. Proposals to make biology-centric along bioinformatics and data analytics did not make the case with administration, i.e., lack of interest from students.
Learn the basics of information theory and its relation to scientific reasoning.
I think that a previous or simultaneous knowledge of statistical analysis may be through

a pre-requisite course is needed.
Understand raw instrumental data (e.g., from genome sequencing) and workflows to analyze its quality and process it into a usable product
Hidden Markov models, basic graph theory, basic linear algebra, electrophoresis, PCR, micro-array analysis
I'm not sure if they are bioinformatics competencies per se but understanding the evolutionary context for doing comparative analysis is a huge, fundamental, and challenging topic. Basically students need to be able to do tree-thinking. I also think that understanding the ways that models (statistical, or otherwise) play an important role in bioinformatic analysis (they establish the assumptions you are working within) in important.
16S rRNA-based microbial community analyses for microbiomes (human and other), and related statistics.
How to annotate a genome. Understand NextGen stats (fold coverage, Q-scores. How and why to submit data to databases
Analyze differences between pathogens and wild type for example resistance genes and virulence genes. Look at SNPs in for example Mycobacterium tuberculosis. Study role of transposons in gene functionality. Perhaps this can be done with programs listed.
No.
machine learning methods, data visualization methods
You've asked about very specific software packages, which are not important to me. If you had asked about conceptual knowledge, my ratings would have higher.
understanding of data standards and the curation process
Identify microbes from SSU rRNA using the Ribosomal Database Projrect Generate a phylogenetic tree from aligned sequences
Understanding the role of genomics in modern biology, personalized medicine, relationship between sequence motifs and transcriptional processes, molecular phylogeny
use R statistical language
n/a
Basic coding in something like PERL or Python to mine biological data
You seem to cover it all
Evaluating and creating phylogenetic trees using various methods such as Maximum Parsimony, Maximum Likelihood and Bayesian.
PDB, stat packages: R/Matlab/SAS
Program writing, UNIX, and Geneious et al.
Maybe more on the computer programming aspect
NA
The questions seem very focussed on using programs and resources, and much less on understanding the unique strengths and weaknesses of the programs and resources. Bioinformatics training should largely focus on discovering and understanding biological uncertainty.

Statistic	Value
Total Responses	175

S. TECHNICAL BARRIERS IN TEACHING BIOINFORMATICS

S. Notes (Technical Barriers): A total of 53% of the respondents noted that they do face technical barriers in teaching bioinformatics, with more common responses identifying challenges with the availability of a computer lab, inadequacy of available computing equipment, different operating systems, the variety of hardware devices that students bring with them, IT support deficiencies, and budget problems for technology. A total of 47% noted that they did not have technical barriers. For respondents that did have technical barriers, a total of 880 also answered an optional followup question on what those technical barriers included. This included a wide range of responses, including responses such as a 1) lack of computing facilities, 2) lack of IT support for bioinformatics, 3) territorial behavior between disciplines, 4) lack of consistent platforms by students, and 5) financial and space restrictions for needed computing resources.

S1. Q26. At your current institution, do you face any technical barriers in teaching bioinformatics, e.g., availability of a computer lab, different operating systems, access to high performance computing for teaching, IT support?

#	Answer		Response	%
1	Yes		468	53%
2	No		412	47%
	Total		880	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.47
Variance	0.25
Standard Deviation	0.50
Total Responses	880

S2. Q27. Optional: Please describe.

Text Response
server space/time; dollars for software
availability of computer lab, different operating systems on students' own computers
availability/modernness of computer lab
Lack of expertise in using most of the above programs. Current curriculum uses BLAST, KEGG, NCBI database in student activities.
all of the above. Space and IT infrastructure are big barriers
We basicallt have PCs and it's a challenge to get the appropriate software loaded and supported. And it's tought to get the control over the software. IT always wants to limit access
access to high performance computing
Lack IT support on our campus. There are two campuses for my institution and IT is located on the other campus. IT travels over once a week to take care of issues on my campus.
Yes, but only in so far as there is a lack of specific bioinformatics technical support (how to use software, which options to choose, etc.). I have excellent general IT support and no trouble with access to the resources.
lack of computer labs
Computers access. Computers too old and slow.
access to high performance computing, IT support
Classroom space with computing facilities are limited to large classes (< 100 students) or for a few smaller classrooms. There is also limited IT support for these facilities.
Lack of Linux-based OS, lack of admin on Windows OS (to download programs on a whim).
availability of a computer lab, different operating systems, access to high performance computing for teaching, IT support
Lack of IT support, no Mac computer labs.
If students are expected to be able to work on course-work at home, they need access to software on their personal computers. Many of my students have a Microsoft Surface instead of a laptop or no computer at all. The tech buy-in for students is expensive. I haven't been able to envision a course set-up yet that get around this hurdle. I'm open to ideas!
We do have computer labs, but the computers are older and not well-maintained.
computer labs are few, Macs & LINUX are not supported or available, no high performance systems available.
no computer labs anymore
limited budget, no high performance computing, limited IT support
Lack of high performance computing resources
If we were to delve deeply into bioinformatics there might be hurdles in getting appropriate software running on sufficiently capable computers. Not insurmountable.
Dedicating computational resources for teaching that are distinct from those for research mostly don't exist at institutions I have been involved with.
lack of dedicated computer lab classroom space
availability of a computer lab, access to high performance computing for teaching, IT support
Lab and computational resources.
mostly access to sufficient computers and computer labs - we are working on this, but have a very real space problem
Students are not required to have a particular OS or even a laptop.

access to high performance computing for teaching
access to programs, operating systems IT support lack of interest with Math/Computer Science colleagues in cooperating funding for development and personel
More computers are needed.
Territorial behavior among disciplines....math and business types make access to teaching labs with computers impossible. I do not think that IT folks here understand high performance computing needs for faculty or students interested in bioinformatics; IT here is more concerned with online learning and Microsoft Office applications.
All of those listed, actually, plus time.
Coming up with a reliable standardized computing environment is challenging, ideally would like some type of robust platform that students could use at home as well as on campus.
suitable computer laboratories, access to different operating systems
availability of software; size, space, and availability of computer labs; student access to computers/software at home.
Access to computers, access to HPC resources, IT support, funding
HPC access for teaching is available by application. I haven't tried this yet.
lack of teaching lab facilities
Wireless network is virtually useless and IT dept. won't fix it, because they don't try to use the network wirelessly, just wander around with a laptop looking at bars. Five bars and the network drops repeatedly when trying to use make for extreme frustration.
lack of time and resources
Not enough computer classrooms for all courses that wish to use them.
It would be difficult to get IT support for more complex operating systems.
We're a small college and have no access to any servers or even MAC or linux operating systems.
Not enough money.
Not enough trained faculty; not enough resources, not enough time
Access to computer labs - often other classes are already scheduled for the labs.
We only have one computer lab in the building with outdated computers that have no plans for replacement.
Access to high performance computing and the IT support that would entail.
Basic computer knowledge is lacking in UGs.
higher power computing abilities are lacking
Hardware deficiencies, some.   I admit to being stupid in bioinformatics.
We only have one computer lab for all of our sciences, so we have to deal with scheduling conflicts with environmental science, chemistry, and physics. We also generally only have Windows or MacOS, and many of our computers are frighteningly slow for even basic programs like Excel.
Competition for scheduling of computer labs.
Lack of dedicated IT support. computers are outdated and not managed very well. The ratio of computers to students is low.
no computers (only laptops which are a hassle to start up, and gain access to) in my lab
no real IT support, no teaching support (TAs and the like) - hard for one person to run around the computer lab and help everybody!
I am at a large (~20K students) state institution. Finding a computer lab available for bioinformatics class is a major barrier to scheduling bioinformatics class. Also, any installation of software needs to be done in the summer for anything taught during the following academic year. There is no flexibility to add an installation during the year (central campus wide-IT department deals with installs) and no ability to trouble shoot if something does not work.

very little funds to upgrade computers. I currently use mini macs purchased 13 years ago in my physiology lab...they work great but.....
We have laptop computers that get reconfigured (broken) every summer and limited access to high performance computer systems via grants.
all listed above
Hard to schedule computer labs because there are numerous constraints on scheduling of all courses, particularly labs, and especially computer-labs (there are only a few). Also, it's not too difficult to teach/learn one program or system, but you would have to be a bioinformatics major to learn all of them- it's a tool for biologists- it needs to be taught, at the undergraduate level, so that bio/chem/other majors can acquire a reasonable level of exposure and expertise in one course that has no math or computer pre-requisites. Beyond that it can be as sophisticated as possible given the resources, faculty expertise, student interest.
I don't know anything about it, and we don't have the computer set up for it.
IT support
More computer access and support for Mac environment.
We have some computer labs but we have gone to bring your own device. So we are limited. IT can be temperamental esp with needs outside of common demand.
lack of interest by students partly due to other faculty downplaying its importance
Computers available, but not necessarily up-to-date or high performing and not necessarily with the right software
Availability of computer lab (described above) Access to high performance computing for teaching IT support
The technical barriers can be overcome with justification.
We do not have effective way to access high performance computing We also do not have a lot of time dedicated to bioinformatics specifically
IT support
We have laptops for students but they are not high perform computing and our network is not that fast on campus.
Computer labs in adequate
computer lab, access to high performance computing, and teaching
Sufficient computer lab capacity
Barrier: number of good computer labs available for teaching labs.
heterogeneity in operating systems, lack of "training" programs that would illustrate the point, but won't take as much time or have all complexity of real tools
Getting tech to work for class is extremely difficult. Hard to synchronize students' personal computers and school computers. Need to do that if you are going to assign classwork outside of the course.
access to high performance computing for teaching, IT support
Two year school. Limited access to computers. Sometimes there are conflicts with more than one instructor wanting to use the computers at same day/time. Many students not very computer savvy. IT staff has become more helpful through the years.
Many online tools are nonfunctional as the websites are not "secure" by our firewall's standards.
Few computer labs available. While students often use their laptops, desks are not optimal for this work (chairs with attached desks; desks at an angle).
We have a number of computer labs on campus, but there are many courses which already use them. Additionally, we find that there are often issues when the college or the software we use in our courses goes through periodic updates, and many times the software will no longer be supported.
Hardware and software support is lacking. My department is reluctant to invest in any

hardware or software to support instruction in computational fields since these assets age quickly, unlike microscopes (no joke, we just bought $30k worth of teaching microscopes).
lab availability, especially for courses that enroll large numbers of students
IT support and computer access is improving as rooms are redesigned
Access to high performance computing for teaching, IT support for software packages
Technical support
in time we hope to segue into the computer science program to offer introductory and intermediate courses in bioinformatics. This would depend on our college supporting a 4-year program in biology.
No dedicated computer lab for biology courses.
IT support is not very good so we have problems trying to get software installed and/or kept updated
Wide availability of programs for analyzing data.
We have computer labs, but they do not belong to our department. but will -probably need additional for teaching bioinformatics
lack of support and training
Lack of a sufficient number of computers with the correct operating systems and ability to use related software.
Don't know. We practice using cladistics on small data sets to learn the process.
All of the above. Plus many students do not own their own computers or know computer basics
Access to high performance computing
my own lack of expertise with the field, lack of computer spaces and old computers in the spaces we do have

Statistic	Value
Total Responses	318

T. COMPUTER PROGRAMMING AND STATISTICS FOR UNDERGRADUTE MAJOR IN LIFE SCIENCES

T. Notes (Computer Programming and Statistics): When asked about the need for computing programing and statistical knowledge for undergraduates, a total of 995 respondents rated the need to be familiar with computer programming as generally moderately important (3.23 on a 5 point scale), and a total of 1,007 respondents rated the need to have a working knowledge of statistics as being between very important and extremely important (4.38 on a 5 point scale).

T1. Q28. In your opinion, how important is it for undergraduates majoring in life sciences or closely related disciplines to...

#	Question	Not at all important	Slightly important	Moderately important	Very important	Extremely important	Total Responses	Mean
1	Be familiar with the elements of computer programming, e.g., by way of a semester course in computer science?	63	218	312	230	172	995	3.23
2	Have a working knowledge of statistics, e.g., by way of a semester course in statistics or biostatistics?	3	23	107	334	540	1,007	4.38

Statistic	Be familiar with the elements of computer programming, e.g., by way of a semester course in computer science?	Have a working knowledge of statistics, e.g., by way of a semester course in statistics or biostatistics?
Min Value	1	1
Max Value	5	5
Mean	3.23	4.38
Variance	1.34	0.62
Standard Deviation	1.16	0.79
Total Responses	995	1,007

U. SKILL DEFICIENCIES FOR INCOMING GRADUATE STUDENTS FROM UNDERGRADUATE PROGRAMS

U. Notes (Deficiencies for Incoming Graduate Students): Numerous skills were mentioned by the 72 respondents on the noted deficiencies for incoming graduate students, and these included such as a lack of: 1) statistical knowledge, 2) computer programming / coding, 3) use of bioinformatics tools and sites, 4) computational and quantitative thinking, 5) publically available data sets, and 6) data cleaning or data refinement strategies.

U1. Q47. In your opinion, what bioinformatics skill(s) are incoming graduate students most deficient in?

Text Response
Most of the students I work have little familiarity with any bioinformatics when they start.
All of them. Even using Excel to manipulate a big data set and do statistics is unknown to nearly all of them.
general management of sequence data
logic behind analyses
Programming
Many have accessed data in NCBI
unserstanding of the role of algirithms in biasing interpretation
Mathematics at all levels. Quantification
Don't know in general
Calculus, computer programming
General computer/coding knowledge and statistics.
SQL, program design, statistical analysis of large data sets
Statistical analysis
databasing, basic coding and script writing
Use of databases, sophisticated understanding of BLAST, coding, knowing how to analyze the data
Varies greatly between students and given the relatively small n I have no opinion.
Appropriate level of math and exposure to computer science.
Statistics, basic mathematics, code development
Bioinformatics is evolving rapidly, which demands constant updating.
data analysis
Everything but basic BLAST searches
Accessing of, and even knowledge of the existence of, large publicly available data sets (genomic, proteomic, variation, expression).
Biostatistics
statistics
Most MS level graduate students do not have experience in bioinformatics.
programming
They are lacking in the basic knowledge of what a fasta file is, how to use BLAST (how to adjust the parameters of the algorithm and what it does) and the NCBI resources. They also lack the knowledge about gene structures and the application of knowledge to understand and perform manual curation of a genome
Again, a focus on basic computer literacy and statistics is important for incoming students.
Computing thinking, the workflow/algorithm of a bioinformatics tool
Coding, working on the command line (to run various programs locally or on a server)
Basic knowledge and more advanced knowledge. They don't know what they don't know.
Understanding basic concepts in statistics
very high variation in this, some come with lots of experience, others have literally no skills or even exposure
Script writing
Ability to program
Coding
Same as the undergrads: basic programming skills are lacking, and selection of the right

tool to answer the question at hand is sometimes challenging.
Statistical concepts beyond the basics.
Fundamental concepts (why are we doing this, what questions would we answer with this, what are the assumptions/pitfalls of some approaches). Experience.
modelling
Pretty much all of them.
Rarely will a applicant to a graduate level bioinformatics program have sufficient background in Biology, Chemistry, Statistics/Biostatistics, and Computation. Applicants come from a variety of backgrounds, so they typically lack prerequisite knowledge in one or more fo the previously listed areas.
They don't know enough biostatistics.
Big picture awareness of what can be done and what skill sets are necessary for common applications
they don't know statistics or how to use even a simple computing environment such as Matlab.
In our program, anything quantitative, anything computational. Very few with useful programming skills or deep statistical understanding
Quantitative analyses
Statistics and use of NCBI software (the basics)
Unix/Linux administration Programming (Perl, Python and/or C++)
computational skills
Statistical inference
Familiarity with basic command line, bash scripting, and the ability to construct and interpret simple bioinformatics scripts.
Statistics.
programming
Programing
Poor knowledge of available tools to facilitate learning.
Reasoning about data, independently solving problems with data, including locating and using online resources
critical thinking
statistics and programming. many are moderately competent around a computing environment, so can run existing software, but not good at file manipulation, troubleshooting, or statistical hypothesis testing and interpretation of statistical data.
Students from biology/chemistry/nursing typically lack the foundations in simple coding (software programming) , which they may need to process data before using a tool like Weka.
Algorithms and mining databases.
All! Few seem to have any skills/experience at all.
data acquisition and analysis, especially appropriate graphics/plot implementation
Given we only have a M.S. program in Biology, the problems are similar to undergraduate issues above.
Everything.
Command-line and scripting skills - this severely limits their ability to deal with large datasets
Programming skills (beyond click-and-run R scripts), basic statistics knowledge
Programming and statistics.
Basic scripting, best practices, experience with command line tools, knowledge of statistics beyond the required intro course from their major.
programming in general
All

General data skills, working in the Shell

Statistic	Value
Total Responses	72

V. CHALLENGES CURRENTLY FACING EDUCATING UNDERGRADUATE STUDENTS IN BIOINFORMATICS

V. Notes (Challenges in Educating Undergraduate Students): A total of 743 respondents described what they thought were the most important challenges for educating undergraduate students about bioinformatics in the life sciences. Challenges mentioned included items such as 1) having faculty members with the needed expertise, 2) working across disciplines, 3) the weak computational and statistical skills of students, 4) a lack of an awareness for the importance of the topic by colleagues and administrators, 5) the needed time and resources for changing the curriculum, and 6) the pace of change, 7) a need for better computing facilities or resources, and 8) an existing curriculum that is already packed with other important topics.

V1. 43. In your opinion, what do you think are the most important challenges currently facing those educating undergraduate life scientists in bioinformatics?

Text Response
Having people with extensive experience in dual disciplines. Many programs focus too heavily on the computers and miss the biology, while others focus too much on data analysis and don't learn coding. I think we find a good balance in our program, but there aren't many like ours, and their need to be.
fast pace of change
differences in student backgrounds and familiarity with computation
I think bioinformatics would best be taught if it was integrated into the sequences of core courses rather than a standalone course. But, not all instructors have the knowledge and experience necessary to do it well. Resources from the bioinformatics community that were targeted to these types of courses would be a great help, I think.
Time and appropriate resources
All courses face the same greatest difficulty, instructors who are not hired based on, or rewarded/respected for, using data and modern reformed pedagogy in teaching.
Bioinformatics takes substantial learning in modeling and systems thinking. Students also need to be familiar with "big data" and have computational skills necessary to work with these large datasets. Ecology (i.e., climate, long-term ecological data) and Molecular data should both be included in these conversations.
Convincing administrators that faculty from disparate departments can and should teach outside of their home department.
time, available (quality) curriculum
Weak/declining quantitative skills among undergraduates, unwillingness to persevere if something is "too hard"
Lack of faculty expertise in the rapidly changing disciplines of genomics/bioinformatics and related technologies; lack of choice of curricula that can be successfully implemented in introductory or advanced courses.
The lack of basic mathematical and computational knowledge and skills among students, even in a private university. Many more traditional biology faculty also lack training in computational methods, and even several of them have "math phobia"
Lack of training in the area, as many of us earned our PHDs before bioinformatics was widely used an available
Students and other faculty seeing the relevance, understanding that this is where biology is. Letting go of traditional approaches to make room recognizing that this is an area in which to hire new faculty.
Building confidence in using computers and statistics. Most of our Biology majors do not have opportunities for learning programming languages. Most Undergraduates also do not consider computer work to be biological research.
It intimidates students.
Students are not aware of the advantages of the bioinformatics skills
lack of comfort with the programs/tools used and the ever changing programs/tools used
THE MULTIPLICITY OF ANALYTICAL TOOLS AND PLATFORMS.
Life science majors tend to have little to no background in statistics and programming - and a good deal of fear of both. The goal of my current CMB 351 is simply to teach the students how to use the available data and online tools correctly, and how to interpret the results critically - along with some low-level information on algorithms involved. I would like to teach a senior level course that is project based and involves programing.

However, enrollment issues would have to be overcome as well as students would have to take a Comp. Sci. programing course as a prerequisite. In other words, for a cell and molecular biology major with huge emphasis on wet lab proficiency, adding 2-4 computational courses to the required curriculum is not palatable. The best target group is CMB-major/CompSci-minor, but there are currently few such students, at least in my institution.
Biology students discomfort with mathematics; instructor hesitation to throw themselves into the fray with students working on projects.
Overcoming the "silo" mentality that relegates computational instruction to the mathematics department, if only in students' minds (like their issues with biology faculty teaching writing). Also the rapid pace of the field and expansion of the tools. Finally the need for high-capacity computing instruments.
A lack of training and experience in bioinformatics. A lack of agreement about what topics should be dropped in order to have space/time to introduce bioinformatics.
Use active learning, problem sets, etc. rather than lecture methods. Students need to DO bioinformatics, and also know why it's important in the post-genomic era.
Computational knowledge (programming, navigating GUIs) Disciplinary knowledge (biology, genetics, cell biology, biochemistry)
Students' computer science skills.
1.) Making room in the biology curriculum for regular offering of the course 2.) Showing bioinformatics early in the curriculum to pump students in that direction
The interdisciplinarity of bioinformatics means (I think) that students need a lot of background before they can even try out bioinformatics. It seems like a field which has no easy entry. Students needs science, math and computer science/programming courses in advance.
I sense students are intimidated by the computer and the amount of information they can find.
Sometimes the instructors themselves (and this includes myself) have received not enough training in bioinformatics (or the underlying math/CS) to be able to teach it well. This could be ameliorated by workshops (designed at times when PUI faculty could attend) to help give us more bioinformatics skills.
training for faculty, computer resources
Students lack quantitative skills and have a lack of interest or fear of mathematics, computer science or other supporting disciplines. Further, students are encouraged to follow pre-professional pathways (Pre-Medicine) rather than pursue research opportunities.
Availability of bioinformatics lab activities geared for an introductory level.
online GUI stuff is not particularly meaningful, but the most meaningful and helpful programs (or coding applications) are on Linus-based OS, or have a steep learning curve.
They do not understand it and it is not easy to teach yourself
Trying to figure out how to incorporate it into a curriculum that competes for time with other important biology courses. After a while, we need to stop just making a new course that focuses on faculty interests or on the latest technique. What does an educated biologist mean these days. Some standard would be good.
How quickly the technologies/approaches change and the new software packages/programs that are created.
Inadequate quantitative/mathematical preparation.
Too much other stuff in the Biology curriculum that is perceived as essential. We'd have to sacrifice some parts of the curriculum to increase bioinformatics content and there would be resistance to that.

lack of computational/math skills among biology faculty (like myself) results in a somewhat "lite" version of bioinformatics being taught. strong on biological context and content, but weak on algorithms, code, and computational background.
student skepticism/resistance.
Teaching what the students need to learn in a very short period of time. There is not enough room in a student's schedule to take all of the courses that are considered important and graduate in 4 years.
No formal training/background in the discipline. This makes it incredibly challenging and intimidating to build a course. Therefore, we simply keep saying "yeah we need a course like that", and never do it.
Many of us are older and not specifically trained in the discipline. At smaller colleges, we do not have enough faculty to specialize and still cover introductory courses.
Hurdles of thinking algorithmically
Many of us have had limited formal training in bioinformatics, and keeping our expertise current can be a challenge. It has been somewhat challenging for me (in a small institution with relatively low student population) to convince enough students of the importance of bioinformatics to get my upper-level courses to 'make'.
Lack of training
Other than Genome Solver, there seem to be few resources for educators to use in the classroom. I also suspect many educators lack much experience with bioinformatics. As I mentioned earlier, our courses are already so packed with content that adding more is difficult.
Being familiar enough with the tools to teach undergraduates how to use them. And to be familiar enough with the tools and content to identify topics that undergraduates can understand.
Availability of computer labs, availability of instructors.
Time, and computer resources. With 1200 majors we can't offer bioinformatics to all of them, not even the 800 premeds. It is tough enough getting the training for the 100 graduate students.
training instructors and attracting students
Lack of training in statistics in our undergraduates.
students are afraid of computational aspects of biology
Time to fit into curriculum
training/education of instructors, availability of computing power, availability of programming/coding skills, computer phobia
Large class sizes, instructor training and support
Students with poor math base, choose biology thinking that they do not have to work with math anymore.
knowledge
Students shy away from mathematical and statistical methods, and few have programming experience
Lack of knowledge in educators and lack of computational resources
Biology students do not take enough math and statistics on average.
convincing older faculty members that bioinformatics is here to stay and should be included in our undergraduate courses
Resources- Change is so rapid in this field- if I teach a class every other year-- I have to fully update the labs to work with the new websites.
Time and staffing. We don't have enough faculty to teach all of the courses we need. We teach three excellent bioinformatics courses on the graduate level, which are heavily enrolled, but do not currently have the ability to extend those to the undergraduate level due to a lack of faculty resources.

Time to learn the required bioinformatics skills.
time
Finding ways to make students interested and engaged in the material presented.
Most students do not have programming skills or experience.
Insufficient time to meaningfully incorporate bioinformatics into the curriculum. Insufficient knowledge by some of the faculty about bioinformatics - this is changing as individuals retire.
Keeping up with new online tools and programs.
Training, curriculum development, acceptability/inforporation of bioinformatics into other established courses
Technical Resources and Finances. Small size of our faculty compared to number of students
Time and the faculty not familiar with the subject.
Sound background and curiosity in interdisciplinary subjects e.g. biology, cs, statistics
Keeping up with the changes to programs and searches Funding at an institutional level
Apathy on the part of students
I believe it's that faculty at our institution face daunting teaching loads: 15 contact hours per semester in a 2-semester academic year.
Resources
Time in the two years to work it into the AA Mathematical training is weak coming in. Very few even take statistics here
Training of faculty and motivation of students. A lot of deadwood faculty are not keeping up with the times and students do not know enough to know what they are missing. Plus, many introductory textbooks are doing a disservice about introducing bioinformatics concepts. I wish I had access to more workshops related to teaching bioinformatics....seems like most are devoted to learning techniques.
Time and inadequate computer labs
Standardized computing environment
Access to good facilities, qualified faculty to teach such courses
The students ability to think critically and effectively evaluate information. They rely on being told exactly what to do and have an inability to problem solve when things don't turn out as they anticipate.
Learning the new tools that are ever evolving
they haveno training
Fitting bioinformatics courses into an already crowded curriculum.
Better basic training on faculty
Interdigitating the courses with non bio informatics courses. Attmepting to show the significance across fields.
Access to appropriate resources and support Student fear of bioinformatics and the associated learning curve (I have to work hard to recruit students to register for my course.)
Not enough training in new tools available for study and research.
1. Rapidly changing field 2. Mismatch between expectation of students and of faculty
time to develop course material, computational resources, computational comfort of students (beyond GUI tools)
This is a challenge for all life scientists: the general under preparation of students. They are often not taking statistics until junior year. For bioinformatics specifically: it is a different approach to biology that UG have rarely encountered before (in part because they are not computer scientists or math majors).
Getting the time to do it.
Students coming out of highschools are unprepared for basic math and reading skills

necessary.
aligning course concepts and content with the changing landscape in the biological sciences
Lack of instructors
Getting a degree before bioinformatics existed. One tries to use the tools, but they are difficult and one really doesn't trust the results because of not knowing how to distinguish garbage from reliable data.
Recongizing that bioinformatics is MORE than genomics data, lack of quantitative requirements for undergraduates, shying away from mathematics requirements for bio majors, especially calculus
Getting formal training in bioinformatics

Statistic	Value
Total Responses	743

W. QUESTIONS PARTICULARLY NEEDING MORE IN DEPTH ANALYSIS AND QUESTIONS DOCUMENTING UPLOAD CONFIRMATIONS

W. Notes (Additional Questions and Respondent Uploads): The responses to the following questions have very useful information particularly need to be analyzed in a different strategy or format in a later analysis phase for the survey responses. The raw responses are still provided here for a skim or quick review for the respondent information, but are relatively dense for a short overview approach.

W1. Q42. For each undergraduate course you teach that includes bioinformatics content, please provide the name of the course, the department/unit(s) in which the course is listed, and a brief description of the course.

Text Response
All courses are in the biology department. 1. Introduction to Bioinformatics: Entry level course for any life sciences student. Students learn basic Python and Linux, and are introduced to common databases. Students are also exposed to many different fields within the Life Sciences in which a bioinformatics skill set is helpful. 2. Computational Biology: Covers major algorithms in bioinformatics. Students are expected to take five computer science classes before this course and are typically strong programmers. They code 20-30 different algorithms and learn the strengths/weaknesses of each, and finally they are asked to solve biological questions using their algorithms. 3. Bioinformatics: Capstone course for bioinformatics majors. Students are given data at the start of the semester and asked to test some hypothesis using computational tools they develop, or download. The questions they are expected to address typically have not been solved, so these tend to be real projects and from time-to-time lead to publications.
Bioinformatic Analysis of Macromolecules (BIOL 325), School of Life Sciences This course will introduce you to the computational analysis of genetic sequences. Emphasis will be placed on genetic information derived from the human genome project but findings from the genomes of other model systems will be presented as well. Each week we will meet for Lectures will discuss available computational tools for extracting biological information from nucleotide and protein sequences. The computer-based laboratory will employ bioinformatics software to demonstrate how to manage, search and analyze genetic sequences. Laboratory sessions will include the use of programs to predict genes, perform multiple sequence alignments and analyses, predict protein secondary structures, construct phylogenetic trees and access publically available databases. Genomics (BIOL 340) School of Life Sciences his course introduces students to the analysis of complex genomes. Emphasis is placed on genetic information derived from the human genome project but advances with genomes of other model systems will be discussed. Lectures cover scientific techniques used to map and sequence the human genome, as well as strategies for identification of disease susceptibility genes. The laboratory utilizes an automated DNA sequencer to demonstrate the acquisition of genetic sequences. Laboratory sessions emphasize cycle sequencing of cloned DNA fragments using an automated fluorescent DNA sequencer. Ethics in Bioinformatics (BIOL 425/625) School of Life Sciences This semester we will review a number of topics related to ethics in bioinformatics and in our contemporary society where information is easily shared, stolen and revised. Your instructor will introduce each topic and lead an introductory discussion. You will follow up with presentations relevant to the weekly topic. All lectures and presentations will be interactive and include ample opportunities for discussion. Consequently, class participation is a key component of this course so you will be expected to participate. Participation will be a component of your grade. Advanced Applied Genomics (BIOL 440) School of Life Sciences In this unique course you will be involved in authentic genomics research through two hands-on projects. DNA sequences obtained from the Genome Institute at Washington University (genome.wustl.edu) will be finished (project

1) and annotated (project 2) during two three hour computer laboratory sessions each week. A weekly one hour lecture will be used to introduce important and relevant topics. At any time during the laboratory sessions we may gather to review common challenges you encounter and review the techniques employed to address them.
BIOL/CHEM327 (Biochemistry I), BIOL363 (Genomics)
BIOL 1402, Biology for Majors I. The purpose of this course is to prepare students in concepts of cellular biology. Topics examined are: macromolecules, cell structure and function, membrane structure and function, cellular respiration, photosynthesis, cell cycle, mitosis, meiosis, Mendelian genetics, chromosomes, DNA structure and function, transcription and translation.
Biol-4790 Biometry - 4 crd hrs - Three hours of lecture, plus a 2.5 hour lab. The course covers basic probability, descriptive and inferential statistics, and statistical modeling. We also cover principles of experimental design, hypothesis testing, philosophy of science, and professional ethics. In the lab students will learn data structures, data manipulation, and how to perform and interpret statistical analysis. All labs are done in the R computational environment. Biol-4670 Population Biology - 3 crd hrs - Students learn the theoretical principles of how biological populations grow and change over time. How biotic and abiotic forces regulate and influence population sizes and distributions. Student also learn how to model populations, interactions, and distribution in the R computational environment. They also learn how to test hypotheses via computational methods.
BIO-333 General Genetics: Introduction to the science of heredity. The lectures present an integrated concept of the gene provided from the study of Mendelian and molecular genetics. Selected topics in quantitative inheritance and human genetics are included. BIO-401 Genomics: Content, organization, function, and evolution of whole genomes. The course examines familiar genetics concepts (e.g. inheritance, transcription, and translation) from the perspective of the entire genome. Students learn about recent advances in genome research, potential impacts on society, and case studies drawn from medicine, evolutionary biology, agriculture, and bioterrorism.
Intro to Bioinformatics (open to CS, Biology, Chemistry, Math, and Psychology students.) Genetics (Bioinformatics 1 week lab) Cell (Bioinformatics 1 week lab)
Biol 1106 - Principles of Biology: Introduction to the science of biology. This course includes topics in the process of science, chemistry of life, metabolism, cell structure and processes, inheritance patterns, the molecular basis of inheritance, and evolution. Biol 2201 - Microbiology: Study of general microbiology including bacteriology, virology, parasitology, and mycology. The course covers aspects of microbial ecology and epidemiology, including host-pathogen interactions and environmental influences on growth and reproduction. The course emphasis is on bacteria: principles of control and culture, genetics and metabolic processes, and microbiological techniques. Three lecture hours and two 90-minute laboratories per week.
MOLECULAR BIOLOGY, BIOMEDICAL SCIENCES, LABORATORY INCLUDES 3 TO 4 SESSIONS DEVOTED TO THE EXPLORATION AND USE OF THE NCBI WEBSITE AND TOOLS FOUND THERE.
Bioinformatics for Life Sciences, CMB 351, Cell and Molecular Biology. The course covers 1) the use of public bioinformatics databases, such as NCBI, UniProt, UniGene, etc., 2) the use of BLAST algorithms, 3) the use and algorithms of pairwise and multiple sequence alignment; 4) phylogenetic analysis; 5) motif identification; 6) co-evolution; 7) elements of genome analysis. Computational Biology, CMB 452, Cell and Molecular Biology. The course covers: 1) structure and folding of proteins; 2) protein structure prediction; 3) computer simulations of proteins and nucleic acids; 4) ligand docking simulations and drug design. The department currently prepares an additional course

CMB 460 - Genomics, focusing specifically on genome analysis. This new course - along with the two above - will form a basis for an undergraduate Bioinformatics and Genomics certificate. I hope the certificate will be approved and offered within the next two years.

Bioinformatic Analysis (Genetics Cell Biology and Development [GCD] 3485 - full computational characterization of human genes of unknown function (project-based course) Personal Genome Analysis (Biology 4950) - exploration of students' own genomes based on 23andMe SNP data, for now, and on full genome sequences in the years ahead.

Willing to share any course materials: email kmetzger@umn.edu Course: MATH2161: Bioinformatics and Biostatistics Department: Center for Learning Innovation Major: Bachelor of Science in Health Sciences Institution: University of Minnesota Rochester Course Description: Brief introduction to quantitative problem solving using bioinformatics and biostatistics approaches. Student will use authentic data sets and tools to explore questions, analyze data and interpret results.   In bioinformatics investigations, students will learn how to obtain and manipulate sequence information from public sources (e.g NCBI Gene database); gain familiarity with database sequence identifiers and conducting database searches; compile sequences and perform sequence alignment; practice basic phylogenetic analysis and interpretation. Biostatistics skills addressed in the course include exposure to clinical trial and/or experiment design; nonparametric analysis; analysis of variance (ANOVA); logistic regression; survival analysis.

Genome Analysis, cross listed in biology and math. We build tools to examine patterns in nucleotide sequences, make conjectures, and develop algorithms to explore the conjectures. We also participate in the GEP project as a portion of the course.

Course title: Genetics. Department: Biology. An intermediate level class that covers the essential topics of classical, molecular and (less so) population genetics. Required lab that largely covers model organism genetics. Some bioinformatics integrated into lab (using the UCSC genome browser, in silico PCR) and sometimes in lecture if a primary lit paper we are reading requires it. Course title: Genomics. Department: Biology. An advanced level seminar that uses primary literature to illustrate how new genomic techniques are changing many areas of biology. Coverage includes evolutionary genomics, genomic screens, new DNA sequencing methods, proteomics, functional genomics, and bioinformatics (e.g., alignment algorithms, sequence assembly concepts, genome databases).

BIOL-150 General Biology I Biological Sciences Department 5 units 1st semester of the first year survey course for biology majors that includes organic chemistry for biology, cell structure and function, genetics and molecular biology

Ecological Genomics, Department of Biology, review contemporary concepts and primary literature on research that integrates ecology and genomics; includes a dry lab component in analyzing high-throughput amplicon sequencing data (some Python scripting, command-line executables, blast algorithms, rudimentary statistics and data visualization).

Biology I Majors - cellular and molecular content

BMB 448 - Model Systems and Approaches to Cell Biology Inquiry. This is a stand alone laboratory course that focuses on the genetics, metabolism and cell biology of eukaryotic organisms. I spend a large portion of this course performing gene annotation in Drosophila teaching all of the bioinformatics necessary to complete this task.

Systems Biology Department of Biology Introduces basic concepts and methods in systems biology with an emphasis on biological networks, gene regulation, intracellular signaling, development and pattern formation, metabolism, and the analysis of high-throughput “omics” data. Computer simulations are used heavily to gain deeper insight into system function.

BIO 351, Principles of Genetics (5 units)...general genetics course required for BIO majors. Most take the course in their Junior year. I integrate a small amount of bioinformatics (BLAST, primer design, CpG island searching)...very minor exposure to bioinformatics. BIO 441, Bioinformatics (4 units, 3 hours lecture, 3 hours lab)...Taken by mostly Seniors and Graduate students. Taught in a computer lab (lecture and lab). Often the course is taught alongside a computer science class and the BIO 441 students write software requirements for the CS students who write code. The BIO 441 students run case studies and ultimately use the software to answer biological questions.

Biology 4930 Genes, Genomes, and Metagenomes Genomics is the study of the content, structure, organization, evolution, and conservation of whole genomes. Because of its reliance on precision instrumentation and scale, and the unprecedented volume of data produced, genomics is unusual among biological disciplines in its integration of engineering, statistics, and information science. Genomics also requires the biologist to engage in systems thinking by taking a wide view of the dynamic physical and informational network that comprises a single genome. One must further consider the human genome as itself a component of an even larger network of genomes that make up the holobiont—that’s us plus our always-changing resident community of microbial pals. After covering these and other topics, and carrying out a substantial genome annotation project for the lab component of the course, we explore personal genomics, or how all this information and understanding affects our lives as 21st century human beings.

Genetics Lab Department of Biology One semester research project describing new spider genes. Includes basic molecular genetics tools such as DNA extraction, sequencing, primer design, PCR. Sequence analysis includes vector removal, homology searches with BLAST, conceptual translations, intron/exon prediction.

Introduction to Bioinformatics: an inquiry based introductory bioinformatics course designed to introduce the genetics and genomic techniques that are employed to solve real-life biological problems.

No thank you

Introductory Biology: Molecular Perspectives (Biology department): Introduction to cell and molecular biology and genetics. This is the foundational molecular biology course for life science majors. Genetics (Biology department): covers fundamental principles of inheritance in prokaryotes and eukaryotes with emphasis on molecular genetics. Genomics (Biology department): Research-based course in which students use a variety of genomics tools to investigate a specific research problem.

Evolution Department of Biology Students learn the concepts and methods of modern evolutionary analysis.

General Population Genetics, Biological Sciences. A senior undergraduate course in population genetics.

Ecology, Department of Biology

Genetics Molecular Biology Senior Capstone Research

Biology 182: Molecules, Cells, and Genes (+ lab): Introductory cell and molecular biology course Biol 204: Cell Biology (+ lab): Intermediate "process-oriented" cell biology course Biol 313: Microbiology (+ lab) Biol 373: Virology (+ lab)

Molecular Biology Techniques; Biology Department; predominately lab-based course for analyzing and manipulating DNA

Microbiology

Introduction to Bioinformatics and Computational Biology- an undergraduate course that does not require programming that teaches biology students how to do basic analyses

(Lesk, Introduction to Bioinformatics) Genomic Biology- a mixed undergraduate/graduate course on lineage-specific genome content and concepts in populatiion genetics, evolution, biochemistry that give rise to this Computational Genomics- a graduate course in applied computational genomics as part of a professional master's program
BIOS 491, Recombinant DNA Laboratory, Biological Sciences. 100% laboratory course with semester-long research project in molecular biology. Includes DNA sequence analysis of database sequences, PCR primer design, DNA sequencing and analysis of isolated clones. (co-taught with BIOS 691, graduate level). BIOS 479, Biotechnology Applications and Techniques. Biological Sciences. Lecture course on current technological approaches to modern genetics and molecular biology. Includes two weeks of bioinformatics lecture/computer lab analyzing utilizing NCBI resources. BIOS 476, Plant Genetics. Biological Sciences. Lecture course in modern approaches to plant molecular biology and genetics. Includes two weeks of bioinformatics lecture/computer lab analyzing utilizing NCBI, TAIR and SGN resources.
Microbiology Microbial Pathogenesis and the Immune Reaponse Microbial Processes and Biotechnology
Biology 380 - Cell Biology: this course is a comprehensive course that describes the cell from the level of basic chemistry to the complexities of cell signaling, cell metabolism and cell-cell interactions. This course is required of all Biology majors.
The SYBB Survey Series is composed of the following course sequence: (A) Technologies in Bioinformatics, (B) Data Integration in Bioinformatics, (C) Translational Bioinformatics, and (D) Programming for Bioinformatics. Each standalone section of this course series introduces students to an aspect of a bioinformatics project - from data collection (SYBB 311/411A), to data integration (SYBB 311/411B), to research applications (SYBB 311/411C), with a fourth module (SYBB 311/411D) introducing basic bioinformatics programming skills. SYBB 311/411A, SYBB 311/411B, and SYBB 311/411C are offered as a block in the fall. SYBB 311/411D is offered in the spring semester. Each class is graded separately.
Biology I - Biological Sciences - Introduction to Biology - part of a two semester sequence for STEM and pre-med, dent, vet, pharmacy, PT, health science students
Genetics at the junior level in the biology majors' curriculum. I include bioinformatics exercise for about three weeks of lab. I also sometimes use it in biology senior seminar as a special topic for a student to present.
biol274-introduction to bioinformatics This course provides a comprehensive overview of bioinformatics – the application of computational and information sciences in studying biology. It emphasizes the learning of real-world computational tools and databases used by biologists in conducting research. Major topics include DNA/RNA/Protein sequence analysis, genome annotation, protein visualization, molecular phylogeny, and system biology. Basic understanding of statistics is preferable but not mandatory. No prior computer programming knowledge is required and no computer programming will be taught in this course. biol356-biomedical informatics This course focuses on using genomic information, statistics and computational methods to study the relation between genomic variations and diseases. Students will learn major biomedical informatics approaches in translating the fount of genomic information into promising actionable treatment options through lectures, journal discussions, and project presentations. Major topics include human genome, genomic variations, genome-wide association study (GWAS), cancer genomics, microarray technology, next generation sequencing, pharmacogenomics, and personalized medicine.
Biochemistry I (chemistry) structure and function of major macromolecules. Genetics (biology) introduction to classical, molecular, and population genetics.

Molecular Genetics, Molecular Biology

Genomics, Department of Biology - Seminar style survey of genome-scale approaches to answering questions about organismal evolution in a comparative context for juniors and seniors, labs and class project are aimed at developing bioinformatics skills Genetics, Department of Biology - Basics of molecular and transmission genetics for freshmen and sophomores, basic bioinformatics skills covered in several labs and a class project

BIOL109-110 Introduction to Experimental Biology. The course emphasizes the development of skills through active involvement in experimental design, data collection, statistical analysis, integration of results with information reported in the literature and writing in a format appropriate for publication.

Practical Bioinformatics (BIOLOGY). This course focuses on practical aspects of molecular data analysis from searching biological databases to organizing and interpreting DNA sequence information. Material will be presented in the context of using bioinformatics to solve problems related to evolutionary, ecological, and disease aspects of genes and organisms. The course will be balanced between theoretical descriptions of computational biology methods, practical aspects of bioinformatics (with hands-on sessions involving computers), and application of bioinformatics to solve biological problems.

Introduction to the Biomedical Sciences. A general biology education course serving students with the intention of entering a health profession. Biology in Your World. A general biology education course serving the non-major.

BIOL 264: Gene Manipulation. Molecular Biology lab course

mol bill genetics cell and developmental biology honors integrated science i and ii

Bio 3312 Genomics Lecture & Laboratory Please see attached syllabus

Biology 161 LN - Laboratory of Biology 161, Cellular and Genetic Systems. Spring semester. For students who participated in the SEA-PHAGES course in the fall semester. Meets twice per week for two hours. Students use BLAST, DNAMaster (ORF-finders), tRNA finders, Dotplots, phylogenetic and distance analysis, and Phamerator to annotate, analyze, and compare phage genomes. Biology 354 - Investigations in Functional Genetics. Taught for the first time Spring 2016, and may be offered occasionally. Students identify promoters and terminators from phage genomes using software found online. They design primers to amplify them and clone them into vectors containing fluorescent protein genes that facilitate the testing their promoting or terminating activity. Computer Science 300 - Bioinformatics. Can be taken for Biology 300-level credit. Co-taught by computer science faculty member and biology faculty member. Science students must have taken at least one programming course. Using the python language, students learn about and design algorithms. ROSALIND is used for assignments with great success. The course has a phylogenetics emphasis due to the expertise of both instructors.

BIOL 1510 Biological Principles - Intro Biology with a lecture and 3 learning objectives devoted to genome analysis. BIOL 2345 Genetics Lab - Sophomore-level genetics lab course for majors and non-majors, includes a 2-3 week barcoding lab that generates genomic data for analysis using BLAST BIOL 2355 Honors Genetics Lab - Sophomore-level genetics lab course for high-performing students, project-based. Projects in the past have included genome annotation.

Molecular Biology 201: Laboratory in molecular and cellular biology and genetics (4 credit hours). Introduction to Genbank and Blast. MB 131: intro to molecular and cellular biology. Multiple lectures on use of alignments to investigate protein evolution, structure, and function. Upper level Molecular Biology courses in microbiology and virology, use of KEGG to explore protein evolution, structure, and function,

integrated Introductory Biology I and II --- Department of Biological Sciences Foundations course that in the first semester focuses on molecular and cellular biology including genetics, and in the second semester is introducing evolution, organismal biology and ecology.
BI142 Principles of Biology BI447 Genetics BI391 Biomolecular Technologies BI344 Computational Genomics
Cell Biology, Epigenetics, Cancer Biology, A new lab course is being designed combining Cell Biology and Genetics that will have bioinformatics.
SEAPHAGES lab (seaphages.org) through HHMI as part of our Honors Freshman Biology Curriculum. The first term, students use microbiological techniques to isolate and purify bacteriophage that infect mycobacterium smegmatis. In the 2nd term, students use gene annotation software to annotate the genomes of class-purified phage.
BIOS 237 Intro Bioinformatics BIOS 427/827 Bioinformatics Lab
BIO331 Bioinformatics - The course is designed to expose students to online databases of biological information and to data analysis software that can be used to study them. Students will work to complete independent projects that explore original biological questions.
Genetics (biol202) required course. In the fly lab students have to map unknown genes and find deletion/insertion in fly base - infer function find mutations.   Evolution (Biol305), students sequence own mtDNA to find where in the world they came from
programming for biologists-- general concepts of scripting   intro to bioinformatics -- basics of unix command line, familiarity with widely used OSS for assembly, annotation, expression, QC, variant calling, etc.
BIO 316: Introduction to Computational Biology, Biology Department   Course Description: Broad overview of computational biology/bioinformatics with a significant problem-solving component. Significant hands-on practice will include using computational tools to solve a variety of biological problems and an introduction to the Python programming language. Topics may include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, comparative and functional genomics.   Learning Outcomes: 1) Understand the current scope of bioinformatics research 2) Understand the position and role of computational analyses in the scientific method 3) Become familiar with commonly used biological databases and software tools 4) Be able to select the appropriate data/tools for your research question 5) Evaluate and accurately interpret results obtained from bioinformatics analyses 6) Use basic programming techniques to access and manipulate sequence data 7) Understand the challenges and basic techniques for handling large datasets 8) Actively engage with primary literature that relies on computational/bioinformatics techniques 9) Develop the ability to approach biological problems in a quantitative fashion
Genome Jumpstart: An Introduction to Bioinformatic Analysis (BIO2117.01) 4 credits This course offers an immersive experience into the world of DNA, genes, and genomes in eukaryotic organisms. In addition to getting a grasp of the foundational biology, we will become familiar with the computational algorithms and methodologies used to analyze and mine the ever-increasing data generated from whole-genome sequencing, high-throughput proteomic analyses, and our improved understanding of evolutionary relationships between organisms based on their molecular fingerprints. For the project portion of the course, all students will utilize public genomic databases and software to contribute to a multi-institute on-going analysis and annotation of understudied regions of the Drosophila genome. This project work makes students eligible for future co-author status on emerging publications by the Genomics Education Partnership consortium.

1. Biochemical Principles; Chemistry and Biochemistry (1st biochemistry course; students work with PDB and protein structure visualization programs) 2. Molecular Biology laboratory; cross-listed in Biological Sciences dept and Chemistry and Biochem ; students work with DNA sequence data and analysis tools. 3. Bioinformatics Applications; cross-listed in Biological Sciences dept and Chemistry and Biochem ; depends on instructor - students work with DNA sequence databases on projects related to genome annotation, gene expression or metagenome analysis.
Biology for non-majors (Two lecture periods dedicated to Bioinformatics) Molecular Evolution and Bioinformatics Bioinformatics and Genome Analysis
BNFO 135. Programming for Bioinformatics. 3 credits, 3 contact hours (3;0;0). The ability to use existing programs and to write small programs to access bioinformatics information or to combine and manipulate various existing bioinformatics programs has become a valuable part of the skill set of anyone working with biomolecular or genetic data. This course provides an unerstanding of the architecture of bioinformatics toolkits and experience in writing small bioinformatics programs using one or more of the scripting ("glue") languages frequently employed for such tasks. BNFO 236. Programming For Bioinfo II. 3 credits, 3 contact hours (3;0;0). Python programs for sequence alignment, BLAST, and distance based phylogeny reconstruction BNFO 330. Sequence analysis bioinformatics. 3 credits, 3 contact hours (3;0;0): Sequence alignment, hidden Markov models, multiple sequence alignment, expected accuracy alignment, genome and short read alignment, cross-validation, substitution matrices, Perl BNFO 340. Data analysis for bioinformatics. 3 credits, 3 contact hours (3;0;0). Prerequisites: BNFO 240 and R120 101 or equivalent or permission of instructor. Phylogey reconstruction, local search, and machine learning applications to bioinformatics problems.
Microbiology (BIOLOGY). This is a general microbiology class for junior and senior biology, ecology and biochemistry majors. We use metagenomic analysis of soil bacterial communities as an integral,part of the microbial ecology unit.
Introduction to Computational Molecular Biology (cross listed as BIO (Biology) MBB (Molecular Biology and Biotechnology) and MAT (Math) for logistical reasons. Active learning course taught in a computer classroom that holds up to 96 students. I have a TA in class with me to help answer questions. Practical class where students learn to get open source molecular biology data and analyze with online or installed tools (alignment, gene prediction, tree building, motifs, protein structure prediction, etc.) Have students from BIO, MBB, MAT but also computer science and other majors so programming can not be a prereq. We learn about algorithms and write pseudo code but there is no programming unless students who already know how want to use it in their projects.
Microbial Diversity and Ecology (BIOL 4408) Microbial Ecology (BIOL 5417)
Bio 1A Cell and Molecular Biology Bio 1B Evolution and Animal Biology
CS 418 Bioinformatics - Bioinformatics algorithms.
Microbial Genetics Lab. 4 units (2 3 hr labs per week). This course teaches students basic molecular genetics of microbes (bacteria and fungi). As part of the course, I teach students the basics of bioinformatics (BLAST, protein domain databases, multiple sequence alignment tools, phylogenetic trees, data mining of fungal genome databases at JGI.
BIO3050 Principles of Genetics - Core Genetics course for sophomore students majoring in Biology and Exercise science BIO5890 Genomics and Bioinformatics - Upper level elective, students work on independent bioinformatics projects as a part of research-intensive training Bio3830 Applied Biotechnology - Upper level elective, students analyze RNA-Seq data and perform various NCBI- and genome browser-related exercises

Molecular Genetics - Upper level course for biology, biochemistry, and bioinformatics majors. Cell Biology - Sophomore level course for biology, biochemistry and bioinformatics majors. Biotechnology - Upper level course for biology, biochemistry, and bioinformatics majors

BIO 4050 Advanced Cell and Molecular Biology. Senior Experience course, 3 credit hours. Variable topics, includes student presentations and reports.

All courses are offered in the Biology Department. BIOL131: Introduction to Computational Biology: Full course for one semester (lecture-laboratory). This course provides an integrated survey of fundamental questions in molecular biology and the computational tools that are used to solve them. Elements of molecular biology and computer programming are presented in parallel throughout the semester. Topics include molecular sequence analysis (identifying repeats, regulatory/binding motifs, and genetic variation) using pattern-matching operations on text strings. Assignments will include writing Python programs to analyze human DNA, RNA, and protein sequences. Prerequisite: Biology 101 or consent of the instructor. BIOL331: Computational Systems Biology. Full course for one semester (lecture-laboratory). A survey of network models used to gain a systems-level understanding of biological processes. Topics include computational models of gene regulation, signal transduction pathways, protein-protein interactions, and metabolic pathways. Laboratory exercises will involve building a collection of biological networks from public data, implementing a graph library and foundational algorithms, and interpreting computational results. A programming-based independent project will answer biological questions by applying graph algorithms to experimental data. BIOL431: Seminar Biology: Computational Cancer Biology. Half course for one semester. Investigation of computational methods to analyze high-throughput biological measurements collected from hundreds to thousands of cancer samples. Biological topics include tumor classification, tumor heterogeneity, and dysregulated signaling pathways. Computational topics include algorithms and models to synthesize, integrate, and manage large-scale cancer datasets.

BIOS 260: General Genetics (offered in the Dept. of Biological Sciences). Fundamental principles including transmission, molecular and population genetics. Laboratory introduces techniques appropriate for investigating a variety of organisms used in the discipline, including microorganisms, plants, lower animals, and humans. Three-hour lecture; three-hour lab. BIOS 435: Experimental Methods / CHEM 308: Biochemistry Lab (cross-listed in both the Depts of Biological Sciences and Chemistry): Familiarization with the use of scientific instruments and techniques, and developing proficiency in the process of scientific investigation. Four-hour lab.

Introduction to Bioinformatics BSC4434 (Microbiology and Cell Science Dpt) Use of basic webbased bioinformatic tools Independent Research in Bioinformatics BSC4913 Advanced Independent Research in Bioinformatics BSC4914 In these two classes co-taught with another faculty, students do bioinfo project in a lab that they find (or that I help them find). We meet every 2 weeks they discuss their progress and we help them write a paper

Biology 47, Genomics: from Data to Analyses

BIO 380: Practical Computing for Scientists This course will focus on developing the base tool set for implementing advanced computing in the design and analysis research projects. Content of the course is geared towards novice students (i.e. those with little or no previous programming experience) who will learn practical computational approaches to modern research questions by applying programming concepts and approaches to real data sets. Areas of study will focus on skills related to data manipulation, management, and analysis. BIO 410: Bioinformatics Emphasizes modern genomics focused on basic and applied questions involving human genome biology and genomics

for drug development and agricultural application. Students will learn to conduct bioinformatic analysis using data from genomic research projects of different species. BIO 412: Comparative Genomics This course will explore the area of genomics and its relationship to both basic and applied areas of research. Students will learn about the applications and contributions of a "genomic" perspective to topics such as evolutionary biology, functional genetics, genetic structure, and systems biology.
Introductory Biology (4 units) and Microbiology (5 units) courses in the department of Math and Sciences
I teach BIOL 222 Molecular and Cellular Biology for majors. Our students have been participating in the ComGen project for the last several years and so must do bioinformatics to learn about the gene(s) that they have sequenced in their authentic research project. More info about ComGen available here: http://www.bellevuecollege.edu/comgen/
Genetics - sophomore level lecture lab course (Biology) - use bioinformatics in a research project Foundations in Molecular and Cellular Biology - first biology course - do a bioinformatics research project
Biology 201 Introductory Cell and Molecular Biology Honors section
Cellular Biology - first of two introductory courses for biology majors and pre-professional students - see syllabus for more details
Genetics Biology Basic principles of genetics including classical transmission, molecular, and population genetics.
Genomics and Bioinformatics - Biology 379 - project-based class (computers only) where students learn to use basic online tools to explore data. Also involves reading the literature about the use of bioinformatics tools and what we can learn about biology. Microbial Genomics - Biology 388 - project-based class (wet lab and computer analysis) where students gather environmental samples then submit for metagenomics analysis.
Molecular Evolution (BIOL 360) taught in the Department of Biology. The course is an introduction to the theory and practice of molecular evolution, including an introduction to neutral theory and expectations for how natural selection works on sequences, molecular clocks, genetic distances and distance trees, phylogeny and estimation of phylogenies (mostly maximum likelihood). The class is based around problem sets and projects to provide students with opportunities to apply the concepts. The course considers only genetic variation among species (divergence), as I teach another course in population genetics that covers topics related to within species genetic variation (polymorphism).
Junior-level course, Genetics, Department of Biology & Agriculture. This course covers transmission, molecular and population genetics. I use bioinformatics in teaching evolutionary concepts - 2 labs plus associated lectures. Senior-level course, Molecular Technology Laboratory, Department of Biology & Agriculture. This course is heavily hands on with wet lab and computer exercises. I use the book, Genome Science, for bioinformatics lessons using DNA subway, NCBI and CoGe. I also wrote some exercises specifically to teach navigation and data analysis using NCBI and Biology Workbench sites.
Independent Research, Biology, Use of BLAST,Cn3D, Microarray, PCR array Immunology, Biology, finding and visualizing relevant protein structural models, sequence alignment Introduction to Bioinformatics, Biology, survey of relevant software and concepts
Bio 312 - Bioinformatics
Introductory Intro Biology for Majors--a one semester inquiry course, where a segment of the course is devoted to genomics and systematics (phylogenetics) Undergraduate independent Research -- in my lab, students blast known sequences to generate primers

to create species-specific primers, ultimately leading to qPCR analysis of gene expression (sophomores thru seniors)
Introduction to Bioinformatics, Biology This course is intended to teach the basic tools used in bioinformatics in order to investigate biological questions. Students will conduct independent projects utilizing existing computer programs and databases for gene searches, sequence comparisons, and phylogenetic analysis.
Intro Bio I: Molecular and Cellular Biology; Biology Department; molecules through cells, basic biochemistry, respiration and photosynthesis, genetics, gene expression, biotechnology. My bioinformatics module: use the NCBI website to explore human chromosomes; identify specific genes and discuss gene expression and effect of mutations.   Intro Bio II: Evolution and Ecology; Biology Department; phylogeny (including molecular phylogeny), invertebrates, vertebrates, animal form and function, population ecology, ecosystems, restoration and conservation ecology. My bioinformatics module: construct a phylogenetic tree using myoglobin sequences.
Molecular Biology - a course that focuses on newer technology in the field of Molecular Biology. I employ the Genomic Education Partnership (GEP) in this course to teach students annotation.
Introduction to Bioinformatics - Students are introduced to basic bioinformatics software and their applications in genomics and proteomics.
Principles of Biology II, BIOL 2108 or BIOL 1108, covers invertebrate diversity (with cladistics), ecology, evolution, animal form & function with emphasis on vertebrates.
Genetics, Biology Department
Biotechnology laboratory - work with DNA characterization, molecualr markers and genome sequencing. Plant Genomics and Proteomics - includes bioinformatic analyses Personalized medicine - genome sequecing, disease markers, susceptibility genes
Molecular Phylogenetics   Workshop based introduction to comparative evolutionary techniques using molecular sequences. Students will learn to produce robust molecular phylogenies, edit and align genetic sequences, select and apply best-fit models of molecular evolution, carry out phylogenetic analyses, interpret phylogenetic tree topologies, and determine timing of divergence using fossil calibrated phylogenies. After completion of this course students will be able to edit and align Sanger sequence data, perform Bayesian and maximum likelihood analyses using appropriate models of nucleotide substitution, understand how to interpret tree topologies and nodal support, be able to produce time-calibrated molecular phylogenies, understand the problems in delimitating species, be able to recognize cryptic species, and have a basic understanding of next generation sequencing using both Roche 454 and Ilumina Hi-Seq platforms. Students will also look at how to optimize morphological characters onto molecular trees, which can be used to test hypotheses about evolution.
Honor's Introductory Biology for Honor's students Cell and Molecular Biology
BIO SCI 5333 Genomics (LEC 3.0) This course offers a general overview of the field of genomics. Topics covered include genome sequencing and annotation, transcriptomics, proteomics, metabolomics, genomic variation, and an overview of human, and several animal, plant, and microbial genome projects. Prerequisite: BIO SCI 4323.

Statistic	Value
Total Responses	307

W2. Q33. Year of highest earned degree.

#	Answer		Response	%
1	2016		7	1%
2	2015		15	1%
3	2014		18	2%
4	2013		28	3%
5	2012		21	2%
6	2011		30	3%
7	2010		34	3%
8	2009		34	3%
9	2008		50	5%
10	2007		27	3%
11	2006		31	3%
12	2005		34	3%
13	2004		37	4%
14	2003		29	3%
15	2002		36	3%
16	2001		31	3%
17	2000		40	4%
18	1999		27	3%
19	1998		34	3%
20	1997		31	3%
21	1996		38	4%
22	1995		20	2%
23	1994		24	2%
24	1993		30	3%
25	1992		35	3%
26	1991		26	2%
27	1990		23	2%
28	1989		30	3%
29	1988		25	2%
30	1987		23	2%
31	1986		26	2%
32	1985		19	2%
33	1984		16	2%
34	1983		13	1%
35	1982		16	2%
36	1981		14	1%
37	1980		11	1%
38	1979		4	0%
39	1978		12	1%
40	1977		8	1%
41	1976		8	1%
42	1975		5	0%
43	1974		4	0%
44	1973		1	0%
45	1972		4	0%
46	1971		6	1%
47	1970		1	0%
48	1969		0	0%

49	1968		2	0%
50	1967		0	0%
51	1966		1	0%
52	1965		0	0%
53	1964		0	0%
54	1963		0	0%
55	1962		0	0%
56	1961		0	0%
57	1960		0	0%
58	1959		0	0%
59	1958		0	0%
60	1957		1	0%
61	1956		0	0%
62	1955		0	0%
63	1954		0	0%
64	1953		0	0%
65	1952		0	0%
66	1951		0	0%
67	1950		0	0%
68	Rather not say		1	0%
	Total		1,041	100%

Statistic	Value
Min Value	1
Max Value	68
Mean	19.30
Variance	116.80
Standard Deviation	10.81
Total Responses	1,041

W3.

Note: The SPSS Table also provides cumulative percent totals for highest year for degree earned.

Year of highest earned degree.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2016	7	.6	.7	.7
	2015	15	1.2	1.4	2.1
	2014	18	1.4	1.7	3.8
	2013	28	2.2	2.7	6.5
	2012	21	1.7	2.0	8.5
	2011	30	2.4	2.9	11.4
	2010	34	2.7	3.3	14.7

2009	34	2.7	3.3	18.0
2008	50	4.0	4.8	22.8
2007	27	2.1	2.6	25.4
2006	31	2.5	3.0	28.3
2005	34	2.7	3.3	31.6
2004	37	2.9	3.6	35.2
2003	29	2.3	2.8	37.9
2002	36	2.9	3.5	41.4
2001	31	2.5	3.0	44.4
2000	40	3.2	3.8	48.2
1999	27	2.1	2.6	50.8
1998	34	2.7	3.3	54.1
1997	31	2.5	3.0	57.1
1996	38	3.0	3.7	60.7
1995	20	1.6	1.9	62.6
1994	24	1.9	2.3	64.9
1993	30	2.4	2.9	67.8
1992	35	2.8	3.4	71.2
1991	26	2.1	2.5	73.7
1990	23	1.8	2.2	75.9
1989	30	2.4	2.9	78.8
1988	25	2.0	2.4	81.2
1987	23	1.8	2.2	83.4
1986	26	2.1	2.5	85.9
1985	19	1.5	1.8	87.7
1984	16	1.3	1.5	89.2
1983	13	1.0	1.2	90.5
1982	16	1.3	1.5	92.0
1981	14	1.1	1.3	93.4
1980	11	.9	1.1	94.4
1979	4	.3	.4	94.8
1978	12	1.0	1.2	96.0
1977	8	.6	.8	96.7
1976	8	.6	.8	97.5
1975	5	.4	.5	98.0
1974	4	.3	.4	98.4

	1973	1	.1	.1	98.5
	1972	4	.3	.4	98.8
	1971	6	.5	.6	99.4
	1970	1	.1	.1	99.5
	1968	2	.2	.2	99.7
	1966	1	.1	.1	99.8
	1957	1	.1	.1	99.9
	Rather not say	1	.1	.1	100.0
	Total	1041	82.7	100.0	
Missing	System	218	17.3		
Total		1259	100.0		

W4. Q43. As part of our work, we are building an online repository of bioinformatics content assessments and syllabi of dedicated bioinformatics courses and life sciences courses with bioinformatics content. Earlier in the survey you indicated a willingness to share your syllabi and/or assessments for this purpose. Please provide those here.To preserve the confidentiality of your survey response, the survey administrator will disassociate any linked or uploaded files from your survey response before sharing these with the research team for the purpose of the repository.ENTER URL LINKS TO ANY CONTENT YOU ARE WILLING TO SHARE HERE:

Text Response
Please contact me by email at szarecka@gvsu.edu for updated 2016/2017 syllabi.
www.davidmatthes.com
https://docs.google.com/document/d/19wUodekszs2bWyQWYIrwMAI-Af-BdVyXubrSIFVFQZg/edit?usp=sharing
https://docs.google.com/spreadsheets/d/1dRc7zHWDJYTwfIRO4_fTdqm6SM7gs3o_Hm87OfGpN5E/edit?usp=sharing
https://www.dropbox.com/sh/mz220rxw77eleag/AAB6sHBZZDyIVbM3lmZ3hp3wa?dl=0
I do not have a public website for the course.
I will contact you offline with this.
gurkan.case.edu/teaching.html
http://serc.carleton.edu/genomics/units/19100.html
I cannot at the time provide links as they are password protected.
http://cs.njit.edu/usman/courses/bnfo135_fall12/ http://cs.njit.edu/usman/courses/bnfo236_spring16/ http://cs.njit.edu/usman/courses/bnfo601_fall15/ (this is a graduate course but taught concurrently with BNFO 330) http://cs.njit.edu/usman/courses/bnfo602_spring16/ (this is a graduate course but is taught concurrently with BNFO 340)
http://comenius.susqu.edu/biol/312/microbiologylecturesyllabus_2016.html
http://www.ncbi.nlm.nih.gov/pubmed/26163561 - supplementary materials include lab handouts and sample data files
http://www.reed.edu/biology/courses/bio131/ http://www.reed.edu/biology/courses/bio431/compcancerbio/
My university syllabi cannot be make available by public url.
Some simulations I developed for teaching: http://evolutiongenetics.georgetown.edu/
We have a dedicated bioinformatics enter at our university: https://www.wku.edu/bioinformatics/
http://workbench.sdsc.edu/ http://www.ncbi.nlm.nih.gov/
http://biology.as.nyu.edu/docs/IO/18547/Biol.UA103BioinformaticsinMedicineandBiology.

pdf http://biology.as.nyu.edu/docs/IO/18547/Biol.UA124FundamentalBioinformatics.pdf http://www.biology.as.nyu.edu/docs/IO/28958/BIOLGA1007.pdf http://www.biology.as.nyu.edu/docs/IO/28958/BIOLGA1009.pdf http://biology.as.nyu.edu/docs/IO/28958/BIOLGA1130.pdf
http://www.math.sjsu.edu/~bremer/Teaching/Old_Math162/
http://biology.hunter.cuny.edu/index.php?option=com_content&view=article&id=162:2013-10-24-16-39-38&catid=12:bioteaching http://www.hunter.cuny.edu/qubi
www.slccgap.org
My course content is on D2L
http://euler.math.uga.edu
https://mdcune.psych.ucla.edu/modules/bioinformatics
I do not have access to these at this time but you may contact me by email: dkovarik@shoreline.edu
Right now not enough time to elaborate, sorry.
https://drive.google.com/open?id=0B4tVIy1tNLpLc04wZkhZazRRVFE
http://lycofs01.lycoming.edu/~newman/ see course and research pages
http://www.bio.davidson.edu/courses/genomics/genomics.html http://www.bio.davidson.edu/courses/Bio343/LabMethods_2016.html http://www.bio.davidson.edu/icb
See the Useful Genetics MOOCs on edX
http://fasta.bioch.virginia.edu/biol4230/
https://github.com/BioinformaticsSpring2015/BioinformaticsMaterials http://www.coursesource.org/courses/making-toast-using-analogies-to-explore-concepts-in-bioinformatics
I don't have these posted online yet. But I am open to doing it in the future. Feel free to contact me (stephen_piccolo@byu.edu).
We have several different resources and tutorials at our web site. Most links can be accessed from this page: http://digitalworldbiology.com/community We are also compiling collections of structures for specific teaching activities: http://digitalworldbiology.com/structure-collections I have bioinformatics activities on my blog, too. Here are two examples: http://scienceblogs.com/digitalbio/2016/03/09/zika-virus-drug-discovery-and-student-projects/ http://scienceblogs.com/digitalbio/2015/12/18/exploring-levels-of-protein-structure-with-molecular-models-and-snake-venom/
http://dpuadweb.depauw.edu/cfornari_web/Genomics/GenomicsLec.htm
Now that I think about it, I can't give you URLs, because our course content is all on Blackboard, which is only accessible to students registered for the course. Also, many of my slides use copyrighted material.
none at this time.
http://faculty-staff.ou.edu/K/Elizabeth.A.Karr-1/Faculty/Practical_Bioinformatics.html
Unfortunately, I don't have any easy way of doing this, since all UMass course content is blocked by the University and requires a passworded account.
https://nmt.instructure.com/courses/1301/assignments/syllabus
https://github.com/Ecological-and-Evolutionary-Genomics/eeg2016

Statistic	Value
Total Responses	41

W5. Q45. UPLOAD COURSE SYLLABI Please securely upload your relevant course syllabi below. Please note that the system is only able to accept one file upload at a time (max size 16 MB), so if you have multiple syllabi to upload, please combine them prior to upload.

File Upload	File Type	File Size
F_2TQNGqEQOXcpuQe	application/pdf	80.3KB
F_sYZ6pnAjryehEOZ	application/x-unknown-application-pdf	36.6KB
F_3dMKTSprMjQpgbo	application/vnd.ms-excel	44.5KB
F_1i589VbGLz4UKdd	application/vnd.openxmlformats-officedocument.wordprocessingml.document	53.1KB
F_Y4wYooMOJ2TwkaB	application/vnd.openxmlformats-officedocument.wordprocessingml.document	29.3KB
F_2dvguNyp9s3bGY7	application/msword	54KB
F_3P67K6STyEB6wIg	application/pdf	104.7KB
F_1Tx0LfLKh66qbOt	application/pdf	93.9KB
F_6A6GTmiJTuJ04NT	application/pdf	76KB
F_8eNCZ6oQys5BVuB	application/pdf	230.7KB
F_dpzx6JmMbICSmKF	application/vnd.openxmlformats-officedocument.wordprocessingml.document	104.2KB
F_eyvQitcKq6sYpil	application/pdf	352.3KB
F_3F9m7q1h6KFjCYt	application/pdf	89.7KB
F_1r9wuphGHe2biBw	application/pdf	54.9KB
F_7aEsiPpAX8eU0aF	application/vnd.openxmlformats-officedocument.wordprocessingml.document	76.2KB
F_d4J3cHZxdfSo5Zr	application/msword	101.5KB
F_8IL05TuYa0Kr6IJ	application/vnd.openxmlformats-officedocument.wordprocessingml.document	40KB
F_31EkM6kxVcYpH0F	application/pdf	229.1KB
F_eVCzo9dQpzLHgYR	application/msword	61KB
F_e57AWuRLSSRMdKd	application/pdf	196.5KB
F_0uOJe8fKShMUcM5	application/vnd.openxmlformats-officedocument.wordprocessingml.document	144KB
F_395s2EFteNHYlil	application/pdf	97.9KB
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	officedocument.wordprocessingml.document	
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Statistic	Value
Total Responses	73

W6. Q46. UPLOAD CONTENT ASSESSMENTS Please securely upload your relevant content assessments (e.g., quiz and exam questions) below. Please note that the system is only able to accept one file upload (max size 16 MB) at a time, so if you have multiple assessments to upload, please combine them prior to upload.

File Upload	File Type	File Size
F_2Ed9zPI9FcUNg7c	application/x-unknown-application-pdf	121.3KB
F_xyWK8xDbRFTwk3T	application/vnd.openxmlformats-officedocument.wordprocessingml.document	148.6KB
F_1gUyurwKObJruMU	application/vnd.openxmlformats-officedocument.wordprocessingml.document	200.6KB
F_eqE33GCHhDCGkC1	application/pdf	106.4KB
F_d1jVTEmRBagJiNT	application/pdf	95.6KB
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F_6hdl1SDCHIC29w1	application/vnd.openxmlformats-officedocument.wordprocessingml.document	25.7KB
F_bj76rnXAr37tNAh	application/vnd.openxmlformats-officedocument.wordprocessingml.document	138.1KB
F_1A0eHwcTACsk9ed	application/pdf	62KB
F_1EcwtAjLXMX8xFk	application/pdf	1.6MB
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F_cY2iWdNX7orGZoh	application/vnd.openxmlformats-officedocument.wordprocessingml.document	51.4KB
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	officedocument.wordprocessingml.document	
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Statistic	Value
Total Responses	27

W7. 48. Additional comments:

Text Response
A focus on specific tools that are available now seems short-sighted. Those tools will evolve over the years, and new, better, easier-to-use ones will appear. It seems more important to me to make sure all biology students can conceive of and code simple algorithms to solve problems and that they can execute enough statistics to derive meaningful results from large data sets.
Students need to learn to code to be a citizen of the modern world, knowing how to use a tool is not enough.
The formatting of this survey is truly among the worst I've ever seen — at least in Safari on a Mac.
We don't have a dedicated course in bioinformatics. Not all sections of the Biology of Majors I course incorporates genomics/bioinformatics activities because not all faculty have any experience in the content/technologies. The activities currently in use are in their "beta" version, and would prefer to share them after assessments/revisions.
I would be most interested in learning more about the outcome of this survey, other instructor's comments and thoughts. If I can be of any help - I'd like to be involved in future work on this project.
Good luck!
Good survey. I'd be interested in the outcome!
Thanks! Willing to share any course materials or talk more! email kmetzger@umn.edu
Bioinformatics is a challenging technical skill set that requires more than a few undergraduate courses for competence. Undergraduate bioinformatics majors are viable, but not simple integration into existing majors with other content empahsis.
The bioinformatics files I have shared are an activity created for the Genomics Education Partnership (GEP - http://gep.wustl.edu/)
Odd wording for the opening question without defining bioinformatics-- a term that seems to have shifted and broadened over time. Some sense of what was intended based on emails that were forwarded.
I am not necessarily opposed to including some picture of bioinformatics into an undergraduate training program, but feel that conceptual foundations rather than methodological approaches should be emphasized and that there are already large time constraints in the general field of biology to deliver the former.
BIOINFORMATICS IS SOMETHING THAT CAN BE PICKED UP ON THE RUN. UNDERGRAD EDUCATION SHOULD BE MORE FOCUSED ON BASICS AND REINFORCEMENT OF THOSE BASICS MAKING THE STUDENTS CAPABLE OF FIGURING THINGS OUT. I DID NOT HAVE BIOINFORMATICS TRAINING AT ANY LEVEL BUT FIGURED THINGS OUT OVER THE COURSE OF SCHOOL.
Bioinformatic courses should not replace statistics or math. Courses should be conceptually based - linked to concepts in genetics, genomics, and evolution. Lab training with specific software has a short shelf life as these are likely to be replaced with more intuitive interfaces in the near future.
I didn't develop the bioinformatics module used in our intro bio lab course BIOL109-110, so I'm not comfortable sharing it without obtaining permission to do so.
Many of our students come from economically challenged families and can not afford to have their own laptop. Some that do, have old out of data, low memory laptops. But most do have good laptops. We do have computer labs that can contain 20-30 students, but most of our lecture classes have 200 or more students. Clickers work.
What the hell is bioinformatics? This term is so broadly used that it approaches meaningless. It is hard to answer anything about this survey unless you actually started

telling us what you feel constitutes bioinformatics.
If you want to focus on genomics and other data - say so. Do not consider that bioinformatics. we will have a world of bio majors with no knowledge of anything else or with the skills needed for quantitative biology that is needed now and in the future.
This material is broken up over blocks of a complex moodle course site. I'm glad to share, but it will take time to assemble.
I will have to submit these at later times as currently I am unable to compile all the materials into one file.
Later maybe,..I dont have time now
BIO 355 is a required course usually taken in the second year. The bioinformatics question is part of a take home exam. There were four different genes used on the take home exam.
After reading through the competencies in this survey, I now feel though I do include considerable exposure to bioinformatics through my teaching. I would not have said that at the start of the survey (and there's always room for more). I think adding computational analyses, use of public databases, molecular biology software, etc. is a key part of teaching science like we do science (I also have a research lab), which is a critical component of undergraduate life science education.
I'm not in favor of EDUCATORS introducing more pedagogy and time-consuming devices. Right now I'm facing the trouble of my student not being able to read nor write cursive! Basic understanding of the psychology of how students LEARN need to be put into operation.
bit disappointing as a survey, you could have asked for a lot more detail I think
The system needs a major overhaul- more efficient and realistic expectations. The students are addicted to technology that they do not pay any attention during the lecture and lab.
I think the level of bioinformatics education will vary with the emphasis area of the students.
This course was aimed at incoming freshmen and at sophomores that had not taken any college biology courses yet.
Contact me if you want materials: heath.ogden@uvu.edu
My course materials and assessments are linked to the website and can be downloaded from there.
I would need to do some editing in order to do this so can't do it now.
Bioinformatics should be a Senior level or graduate level coursework.
If you could provide training, lesson plans, activities, and/or instructions to add bioinformatics to our classes, we would be VERY interested in doing so.
At this point I am not ready to share my syllabus. As part of the assessment for the bioinformatics part of my course, students have to do an oral presentation in which they are given a protein and they have to retrieve homologs from different fungi and other organisms, compare conservation of domains, build phylogenetic trees, and describe research articles in which structure/function analysis of the gene has been carried out.
This survey was very timely as I received it shortly after a conversation with the dean and division chair about the need for updating the intro to biology laboratory and lecture hall. We discussed possible needs and funding.
In the future I may be willing to upload my course syllabi; currently, my intro course is primarily based on Pevzner's & Compeau's new textbook "Bioinformatics Algorithms: an Active Learning Approach". I am very glad I received this survey - I signed up for the group, since I think it will be extremely useful for course development.
The final is an in class 4 Hours exam they have access to everything
Egads, no time to upload assessments now...sorry!

I want to stress the difficulty I have had getting information in a form that can be understood. For example, I know what "genome annotation" is, and I know, *in principle*, how it is done. Finding out how to do it *in practice* has been extremely challenging. We even arranged a visit by a bioinformatician who was interested in having my students annotate genomes for him. After a day long workshop on how to do it neither I nor my students were any the wiser.
Attached assessment tool is the pre-/post-quiz we have developed for the Genome Solver project.
We have recently been very successful in hiring faculty working in computational biology, broadly defined (genomics, systematics and protein structure areas), and have good access to computational resources. This has allowed us to create some new, and very popular grad courses. However, nothing has been done on the undergrad front. We used to have a requirement for a semester of programing, but this was dropped ten years ago due to it being taught by the Comp Sci department with complete irrelevance to Biology (Pascal, no Bio examples, etc.).
General Biology courses need to include more bioinformatics modules but are limited by content required in pre-health designated courses
I am a professor willing to formally train in bioinformatics if given an opportunity that is paid or inexpensive. I have plans to train and pursue a career in bioinformatics or data science in the future. However, I cannot afford to leave my current work until my training is compete (at least enough to find employment). To that end, I am taking online programming and data science courses and have been integrating some bioinformatics (not programming) into my research courses.
do not want to slow our students down by adding more requirements (computer science course, statistics course, bioinformatics course). this will take a small percentage of graduates and transfer students and make it even smaller
My courses haven't been taught yet, so I do not have course materials. I would be happy to share information in the future.
Perhaps it is a good idea to offer basic and advanced training for faculty
Please feel free to contact me for syllabi. Derrick Brazill - brazill@genectr.hunter.cuny.edu
Thanks for your efforts!
Problem: all,or none attitude among faculty. Some feel bioinformatics is critical and should be incorporated into,every course to a significant extent, some don't even know how to spell it and don't care to learn.
Would like to see larger emphasis on environmental applications. E.g., molecular cryptoecology and environmental surveys/monitoring.
How do we access these sources?
I am willing to be contacted to potentially share course materials, provided I have a bit more information about their use and copyright (e.g., Creative Commons). My email address to be disassociated from this survey is afusaro@marygrove.edu.
This is the second year I have taught this. But this year is the first year we are doing the class project where the end goal is a publication using metagenomic data from my lab
Sorry, I did not read the instructions on uploaded completely before I started to upload. I have merged into one file the syllabi, schedules and assessments. I uploaded them under assessments. The final exam annotation document - was used to assess the ability of students in BIOL1102 and BIOL4200 for their ability to do what was taught in the course (annotate several genes from a phage genome.
Bioinformatics training is extremely important. Every life science undergrad should be introduced to at least the existence of bioinformatics in a first year lecture.
I also used the pre- post- RNA-seq assessment instrument developed by GCAT. You

can view it at http://lycofs01.lycoming.edu/~gcat-seek/assessment.html

Thank you for this survey. I am amazed at how many people in the life sciences do not emphasize the importance of teaching bioinformatics. I have worked at two different institutions where they have tried to offer programs in bioinformatics or a closely related field and they struggle with enrollment. I think at least one course in bioinformatics should be required in all life science degrees, or at least those where the student's intention is to go into research. This is a critical/essential skill needed in today's labs.

A fuller description of this module's execution can be found in CBE Life Sciences Education at http://www.lifescied.org/content/9/2/98.full?sid=a4246a81-42c0-4e86-a439-db7d7b222da4

We need more money for science.

I am very interested in these challenges. I teach undergraduate and graduate students in the Biotechnology Program at North Carolina State University. We are integrating more and more deep sequencing in our courses, and I would like to establish a local collaborative network partnering researchers, local museums, and educators to allow primarily undergraduate institutions to do some of the projects we do in our BIT courses. I would love to chat with you, learn from your experience, and see if I can help! Carlos C. Goller ccgoller@ncsu.edu

I am not against adding aspects of bioinformatics to course curriculum. However, I think much thought needs to be put into adding/creating dedicated bioinformatics curriculum. Bioinformatics is still a rapidly developing field. It relies on the newest techniques and knowledge in genetics, computer science, and statistics. Unfortunately my experience with dedicated bioinformatics curriculum has been that the bioinformatics courses are taught as a hodgepodge, containing many different disciplines that students are never able to fully master. Many of the students I have worked with walk away feeling as though they are more aware of bioinformatics, but have not mastered any part of it. I feel that many students would be better served by completing a degree in computer science with a masters in biology, or vice versa. However, with a rigorous curriculum combining genetics, computer science, and statistics, I do believe it would be possible to create a core bioinformatics program.

My teaching in this context is still developing

Tribal institutions have an additional limitation related to a major issue of student's abseentism.

All of my course material is in the above Google Drive folder. Enjoy :)

Maybe during the summer I might have time to dig out assessments. Syllabi are available on my website

I want to do this and have tried but I need help.

Difficult to upload content since it is on Blackboard. Contact me if you want me to send you Blackboard content.

Please add me to your mailing lists or let me help out in any way possible. Sincerely, Jed Rasmussen jed.rasmussen@snow.edu

I am not able to share these materials at this moment, but would like to complete the survey at this time

assessment is built into course tests, papers and oral presentations.

I have some out of class assignments that students do to ask questions about bacterial physiology that uses computational tools. I can share anytime (william.self@ucf.edu)

I teach at a 2 year community college. The teaching load is demanding and I have limited contact with researchers actually using bioinformatics tools. I need time and training to get my skills to where I can effectively teach undergrads. Next fall I will have a sabbatical where I explore tools available to teach bioinformatics - I'm glad to know about "nibbles".

The students at our institution struggle with information in the general biology class. There really isn't room to add bioinformatics given students can't get the basics of cell structure and function.
I think that Bioinformatics has a place in Biological education for certain classes (majors, higher level), but the lower level or for some specific subjects, it just doesn't make sense.
Good luck getting academics to emphasize bioinformatics!
Our program is in a bit of a state of flux, biology redesigned their intro sequence and so did computer science -- next year will be more stable, would be happy to share syllabi then, just contact me at that time: burhansd@canisius.edu
Bioinformatics should be integrated into cell/molecular biology curricula, not required for all majors, such as environmental science. Currently, universities are hiring bioinformatics people that cannot teach their students what plants look like out in the field.
I do not have time to sort through my syllabi, protocols, or assessment tools at this moment. Your notification of how much time this would take did not suggest that such a time-consuming task would be part of my participation.
Working with data from bioinformatics is crucial for molecular students...but doing coding etc really is a less important skill than bench biology. We have lots of bioinformatics students who can't provide a scientific justification for their work...other than "a technique exists, so I am using it" Frankly this is a huge problem, for our students their biggest problem is that they understand computer science...but not Biology. I just sat down with a student looking at transcripts from liver from high fat and low fat diet mice...who is unaware that diet is not a predictor of mortality...again the worse sort of "big science" right now...brainless but can be put in a database.
I teach a two-semester graduate level sequence in computer science for life scientists. This could be a model for an undergraduate sequence for biologists.
Not ready to do this at this time
Our department has specifically scaffolded our intro sequence to include bioinformatics principles. Several years ago we quit teaching a formal genetics course in favor of distributing genetic and bioinformatics principles across our 4 introductory courses. Currently, genomic concepts are used in the Population, Cell Biology, and Molecular Biology courses. Organismal is the second course in the sequence and doesn't include any bioinformatics just because we can't fit it in. All Biology majors also have to take a computer science course based on algorithms and basic programming techniques.
Having some short courses of how to include into the biology classroom for faculty.
I think project-based courses incorporating the use of bioinformatics tools is the way to go.
At our institution students entering have no knowledge of how to use excel or any computer program. There is a tremendous resistance from both students and faculty towards using any technology. It's like we're 15-20 years in the past.
Since I am not currently teaching a course with bioinformatic content, I don't have anything to upload at this point,
I have been out of school for a very long time. I would really like to learn more about genomics and bioinformatics. Will anyone do teacher education regarding these topics? Also, regarding teaching bioinformatics in the undergraduate classroom. I have students who have no time management skills or study skills or reading skills (and then I have some really awesome students). But even my awesome students need to learn basic biological concepts before they delve into bioinformatics. My opinion.
Lecture Schedule* Topics 1. Introduction (Week 1) Understanding Gene Structure and Function 2. Storage and Expression of Genetic Information (Self Reading Assignment) 3. Structure and Function of Proteins (Self Reading Assignment) 4.

Molecular Structure of Eukaryotic and Prokaryotic Genes (Weeks 1 & 2) Data Search and Sequence Comparisons 5. Sequence Alignment methods (Weeks 2 & 3) 6. Database Searching methods (Week 4) 7. Multiple Sequence Alignments (Week 4) (Week 5: First Exam) Structure Prediction 8. Basic concepts (Self Reading Assignment) 9. Methods for Secondary Structure prediction (Week 6) 10. Tertiary and Quaternary Structure (Week 7) 11. Protein folding models and Structure prediction (Week 7 & 8) 12. Prediction of RNA Secondary Structures (Week 8) (Week 9: Spring Recess) Genomics 13. Introduction to Genomics (Week 10) (Week 11: Second Exam) 14. Prokaryotic Genomes and Gene Recognition (Week 12) 15. Eukaryotic Genomes and Gene Recognition (Week 13) 16. Gene Expression analysis and Microarrays (Week 14) Proteomics 17. Proteome, Protein Classification, and Techniques (Week 15) 18. Post Translational Modification and other predictions (Week 15) 19. Inhibitors, Drug Design and Ligand Screening (Week 15) (Week 16: Final Exam) Schedule of Laboratory Exercises: 1 01/21/16 Introduction to Bioinformatics, non-commercial and commercial Bioinformatics Resources. 2 01/28/16 Introduction to NCBI-Entrez System: GenBank, Protein, RefSeq and PubMed databases 3 02/04/16 Exploration of Genomic Information: Entrez Gene, Human Ensembl, MGD, HGNC, and Gene Ontology databases: Student presentations 4 02/11/16 Analysis of Genomic Variations: SNP, OMIM, and HGMD databases: Student presentations 5 02/18/16 Regulated Gene Expression: EPD Database: Student presentation FIRST EXAM 6 02/25/16 Information Retrieval and Analysis of Proteins: UniProt and HPRD databases: Student presentations 7 03/03/16 Protein Structure/Function relationships: Pfam, ProDom, and Conserved Domains databases: Student presentations 8 03/10/16 Self-Study: Vector NTI Advance (Informax) package. 9 03/17/16 Spring Recess 10 03/24/16 Sequence comparisons: Global and Local Alignments; Multiple Sequence Alignments. Database Searching. 11 03/31/16 Protein Structure/Function Predictions: Secondary Structure, Hydrophobicity and Functional Domains. SECOND EXAM 12 04/07/16 Proteomics Tools, Protein Sorting and cellular localization prediction . 13 04/14/16 Self-Study: Vector NTI Advance (Informax) package. 14 04/21/16 Protein Structure Analysis: Structure databases 15 04/28/16 Gene Identification Methods. Final Project Report Due 16 05/05/16 Final Exam Presentations: By the second week of semester, every student will be assigned topics for presentation. The goal of the presentations is to introduce important molecular biology/bioinformatics databases available freely on the Internet. Each 15-20 minute presentation will start with a brief introduction of the data stored in the database. This should also include description of the data model and associated background information. The introduction should be followed by a hands-on tutorial that you will design. The tutorial should use one or two examples of typical queries in order to teach the following skills to the class: 1. query the database and retrieve the information 2. understand, analyze, evaluate (including statistical evaluation and/or mathematical confidence of the results) and interpret the retrieved information 3. use it for further computations and/or analysis with other bioinformatics tools You are required to provide a summary/outline of your presentation in the form of a handout (up to two pages only) for each member of the class. The handout should enlist all the steps in the tutorial in addition to an introductory paragraph, the URL where the database can be accessed and references (only in a standard format) that you consulted, and 2-3 problems for practice. Your presentation will be graded for: Introduction, Information Presented, Overall Clarity, Organization of the seminar, Ability to answer questions and Summary/Outline that you will provide. Final Project: (Outside the classroom hands-on activity) Towards the end of semester, you will be assigned a project which will utilize the methods learnt during the course. Each student/team in the class will be assigned a unique and novel protein sequence.

The goal of your project will be to apply bioinformatics skills that you have acquired during the semester to predict the structure and function of this previously unknown protein. You will name the protein based on your findings and will also predict what type of diseases may result due to a mutation in this protein. This activity requires unmonitored research experience outside of the classroom. The final project report will be graded by the instructor and will count significantly towards your final grade in this course. The completed 'final project' report is due for submission on the last day of the class (usually one week before the final exam). The detailed outlines for the 'final project' report can be accessed at: http://pages.ramapo.edu/~pbagga/binf/binf/binf_project_assignment.docx. Briefly, the format is as follows: Date. Date you started writing the report. Title: Meaningful description of the experiment in one sentence. Objective(s): A concise statement(s) of the purpose(s) of the project. Background: General information about the topic, the significance of the project and the sequence analysis based predictive methodology. Tools & Methods: Describe all the tools, software etc. that you used. Describe your experimental approach. Provide sufficient background information about all the predictive methods that you used. Results: Include and describe all necessary data obtained. Discussion: A thoughtful interpretation and analysis of the results obtained. Compare information obtained by different methods, put 'two and two' together. Conclusions: Final conclusions and major findings of the project. References: Cite sources (do not use encyclopedias) used in the writing of your project report. The references should be provided in a standard format only. To learn how to cite references correctly, visit: https://owl.english.purdue.edu/owl/ Extra-Credit Activities (optional) You can choose one or more of the following activities to earn a maximum of 2% points towards your final course average as extra credit. (None of these activities can be double counted for credit in another course). 1. Journal Club Participation: The goal of TAS Journal club is to enhance awareness of the current research developments in specific scientific disciplines. Journal Club meets on Wednesdays at 4-5 PM in ASB 426. You can earn 1% point as extra credit towards your final course average for regular, active participation for the entire semester in this club. You will have to attend all the weekly meetings (attendance will be taken) AND demonstrate active participation in the discussions to earn this credit. 2. Journal Club Presentation: You can earn 1% point as extra credit towards your final course average by making a presentation in the Journal Club. For this presentation, you will need to pick a recent (published not more than 6 months ago) research article related to Bioinformatics, published in a standard peer-reviewed scientific research journal. News articles will not be acceptable. The article has to be a report of a hard core research project with original data generated, analyzed and interpreted. The Journal club is not just about presentations. The purpose of presentation is, in fact, to initiate scientific discussions. Open discussions during and after the presentation are highly encouraged and anticipated. Up to 25 minutes of brief presentation will generally be followed by 25 minutes of discussion. Presenting student will be expected to initiate discussions by asking questions to the audience following their talks. In case all the students of this course cannot be accommodated in the Journal Club, two presentations of 20 minute each followed by 10 minute discussions for each of the respective presentations can be attempted. If this measure is still not enough to accommodate all students, an election may be held in the class to select the presenting students.

No URLs are available, content is not available online. Course materials are copyrighted and cannot be released. Syllabi do not contain course outlines only university policies.

I have multiple assessments but I don't have time to bundle them...you should allow multiple file uploads.

I woudl like ro see a course in bioinformatics offered to our undergrdauates in biology and biochemistry.
Email me at walkerk@uapb.edu about course syllabi.
In A&P I set up "scavenger hunts" where the students use the various databases to find out about genes and genetic diseases.
Currently there is no time to teach bioinformatics to undergraduate level. They are overwhelmed with several irrelevant cognitives already.
This survey appears to have a binary assumption about the importance of bioinformatics in undergraduate curriculum. I think the answers to that question depend on what the student is going to do. If they are going to grad school then yes; if they are doing field work then stats may matter, but bioinformatics is not obviously as helpful. I think everyone should have some idea of the big picture, but I'm not sure how important it is to someone who spends most of their work hours in the field.
1. There was a question that assumed students were either freshman or sophomores. About half of the students who take my course at the community college already have bachelor's degrees.   2. Our college includes bioinformatics activities in the biology department through the SEA Phage program and also with a research project using DNA barcoding.
I can't upload syllabi right now, but I am happy to provide them at a later date.
Although we do not offer a Bioinformatics Major or Minor, we do have an advanced Bachelors?Masters degree that allows student to graduate in 4 yrs with a BS (or BA) in Biology and then an MS in Bioinformatics and Computational Biology at the end of year 5.
Bioinformatics is important, but there are so many other things we have to get to first. I think it would be a great stand alone course that I wish we had. We offer one called, "genomics", but I don't think its very useful (I don't teach it.)
I have a large collection of so-called 'One Point Assignments' which when completed satisfactorily prior to an exam add points to the exam score; these assignments are usually problems to solve, but span a variety of questions, both theoretical and practical.
I don't have access to all of these items tonight. Since I'm a NIBLES member, I will make sure to make what I can available.

Statistic	Value
Total Responses	131