

FORM TO REQUEST SUBSTANTIAL CHANGES TO AN EXISTING UNDERGRADUATE MAJOR

A request for substantial changes to an existing program requires approval from the school director/department head (managing administrator), college academic dean, Curricular Affairs, Undergraduate Council (UGC), and College Academic Administrators Council (CAAC). Additional approvals may be required, depending on the requested changes. Complete this form and submit to Martin Marquez (martinmarquez@email.arizona.edu) no later than October 25, 2019 to be considered for inclusion in the 2020-2021 Academic Catalog.

I. Requested by (College & School/Department):

II. College of Science/Ecology & Evolutionary Biology

III. Proposer's name, title, email and phone number:

Michael Barker, Associate Professor, msbarker@email.arizona.edu, (520) 621-2213

IV. Degree, major and number of students enrolled in the major. If you have emphases (sub-plans), list the number of students enrolled by emphasis:

Bachelor of Science in Bioinformatics with 4 emphases offered: Ecology & Evolutionary Biology (2 enrolled), Molecular & Cellular Biology (5 enrolled), Systems Biology (4 enrolled), and Computer Science (3 enrolled), and 4 undecided on emphasis.

V. Describe proposed changes to the major. Provide a rationale and explanation for making changes to the major and include any relevant supporting data. Are the changes proposed a result of Annual Program Review (APR) and/or a result from the assessment of programmatic outcomes? If you are requesting a name change, please indicate if the subject code (course prefix) will also change. Include requested new prefix code and description.

Our proposed changes will simplify the major by eliminating the four emphases. Although the four existing emphases were originally conceived to help advising staff and students select courses to focus students on different areas of specialty, they have become increasingly difficult to manage as course schedules and pre-requisites in other departments have evolved. This has resulted in multiple work-arounds to help students find courses to meet the needs of their chosen emphasis. The proposed change will simplify this process by defining a core set of courses that complement the existing Bioinformatics BS core courses while making the remaining courses electives rather than proscribed by emphases. We will maintain a list of the courses organized by emphasis so students can see the options available organized by theme. Themes will not be indicated on any official documents, rather, they are meant to aid the student in course selection. This flexibility will allow students to work with advising staff and faculty to tailor their degree from the list of electives to better fit schedules and their career plans.

We also propose to adopt newly developed School of Information (iSchool) courses in informatics and data sciences as core courses to replace comparable Computer Science courses. Doing so better aligns our major with recent community developed curricula for Bioinformatics programs as described in a recent white paper Bioinformatics Core Competencies for Undergraduate Life Sciences Education by Wilson Sayers et. al. 2018. Further, Computer Science has changed the content and pre-requisites of their introductory courses. In past conversations with the Bioinformatics curriculum committee when the major was developed, CS indicated that they would transition their introductory courses to be taught using the programming language Python. However, they appear to have gone in a different direction. Python is one of the major languages of Bioinformatics and this decision leaves our majors without the required knowledge and expertise to be competitive in the field. We are fortunate at UA to have the iSchool provide an alternative approach to informatics. The courses taught by iSchool teach students algorithms and data science skills in Python, and will provide our majors with the education they require. iSchool is working closely with EEB to provide Bioinformatics majors with the practical computational and data science skills needed for successful careers in bioinformatics. Overall, the proposed changes will streamline our major so students and advising staff can more flexibly navigate student schedules, and update our curriculum to meet the evolving standards of our discipline.

- VI. Comparison Chart**—complete the chart below using your existing [academic advisement report](#). You may not need to complete all portions. Highlight row(s) indicating the proposed significant changes. You can find course information to help complete the chart below by using the [UA course catalog](#) or [UAnalytics](#) (Catalog and Schedule Dashboard> “Printable Course Descriptions by Department” On Demand Report; right side of screen). Proposed changes resulting in similar curriculum with other plans (within department, college, or university) may require completion of an additional comparison chart. **Delete Example columns before submitting.**

	Existing Major Requirements	Requirements For Modified Major
Major, emphasis (if applicable) and degree *	Bioinformatics, EEB emphasis, MCB emphasis, Systems Bio emphasis and Computer Sci emphasis, BS degree	Bioinformatics, BS
CIP Code –lookup here or contact Martin Marquez for assistance, if needed	26.1103, Bioinformatics	26.1103, Bioinformatics
Total units required to complete the degree*	120	120
Upper -division units required to complete the degree	42	46
Total CC transfer units that may apply to this degree*	64	64
Foundation courses		
Math	Substantial Math Strand	Substantial Math Strand
Second Language	Second Semester Proficiency	Second Semester Proficiency
General Education		
Tier I GE Requirements (150, 160, 170)	2- Tier 1 150 (INDV) 2- Tier 1 160 (TRAD) 0- Tier 1 170 (NATS)	2- Tier 1 150 (INDV) 2- Tier 1 160 (TRAD) 0- Tier 1 170 (NATS)
Tier II GE Requirements (Arts, HUMS, INDV, NATS)	3 units -Tier II Arts 1-Tier II Humanities 1- Tier II Individuals and Societies 0-Tier II Natural Sciences	3 units -Tier II Arts 1-Tier II Humanities 1- Tier II Individuals and Societies 0-Tier II Natural Sciences
Pre-major? (Yes/No)	No	No
List any special requirements to declare or gain admission to this major (completion of specific coursework, minimum GPA, interview, application, etc.)	New Students- none Change of major for current students- good academic standing (GPA 2.0)	New Students- none Change of major for current students- good academic standing (GPA 2.0)

Minimum # of units required in the major (units counting towards major units and major GPA)	53	53
Minimum # of upper-division units required in the major (upper division units counting towards major GPA)	34	46
<u>Minimum # of residency units to be completed in the major</u>	18	18
Required supporting coursework (courses that do not count towards major units and major GPA, but are required for the major). Courses listed must include prefix, number, units, and title. Include any limits/restrictions in place/needed (house number limit, etc.). Provide email(s)/letter(s) of support from home department head(s) for courses not owned by your department.	<p>Foundation</p> <p>- CHEM 151 or 141/143, or 161/163 (4) General Chemistry I</p> <p>-CHEM 152 or 142/144 or 162/164 (4) General Chemistry II</p> <p>- CHEM 241 A or 242A or 246A & 243 A or 247A (4) Organic Chemistry I</p> <p>- CHEM 241 B or 242B or 246B & CHEM 243 B or 247B (4) Organic Chemistry II</p> <p>-MATH 122A/B (5) Calculus I or MATH 125 (3)</p> <p>-MATH 129 (3) Calculus II</p> <p>-CSC 110 (4) Introduction to Computer Programming I or ISTA 130 (4) Computational Thinking and Doing</p> <p>- CSC 120 (4) Introduction to Computer Programming II</p>	<p>Foundation</p> <p>-CHEM 151 or 141/143, or 161/163 (4) General Chemistry I</p> <p>-CHEM 152 or 142/144 or 162/164 (4) General Chemistry II</p> <p>- CHEM 241 A or 242A or 246A & 243 A or 247A (4) Organic Chemistry I</p> <p>- CHEM 241 B or 242B or 246B & CHEM 243 B or 247B (4) Organic Chemistry II</p> <p>-MATH 122A/B (5) Calculus I or MATH 125 (3)</p> <p>-MATH 263 (3) Biostatistics</p> <p>- ISTA 130 (4) Computational Thinking and Doing</p> <p>-ISTA 131 (4) Dealing with Data</p>
Major requirements. List all major requirements including core and electives. If applicable, list the emphasis^ requirements. Courses listed count towards major units and major GPA. Courses listed must include prefix, number, units, and title. Mark new coursework (New). Include any limits/restrictions in place/needed (house number limit, etc.). Provide email(s)/letter(s) of support from home department head(s) for courses being added and are not owned by your department. Recommend ordering requirements in the same order as your advisement report.	<p>-MCB 181 R & MCB 181 L (4) Introductory Biology 1</p> <p>- ECOL 182 R & ECOL 182 L (4) Introductory Biology II</p> <p>- ECOL 296B (1) Seminar in Bioinformatics</p> <p>-CSC 245 (4) Introduction to Discrete Structures or MATH 245 (3) Discrete Math in CS</p> <p>-CSC 250 (3) Essential Computation for the Sciences</p> <p>-CSC 345 (4) Analysis of Discrete Structures</p> <p>-ECOL 346 (4) Bioinformatics</p>	<p>-MCB 181 R & MCB 181 L (4) Introductory Biology 1</p> <p>-ECOL 182 R & ECOL 182 L (4) Introductory Biology II</p> <p>- ECOL 296B (1) Seminar in Bioinformatics</p> <p>-ISTA 116 (3) Statistical Foundations for the Information Age</p> <p>-ISTA 331 (3) Principles and Practices of Data Science</p> <p>- ISTA 350 (4) Programming for the Informatics Applications</p> <p>-ECOL 346 (4) Bioinformatics</p>

	<p>Emphasis</p> <p>Ecology and Evolutionary Biology Emphasis</p> <ul style="list-style-type: none"> -MATH 263 (3) Biostatistics -ECOL 302 (4) Ecology -ECOL 320 (4) Genetics -ECOL 335 (4) Evolution -ECOL 326 (3) Genomics <p>Additional minimum of 11 units of approved upper division electives</p> <p>Molecular and Cellular Biology Emphasis</p> <ul style="list-style-type: none"> -MATH 263 (3) Biostatistics -BIOC 384 (3) Foundations in Biochemistry or MCB 310 (4) Molecular Basis of Life -MCB 304 (4) Molecular Genetics -MCB 305 (4) Cell & Developmental Biology -MCB 315 (4) Key Concepts in Quant. Bio <p>Additional minimum of 11 units of approved upper division electives</p> <p>Systems Biology Emphasis</p> <ul style="list-style-type: none"> -MATH 263 (3) Biostatistics -BIOC 384 (3) Foundations in Biochemistry or MCB 301 (4) Molecular Basis of Life - MCB 304 (4) Molecular Genetics -MCB 305 (4) Cell & Developmental Biology -ECOL 302 (4) Ecology - ECOL 335 (4) Evolutionary Biology <p>Additional minimum of 7 units of approved upper division electives</p> <p>Computer Science Emphasis</p> <ul style="list-style-type: none"> -MATH 223 (4) Vector Calculus 	<p>- ECOL 320 (4) Genetics</p> <p>- ECOL 335 (4) Evolution</p> <p>Minimum of 22 elective units. Of the 22 units, a minimum of 16 upper division electives. Elective options will remain from the current options from the emphasis and the current approved electives</p>
--	---	---

	-MATH 254 (3) Differential Equations -MATH 363 (3) Statistical Methods -CSC 445 (3) Introduction to Algorithms -MCB 304 (4) Molecular Genetics or ECOL 320 (4) Genetics -MCB 305 (4) Cell & Developmental Biology or ECOL 335 (4) Evolutionary Biology Additional minimum of 8 units of approved upper division electives	
Internship, practicum, applied course requirements. (Yes/No). If yes, provide description.	No	No
Senior thesis or senior project required (Yes/No). If yes, provide description.	No	No
Additional requirements (provide description)	None	None
Minor (optional or required)	Optional	Optional

*May require Arizona Board of Regents (ABOR) approval

^Emphases are officially recognized sub-specializations within the discipline. [ABOR Policy 2-221 c. Academic Degree Programs Subspecializations](#) requires all undergraduate emphases within a major to share at least 40% curricular commonality across emphases (known as “major core”). Total units required for each emphasis must be equal.

VII. Peer institution comparison- describe how your modified major requirements are similar and different from major requirements of two peer institutions. Select peers from (in order of priority) [ABOR approved institutions](#), [AAU members](#), and/or other relevant institutions recognized in the field.

We offer the only Bachelor of Science in Bioinformatics in the Southwest, which is one of only 16 such programs in the country. Similar to the UC San Diego Biology degree with Bioinformatics specialization, our students will take informatics and data sciences, foundational science, math, upper division biology and upper division data science courses. The core classes emphasize informatics, genetics and evolution. Our core course changes bring us in line with recent community recommendations for an undergraduate Bioinformatics program. These changes will update the computational side of our program to bring it in line with peer recommendations per *Bioinformatics Core Competencies for Undergraduate Life Sciences Education* by Wilson Sayers et. al. 2018.

VIII. Faculty impact- indicate if new faculty hires will be required to deliver the proposed modified/new curriculum.

None


IX. Budgetary impact- indicate new resources needed and source of funding to implement the proposed changes. If reallocating resources, indicate where resources will be taken from and the impact this will have on

students/faculty/program/unit.

None

X. Required signatures

Managing unit administrator (print name and title): Michael S. Barker, Associate Professor

Managing administrator's signature: 

Date: 8 Dec 2019

Managing unit administrator (print name and title): _____

Managing administrator's signature: _____

Date: _____

Dean (print name): _____

Dean's signature: _____

Date: _____

Dean (print name): _____

Dean's signature: _____

Date: _____

Note: In some situations, signatures of more than one unit head and/or college dean may be required.

For use by Curricular Affairs:

Committee	Approval date
Academic Programs Subcommittee	
Undergraduate Council	
College Academic Administrators Council	
Arizona Board of Regents (if applicable)	

- ☐ Notify proposers of approval
- ☐ Upload proposal documents to relevant UAccess tables
- ☐ Notify ADVIP team and proposers

If ABOR approval required :

- ☐ If applicable, create approval memo
- ☐ Send memo to college/dept and acad_org listserv.
- ☐ If applicable, create new plan code (secondary too)
- ☐ If applicable, update emphases
- ☐ If applicable, add last admit term to prior plan code(s)
- ☐ Upload proposal docs to relevant UAccess table values
- ☐ Notify ADVIP team and proposers

From: [Worobey, Michael - \(worobey\)](#)
To: [Kortessis, Sarah M - \(sarahkortessis\)](#)
Cc: [Gomez, Rebecca L - \(rgomez\)](#); [Harrison, Lauren A - \(lashley\)](#); [Sandoval, Liz - \(esandmar\)](#); [Marquez, Martin - \(martinmarquez\)](#)
Subject: Re: Bioinformatics curriculum change
Date: Wednesday, December 18, 2019 8:48:53 PM

Hi Sarah,

Looks great, thanks.

I approve.

Best wishes,

Mike

Michael Worobey
Louise Foucar Marshall Science Research Professor
Department Head, Ecology and Evolutionary Biology
Associate Director, BIO5 Institute
University of Arizona
Tucson AZ, 85705
Tel (520) 626-3456

On Dec 18, 2019, at 7:47 PM, Kortessis, Sarah M - (sarahkortessis)
<sarahkortessis@email.arizona.edu> wrote:

Hi Mike and Rebecca,

Attached is our Bioinformatics curriculum change request form that we are submitting to update the major to best serve our students. Dr. Barker and I have worked hard with ISTA to find excellent course options in data science for our Bioinformatics majors and to clean up the degree. As it says in our proposal, the multiple emphasizes have become increasingly difficult to manage as course content and pre-requisites in other departments have evolved. This has resulted in multiple work-arounds to help students find courses to meet the needs of their chosen emphasis.

The final step before submission is a signature or email of approval from our Department Head and the associate Dean. Email approval would need to go to Martin Marquez martinmarquez@email.arizona.edu and Liz Sandoval esandmar@email.arizona.edu

I'm happy to address any questions or concerns you have!

Thank you,

Sarah

From: [Gomez, Rebecca L - \(rgomez\)](#)
To: [Kortessis, Sarah M - \(sarahkortessis\)](#); [Worobey, Michael - \(worobey\)](#)
Cc: [Harrison, Lauren A - \(lashley\)](#); [Sandoval, Liz - \(esandmar\)](#); [Marquez, Martin - \(martinmarquez\)](#); [Gomez, Rebecca L - \(rgomez\)](#)
Subject: Re: Bioinformatics curriculum change
Date: Tuesday, January 7, 2020 5:21:29 AM

Thank you for this information Sarah. I approve this curriculum change as well.

Rebecca Gomez, PhD
Interim Associate Dean for Student Academic Success
College of Science
Professor, Psychology and Cognitive Science
The University of Arizona

From: "Kortessis, Sarah M - (sarahkortessis)" <sarahkortessis@email.arizona.edu>
Date: Monday, January 6, 2020 at 6:36 PM
To: "Gomez, Rebecca L - (rgomez)" <rgomez@email.arizona.edu>, Mike Worobey <worobey@email.arizona.edu>
Cc: Mike Worobey <lashley@email.arizona.edu>, "Sandoval, Liz - (esandmar)" <esandmar@email.arizona.edu>, "Marquez, Martin - (martinmarquez)" <martinmarquez@email.arizona.edu>
Subject: RE: Bioinformatics curriculum change

Hi Rebecca,

Thank you! I did submit letters from both parties with my original submission to Martin and Liz. We should be all set now

Best,

Sarah

Sarah Kortessis
Undergraduate Program Coordinator
Dept. of Ecology & Evolutionary Biology
Biological Sciences West 230

From: Gomez, Rebecca L - (rgomez) <rgomez@email.arizona.edu>
Sent: Friday, January 3, 2020 11:46 AM
To: Worobey, Michael - (worobey) <worobey@email.arizona.edu>; Kortessis, Sarah M -

From: [cschustr](#)
To: [Kortessis, Sarah M - \(sarahkortessis\)](#); [Moore, Tina Schuster - \(cschuste\)](#)
Subject: Re: Bioinformatics Curriculum Change
Date: Friday, October 4, 2019 5:36:10 PM

Hi Sarah,

I sent this to our associate heads and they see no issue with this. Thank you for letting us know.

Tina S Moore
Assistant Director for Placement and Curriculum
Department of Mathematics
University of Arizona
Mathematics Room 108
cschustr@math.arizona.edu
phone: (520) 621-6892
fax: (520) 621-8322

On 10/4/2019 5:17 AM, Kortessis, Sarah M - (sarahkortessis) wrote:

Hi Tina,

Of course! Sorry- We already had MATH 263 and are just including it for everyone instead of having it in specific tracks. The major has about (analytics won't open!) 24 students in it currently.

Best,

Sarah

*Sarah Kortessis
Undergraduate Program Coordinator
Dept. of Ecology & Evolutionary Biology
Biological Sciences West 230*

From: cschustr <cschustr@math.arizona.edu>
Sent: Thursday, October 3, 2019 1:19 PM
To: Kortessis, Sarah M - (sarahkortessis) <sarahkortessis@email.arizona.edu>; Moore, Tina Schuster - (cschuste) <cschuste@email.arizona.edu>
Subject: Re: Bioinformatics Curriculum Change

Also, how many majors do you have?
Thanks.

Tina S Moore
Assistant Director for Placement and Curriculum
Department of Mathematics

University of Arizona
Mathematics Room 108
cschustr@math.arizona.edu
phone: (520) 621-6892
fax: (520) 621-8322

On 10/2/2019 7:16 PM, Kortessis, Sarah M - (sarahkortessis) wrote:

Hi Tina,

I hope the semester is going well! We are making big changes to the Bioinformatics curriculum and wanted to send this over the you all at Math to make sure these changes are supported by your department. Nothing crazy, but they always ask for support from impacted departments when you submit!

Thanks for any input you have,

Sarah

Sarah Kortessis
Undergraduate Program Coordinator
Dept. of Ecology & Evolutionary Biology
Biological Sciences West 230



THE UNIVERSITY OF ARIZONA
COLLEGE OF SOCIAL & BEHAVIORAL SCIENCES
School of Information

Harvill Building, 4th Floor
1103 E 2nd St.
Tucson, AZ 85721
520.621.3565
si.arizona.edu

January 9, 2020

Dr. Worobey

Department Head, Dept. of Ecology & Evolutionary Biology

Dear Dr. Worobey,

This is a letter of support for the use of ISTA courses to support your bioinformatics program. We are so pleased to be a part of this as we aim to serve the campus in interdisciplinary data science education as needed. We look forward to working with you and wish you a positive experience with your new plan. Data Science in many forms is a critical skill needed in many sciences and professions.

There is no conflict with School of Information programs and there are certainly opportunities for synergy moving forward. We are eager to welcome your students into our relevant courses (notice interdisciplinary data mining, ISTA 321 and others too).

We look forward to our ongoing collaboration.

Sincerely,

Catherine Brooks
Director, School of Information



Spring Offering

BIOINFORMATICS ELECTIVES

Students may only use a course once within their major electives. Courses that are part of the core of your particular major track may not also be used as electives (e.g. MCB 301 or BIOC 384 in the MCB track). Courses with a ^ have an online component.

Biological Options

ACBS 423 - Mechanisms of Disease
BIOC 384 - Fundamentals of Biochemistry (*EEB & CS Sub-plan only*)
BIOC 385 - Metabolic Biochemistry
ECOL 330 - Evolution of Animal Form & Function
ECOL 360 - Marine Ecology & Conservation
ECOL 406R - Conservation Biology
ECOL 409 - Evolution of Infectious Disease
ECOL 426 - Population Genetics
ECOL 472 - Systematic Botany
ECOL 473 - Topics in Behavioral Ecology
ECOL 475 - Freshwater and Marine Algae
ECOL 383 - Herpetology
ECOL 484 - Ornithology
GEOS 412A & 412B - Ocean Sciences w/ Field Experience
MCB 301 - Molecular Basis of Life (*EEB & CS Sub-plan only*)
MCB 410 - Cell Biology
MCB 416A - Statistical Bioinformatics & Genomic Analysis (Even years only)
MCB 422 - Problem Solving with Genetic Tools
MCB 473 - Recombinant DNA Methods and Applications
MIC 328R - Microbial Physiology
PLP 428R - Microbial Genetics Lecture
PLP 428L - Microbial Genetics Lab
PLS 312 - Plant and Animal Genetics
PLS 333 - General Virology

Computer Science Options

CSC 335 - Object Oriented Programming and Design
CSC 352 - Systems Programming and Unix
CSC 372 - Comparative Programming Languages
CSC 401B - Symbolic Logic
CSC 422 - Introduction to Parallel & Distributed Programming
CSC 444 - Data Visualization
CSC 460 - Database Design
ISTA 350 - Programming for Informatics Applications
ISTA 410 - Bayesian Modeline & Inference
ISTA 454 - Informatics in Biology
For assistance enrolling in Computer Science courses, please contact advising@cs.arizona.edu.

Mathematics Options

MATH 310 - Applied Linear Algebra
MATH 313 - Introduction to Linear Algebra
MATH 355 - Analysis of Ordinary Differential Equations
MATH 401B - Symbolic Logic
MATH 413 - Linear Algebra