



UNDERGRADUATE EMPHASIS (SUB-PLAN) REQUEST FORM

MAJORS WITHOUT EXISTING EMPHASES (SUB-PLANS)

Complete this form and submit to the [Office of Curricular Affairs](#), no later than January 1 to be considered for inclusion in the following year's Academic Catalog.

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

College of Science/ Department of Mathematics, in collaboration with Computer Science and Molecular and Cellular Biology

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

Bryden Cais, PhD

Professor of Mathematics

Associate Head of Undergraduate Programs

cais@math.arizona.edu

520-621-6872

III. Degree, major and number of students currently enrolled in the major (include dual majors):

Current: B.S. in Statistics & Data Science. Requesting Name Change to: B.S. in Data Science

Current enrollment: 178 students Main campus, 69 students at CUEB

(also have 34 students in the STATDSBA/STATDSBA2 on Main campus; for now, we would like to maintain the STATDSBA as-is, until we have had more time to consider what changes are needed there)

IV. Total number of students that have completed the major in the past 3 years:

In the last 3 academic years (2020-21, 2021-22, 2022-23), we have had 89 total students complete STATDSBS or STATDSBS2.

(For STATDSBA/STATDSBA2, there have been 19 completions.)

V. Minimum number of units required to complete the major (do not include foundation, general education, general electives or supporting coursework):

Currently 34; increasing to 54

VI. Name of the proposed emphases:

-Comprehensive Statistics

-Applied Statistics

-Global (for students in our existing Dual Degree Program at Capital University of Economics & Business (CUEB) in Beijing, China)

-Computing

-Molecular and Cellular Biology

VII. When is the anticipated semester and year to launch the proposed emphasis?

Fall 2024



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VIII. Campus and location offering: Please attach a completed [Add/Remove Campus form](#) to your proposal if offered via Online or Distance.

Main (all subplans except Global); Global - CUEB (Global Subplan only)

IX. Provide a rationale for the proposed new emphases.

- Request from Dean of College of Science to make our existing SDS major more accessible and interdisciplinary
- Desire to better prepare students for a greater variety of post-graduation options
 - Set up one emphasis to prepare students for graduate studies in statistical data science
 - Another emphasis to prepare for jobs in statistical data science
 - A separate emphasis for students in our dual degree program at Capital University of Economics & Business in Beijing, China
 - Additional emphases in computational and biological data science
 - Flexibility to add more emphases in future
 - Inclusion of additional career preparation/exploration experiences and directed research credit in the Applied Statistics emphasis
- Changes include:
 - To better reflect the importance of computational skills in data science, the introductory computer programming course (CSC 110/ISTA 130) and the databases/SQL course (ISTA 322/CSC 460) have been moved into the core (they were previously supporting course requirements)
 - Added another computer programming course (CSC 120/ISTA 131), a lower-division statistics course (MATH 263), and an introduction to data science (DATA 201) to the core
 - Added five emphasis areas:
 - “Comprehensive Statistics” (intended for students planning to attend graduate school in statistics or statistics & data science). **This emphasis contains the existing Statistics & Data Science major, with some extra courses added: DATA 201, CSC 120/ISTA 131, MATH 263, DATA 474 (DATA 201 and DATA 474 were included in our annual curriculum updates for the STATDSBS, so we expect to add these regardless of this proposal).** As noted above, CSC 110/ISTA 130 and ISTA 322 have been upgraded from supporting requirements to core & emphasis requirements, respectively.
 - “Applied Statistics” (intended for students wanting a more statistical-focused data science major in preparation for entering the work force after graduation)
 - “Global” (for our dual degree program in China)
 - “Computing” (intended for students who want to learn more about the computational side of data science)
 - “Molecular and Cellular Biology” (intended for students who are interested in applying data science methods to biology)
 - From the existing major core, many courses have been moved into emphases:
 - MATH 223 – required in Comprehensive Statistics & Global, elective in Applied Statistics
 - DATA 363 – required in Comprehensive Statistics, Applied Statistics, Global, and Molecular & Cellular Biology. The Computing emphasis has a related course
 - DATA 375 – required in all proposed emphases
 - DATA 467 – required in Comprehensive Statistics, Applied Statistics, & Global



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- DATA 474 (submitted through annual curriculum update process to be added for fall 2024) – required in Comprehensive Statistics, Applied Statistics, & Global; Computing and Molecular & Cellular Biology emphases each have a related course
- DATA 498A – required in Comprehensive Statistics, Applied Statistics, Global, & Computing; Molecular & Cellular Biology will require either this course or their own equivalent
- MATH 464 – required in Comprehensive Statistics & Global, elective in Applied Statistics
- MATH 466 – required in Comprehensive Statistics & Global
- Existing major electives are also available in the Comprehensive Statistics emphasis, with the addition of MATH 323 to serve students who need it for graduate school preparation. A selection of the existing electives plus some new options are available in the Applied Statistics emphasis

X. Requirements to meet 40% commonality across emphases.

<u>Requirement Title/Description</u>	<u>Courses (include prefix, number, title, units)</u>	<u>Minimum units needed to satisfy requirement</u>
Calculus I	MATH 122B (4) First-Semester Calculus OR MATH 125 (3) Calculus I	3
Core	CSC 110 (4) Computer Programming I or ISTA 130 (4) Computational Thinking & Doing (Add) CSC 120 (4) Intro to Computer Prog II or (Add) ISTA 131 (4) Dealing with Data MATH 129 (3) Calculus II (Add) MATH 263 (3) Intro: Stat+Biostatistics (New) DATA 201 (3) Foundations of Data Science	17
Linear Algebra:	MATH 215 (3) Intro to Linear Algebra Or MATH 310 (3) Applied Linear Algebra Or MATH 313 (3) Intro to Linear Algebra	3
	Total major core upper division units required	0
	Total major core units required	23

Required Supporting Coursework (Not included in major units or GPA)

*Note: we DO wish to allow supporting courses to double-dip with other major requirements, as appropriate

<u>Requirement Title/Description</u>	<u>Courses (include prefix, number, title, units)</u>	<u>Minimum units needed to satisfy requirement</u>
Lab Science Choose 2 from the following.	First Semester General Chemistry:	8



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<p>Selections may be from different subject areas (ie, Chemistry I and Physics I)</p>	<p>CHEM 141 (3) Gen Chem I: Quantitative + CHEM 143 (1) Gen Chem: Quantitative Lab 1 OR CHEM 145 (1) Quantitative Chem Lab I CHEM 151 (4) Chemical Thinking I CHEM 161 (3) Honors Chemical Thinking I + CHEM 163 (1) Honors Fund Tech of Chem CHEM 181 (4) Majors General Chemistry I</p> <p>Second Semester General Chemistry: CHEM 142 (3) Gen Chem II: Quantitative + CHEM 144 (1) Gen Chem: Quantitative Lab II OR CHEM 146 (1) Quantitative Chem Lab II CHEM 152 (4) Chemical Thinking II CHEM 162 (3) Honors Chemical Thinking II + CHEM 164 (1) Honors Fund Tech of Chem CHEM 182 (4) Majors General Chemistry II</p> <p>Geosciences GEOS 251 (4) Physical Geology GEOS 255 (4) Historical Geology GEOS 302 (4) Prin Stratigraphy+Sedim GEOS 304 (4) Structural Geology GEOS 308 (3) Paleontology GEOS 322 (3) Intro To Geophysics</p> <p>Introductory Biology I MCB 181R (3) Introductory Biology I + MCB 181L (1) Intro Biology I Lab MCB 184 (4) Introductory Biology I</p> <p>Introductory Biology II ECOL 182R (3) Introductory Biology II + ECOL 182L (1) Intro Biology II Lab</p> <p>Human Anatomy and Physiology PSIO 201 (4) Human Anat+Physiology I PSIO 202 (4) Human Anat+Physiology II</p> <p>Physics I PHYS 141 (4) Introductory Mechanics PHYS 161H (4) Honors Intro Mechanics PHYS 140 (3) Introductory Mechanics + PHYS 139 (1) Intro Mechanics Lab (Add) PHYS 102 (3) Introductory Physics I + PHYS 181 (1) Introductory Laboratory I – letter included</p> <p>Physics II PHYS 142 (3) Intro Optics + Thermodyn PHYS 162H (4) Hnrs Intr Optics+Thermod</p>	
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	PHYS 241 (4) Intro Elec+Magnetism PHYS 261H (4) Honr Intro Electr+Magnet PHYS 240 (3) Intro Electric+Magnetism + PHYS 239 (1) Intro E&M Lab (Add) PHYS 103 (3) Introductory Physics II + PHYS 182 (1) Introductory Laboratory II – letter included Hydrology HWRS 350 (3) Principles of Hydrology (Add) Materials Science MSE 110 (4) Solid State Chemistry – letter included	
	Total Supporting Coursework upper division units required	0
	Total Supporting Coursework units required	8

XI. Requirements specific to the proposed emphases.

Comprehensive Statistics:

<u>Requirement Title/Description</u>	<u>Courses (include prefix, number, title, units)</u>	<u>Minimum units needed to satisfy requirement</u>
Comprehensive Statistics Core	MATH 223 (4) Vector Calculus DATA/MATH 363 (3) Intro Statistical Method DATA 375 (3) Intro to Statistical Computing DATA 467 (3) Intro to Applied Linear Models (New) DATA 474 (3) Intro Stat Machine Learning DATA 498A (3) Capstone: Stats/Data Science MATH 464 (3) Theory of Probability MATH 466 (3) Theory of Statistics	25
SQL/Databases, choose one	ISTA 322 (3) Data Engineering OR (Add) CSC 460 (3) Database Design	3
Elective, choose one	MATH 323 (3) Formal Math Reasoning+Wrtg DATA 367 (3) Sports Analytics DATA 396T (3) Tpcs in Undergrad Stats DATA/MATH 412 (3) Linear Algebra for Data Sc DATA/MATH 462 (3) Financial Math DATA/MATH 468 (3) Appl Stochastic Process DATA 496T (3) Advncd Tpcs in Undergrad Stats DATA 498H (3) Honors Thesis SIE 440 (3) Survey Optimization Meth	3
	Total emphasis upper division units required	27
	Total major emphasis units required*	31



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***All emphases offered for this major must have the same minimum number of units required**

Applied Statistics:

Requirement Title/Description	Courses (include prefix, number, title, units)	Minimum units
Applied Statistics Core	DATA/MATH 363 (3) Intro Statistical Method DATA 375 (3) Intro to Statistical Computing DATA 467 (3) Intro to Applied Linear Models (New) DATA 474 (3) Intro Stat Machine Learning DATA 498A (3) Capstone: Stats/Data Science	15
(Add) Colloquia/career exploration opportunities, choose one	DATA/MATH 195M (1) Major Colloquium DATA/MATH 395M (1) Career Exploration Math & SDS DATA 391 (1) Preceptorship DATA 491 (1) Preceptorship DATA 393 (1-10) Internship DATA 493 (1-10) Internship	1
SQL/Databases, choose one	ISTA 322 (3) Data Engineering OR (Add) CSC 460 (3) Database Design	3
Electives, choose four	MATH 223 (4) Vector Calculus MATH 464 (3) Theory of Probability DATA 367 (3) Sports Analytics DATA 396T (3) Tpcs in Undergrad Stats DATA/MATH 462 (3) Financial Math DATA 496T (3) Advncd Tpcs in Undergrad Stats DATA 498H (3) Honors Thesis SIE 440 (3) Survey Optimization Meth (Add) ISTA 320 (3) Data Visualization (Add) ISTA 321 (3) Data Mining & Discovery (Add) ISTA 410 (3) Bayesian Modeling & Inference (Add) LING 439 (3) Stat Natural Lang Processing (Add) MCB 416 (3) Bioinformatics + Functional Genomic Anls (Add) MCB 447 (3) Big Data in Molecular Bio +Medicine (Add) DATA 492 (1-6 units, a maximum of 3 units may count toward this requirement) Directed Research	12
Total emphasis upper division units required		26
Total major emphasis units required		31

Global:

Requirement Title/Description	Courses (include prefix, number, title, units)	Minimum units
Core	MATH 223 (4) Vector Calculus DATA/MATH 363 (3) Intro Statistical Method	25



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	DATA 375 (3) Intro to Statistical Computing DATA 467 (3) Intro to Applied Linear Models (New) DATA 474 (3) Intro Stat Machine Learning DATA 498A (3) Capstone: Stats/Data Science MATH 464 (3) Theory of Probability MATH 466 (3) Theory of Statistics	
Thesis	DATA 499 (3) Independent Study* *Students at the CUEB campus will enroll in thesis units through their home university, and we will substitute for DATA 499.	3
SQL/Databases	ISTA 322 (3) Data Engineering	3
Total emphasis upper division units required		27
Total major emphasis units required		31

Computing:

<u>Requirement Title/Description</u>	<u>Courses (include prefix, number, title, units)</u>	<u>Minimum units</u>
Computing Core	(Add) CSC 144 (3) Discrete Math for Computer Science Or (Add) MATH 243 (3) Discrete Math (Add) CSC 244 (3) Discrete Math for Computer Science II (Add) CSC 210 (4) Software Development (Add) CSC 335 (3) Object-Oriented Programming and Design (Add) CSC 345 (3) Anls of Discrete Structures (Add) CSC 380 (3) Principles of Data Science Or DATA 363 (3) Intro Statistical Method DATA 375 (3) Intro to Statistical Computing DATA 498A (3) Capstone: Stats/Data Science (Add) CSC 460 (3) Database Design (Add) CSC 480 (3) Principles Machine Learning	31
Total emphasis upper division units required		21
Total major emphasis units required		31

Molecular and Cellular Biology:

<u>Requirement Title/Description</u>	<u>Courses (include prefix, number, title, units)</u>	<u>Minimum units</u>
MCB Core	(Add) MCB 181R (3) Intro Biology I (Add) MCB 330 (1) Critical Reasoning and Problem Solving in Biomedicine DATA 363 (3) Intro Statistical Method DATA 375 (3) Intro to Statistical Computing (Add) MCB 410 (3) Cell Biology Or (Add) MCB 411 (3) Molecular Biology	25



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	(Add) MCB 404 (3) Bioethics (Add) MCB 416A (3) Bioinformatics & Functional Genome Anls (Add) MCB 447 (3) Big Data in Bio & Medicine (Add) MCB 480 (3) Intro to Systems Biology Or (Add) MCB 489 (3) Foundations of Synthetic Biology	
SQL/Databases, choose one	ISTA 322 (3) Data Engineering OR (Add) CSC 460 (3) Database Design	3
Capstone	DATA 498A (3) Capstone: Stats/Data Science Or (Add) MCB 498 (3) Capstone	3
Total emphasis upper division units required		28
Total major emphasis units required*		31

XII. Transfer Student Considerations –

The table below shows that very few of the required courses in the existing Statistics & Data Science BS are available at Arizona community colleges. The proposed changes will increase available options for in-state community college students who plan to transfer into the major from three core courses to five core courses and 1-2 emphasis courses.

Regarding MATH 263:

- We are enthusiastic about adding this course to the major core
- This course is available at some AZ community colleges, but also available via AP credit
- It is valuable for students to take some statistics early on – it is difficult to know if a major that involves statistics & data analysis will be a good fit without having some background already; it can be taken earlier than DATA 363, which is the first statistics course in the existing major so is more accessible to everyone

Regarding MATH 223:

- Moving this course out of the core should also increase accessibility
- This course is sometimes a barrier for students, both at community colleges and at UA
- Moving it from the core to some of the emphases will allow students an opportunity to utilize it if they have already completed it

Regarding DATA 201:

- We are very excited about this course, since it will not only introduce students early to different perspectives within the field of Data Science, but also will fulfill a gen ed requirement and serve as a recruitment tool for Data Science programs
- We plan to talk with Pima Community College (perhaps others as well) about the possibility of creating an equivalent course to offer there

Lower-division courses	Existing STATDS major	Proposed DS major
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Lab Science courses	Many options available at AZ community colleges (supporting requirement)	Many options available at AZ community colleges (supporting requirement)
Intro Comp Prog I (CSC 110 or ISTA 130)	CSC 110 available at AZ community colleges; ISTA 130 available at AZ Western (supporting requirement)	CSC 110 available at AZ community colleges; ISTA 130 available at AZ Western (core)
Intro Comp Prog II (CSC 120)	n/a	Available at AZ community colleges (core option 1)
Dealing With Data (ISTA 131)	n/a	Available at Yavapai College (core option 2)
Calculus I (MATH 122B) & Calculus II (MATH 129)	Available at AZ community colleges (core)	Available at AZ community colleges (core)
Vector Calculus (MATH 223)	Available at AZ community colleges (core)	Available at AZ community colleges (emphasis/elective)
Intro: Stat+Biostatistics (MATH 263)	n/a	Available at some AZ community colleges (core); also available via AP exam
Intro Linear Algebra (MATH 215/313)	MATH 215 available at AZ community colleges (core)	MATH 215 available at AZ community colleges (core)
Foundations of Data Sci (DATA 201)	Not currently available (submitted via curriculum update to be added to core)	We plan to talk to PCC about the possibility of offering an equivalent (core)
Discrete Math (CSC 144 or MATH 243)	n/a	MATH 243 available at AZ community colleges (emphasis)
Discrete Math II (CSC 244)	n/a	Not currently available (emphasis)
Software Development (CSC 210)	n/a	Available at PCC (emphasis)
Intro Bio I (MCB 181R)	n/a	Available at AZ community colleges (emphasis)

Transfer students pursuing the Computing Emphasis in the BS in Data Science program may transfer a majority of the CS foundational coursework including CSC 110, CSC 120, CSC 210 and MATH 243 (currently used in lieu of CSC 144). Actual transferability of courses depends on transfer institution and articulation rules. The transferability of these courses matches our current transfer pathway for our BS in Computer Science program. Our department is considering accepting MATH 243 in lieu of CSC 144 and CSC 244 (combined). If approved, transfer students may be able to complete all foundational/lower-division CS coursework at their transfer institution. Our advising team is working closely with Pima CC advisors to connect prospective transfer students early on, in order to best advise students interested in CS. Our advising team looks forward to working with students interested in the Computing Emphasis.

XIII. Do you want the emphasis name to appear on the transcript? Yes No

XIV. Do you want the emphasis name to appear on the diploma? Yes No

XV. Anticipated semester and year to launch the proposed emphasis:

Fall 2024



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XVI. Number of new faculty hires required to deliver the emphasis:

The Department of Mathematics was previously approved to hire two Career Track faculty positions in 2023-24 which will help cover courses under the DATA/MATH prefixes. Hiring is already in progress. We also hired two Career Track faculty in 2022-23 to cover courses for the existing Statistics & Data Science degrees.

As indicated in their letters of support, the Departments of Computer Science and Molecular and Cellular Biology intend to make adjustments to course offerings as needed to support demand. They do not expect that any new faculty hires will be necessary in the immediate future.

XVII. Budgetary impact –

The Department of Mathematics intends to transition resources from the existing Statistics & Data Science undergraduate degrees into the new Data Science degree.


The Dean of the College of Science fully supports this change, and we will rely on the college to provide financial assistance should it be needed in future to support the potential enrollment growth.

Decision process for approval will include:

- 1) Efficiency of course offerings
- 2) Course offerings are appropriate and match the expertise of the faculty.
- 3) Evidence of sufficient student demand
- 4) No major conflict with existing programs.

XVIII. Required Signatures

Managing Unit Administrator (print name and title): Bryden R. Cais, *Professor and Associate Head of Undergraduate Programs*, Department of Mathematics

Managing Administrator's Signature: 

Date: November 30, 2023.

Managing Unit Administrator (print name and title): Douglas Ulmer, *Professor and Head*, Department of Mathematics

Managing Administrator's Signature: 

Date: November 30, 2023

Dean/Assistant Dean (print name and title): Carmala Garziona, *Professor and Dean* of the College of Science

Dean's Signature: 

Date: November 30, 2023



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For use by Curricular Affairs:

Committee	Approval date
Academic Programs Subcommittee	
Undergraduate Council	
Undergraduate College Academic Administrators Council	

- Create approval memo
- Send memo to college/dept and acad_org listserv
- Create emphasis code in UAccess, including secondary major emphasis code
- Upload approval memo and proposal documents to UAccess
- Notify acad_org of the plan code creation
- Notify ADVIP team, include proposers

BS in Statistics and Data Science Program Learning Outcomes:

1. Produce effective analyses from data using a variety of computational, mathematical, and statistical approaches
2. Effectively use one or more professional statistical and data analytics software packages. Be able to manipulate data, implement statistical methods and machine learning tools, document, and debug code in one or more professional statistical and data analytics software.
3. Collect, organize, and visualize data for exploration, analysis, and effectively communicate results.
4. Identify data science tasks, be able to formulate and choose appropriate models and analytical tools to solve data science tasks
5. Identify and analyze social, legal, and ethical issues in data science

Provide a unique learning outcome for each proposed emphasis. Add rows and tables as needed. Visit the [University Center for Assessment, Teaching and Technology \(UCATT\)](#) for resources and consultation.

1. Comprehensive Statistics

Unique Learning Outcome: Be able to define mathematical and statistical terms precisely
Concepts: Probability distribution, random variable, normal distribution, chi-squared distribution, regression
Competencies: Be able to precisely define central concepts in descriptive and inferential statistics

Curriculum Map: Which courses in the emphasis connect to these learning outcomes? Use the table below to provide the information, Key: "I"=Introduced; "R"=reinforced and opportunity to practice; "M"=mastery at the senior or exit level; "A"=assessment evidence collected for program-level decision making

Courses	Comprehensive Statistics Emphasis
	Be able to define mathematical and statistical terms precisely
DATA 201	I
DATA 263	I
DATA 363	I/R
DATA 467	I/R

MATH 466	A
DATA 474	M
DATA 498A	M

2. Applied Statistics:

Unique Learning Outcome: Apply methods and concepts of statistics to model and analyze real-world, data-based problems

Concepts: Data cleaning, statistical models, data analysis, statistical computing, machine learning

Competencies: Master a variety of modern statistical tools and techniques for data cleaning, data exploration, visualization, data analysis and interpretation.

Curriculum Map:

Courses	Applied Statistics Emphasis
	Apply methods and concepts of data science to scientific problems
DATA 201	I
DATA 263	I
DATA 363	I/R
DATA 375	R
DATA 467	I/R
DATA 474	I/R
DATA 498A	M/A

3. Global:

Unique Learning Outcome: Demonstrate ability to communicate technical and scientific concepts of data science in English as part of an international team.

Concepts: Probability distribution, random variable, normal distribution, chi-squared distribution, regression

Competencies: Precisely define central concepts and communicate ideas of statistics and data science in English, and utilize modern statistical tools and techniques for data cleaning, data exploration, visualization, data analysis and interpretation.

Curriculum Map:

Courses	Global Emphasis
	Demonstrate ability to communicate technical and scientific concepts of data science in English as part of an international team.
DATA 201	I
DATA 363	I/R
DATA 375	R
DATA 467	I/R
DATA 474	I/R
DATA 498A	M/A

4. Computing

Unique Learning Outcome: Design, implement, and test programs that solve significant, data-driven problems, making appropriate design choices that best meet given requirements.

Concepts: Data wrangling and database management, software design for data science, data visualization, machine learning.

Competencies: Mastery of contemporary data-science computing tools and languages with emphasis on obtaining, managing and analyzing large datasets.

Curriculum Map:

Courses	Computing Emphasis
	Design, implement, and test programs that solve significant, data-driven problems, making appropriate design choices that best meet given requirements.
CSC 110	I

CSC 120	I
DATA 201	I
CSC 210	R
CSC 380	I/R
DATA 375	R
CSC 480	I/R
DATA 498A	M/A

5. Molecular and Cellular Biology:

Unique Learning Outcome: Apply quantitative, data-driven strategies to analyze and understand biological processes.

Concepts: Biological big data, visualization, clustering, regression, and classification

Competencies: Evaluate the suitability of various analysis approaches for different biological questions and data and use them to analyze and visualize the data, modeling relationships between variables

Curriculum Map:

Courses	Molecular and Cellular Biology Emphasis
	Apply quantitative, data-driven strategies to analyze and understand biological processes.
MCB 181R	I
DATA 201	I
DATA 263	I
DATA 363	I/R
DATA 375	R
MCB 416A	I/R

MCB 447	I/R
DATA 498A	M/A