Calculus for Life Sciences

Mario Bretfeld (EEOB)
Somayeh Mashayekhi
Lake Ritter
Glenn Young

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Meghan Burke & Ken Keating

- Life science students at KSU (and other institutions) question the relevance and applicability of calculus to their degree program and career goals.

- An interdisciplinary course, developed by faculty in Math and Bio, can positively affect student's attitude towards the application of math to biological studies (Luque et al., 2021).

- Demonstrating the value of other STEM disciplines to biology is effective (Redish et al., 2014) but remains a critical need in advancing life science education (Aikens 2020).

An excellent hub for additional resources and information is **Q**uantitative **U**ndergraduate **B**iology **E**ducation and **S**ynthesis; (QUBES) https://qubeshub.org/

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MATH 1190 is among the General Education courses with high DFW rates. Between Fall 2016 and Spring 2021, the DFW rate among

- All CSM majors: 38.2%
- The Two Math B.S. programs: 26.7%
- The B.S. Biology and B.S. Env. Sci.: 39.3%

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CSM Advising

Students report a number of issues with Calculus:

1) They've never seen any math course close to the rigor of 1190 or

2) They've never had to apply so much previous course knowledge or

3) They become frustrated and don't see it's relevance or appropriateness to themselves or their career/educational goals. We hear from them "I don't see why I need to know Calculus if I want to be a Doctor" (or exchange doctor with conservationist, wildlife biologist, microbiologist, etc.)

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MATH 1179 Calculus for Life Sciences

Prerequisites: MATH 1113 or by placement

The placement criteria will match that of MATH 1190

High school GPA ≥ 3.2 AND ACT math score ≥ 26 or SAT math score ≥ 620 (600 if taken prior to March 2016)

OR

ALEKS score = 76

This course will include treatment of trigonometry.

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MATH 1179 Calculus for Life Sciences

Catalog Description:

MATH 1179: Calculus for Life Sciences

4 Class Hours 0 Laboratory Hours 4 Credit Hours

Prerequisite: MATH 1113, or By Placement

This course introduces the central concepts of single variable calculus including limits, derivatives, and integrals of algebraic and transcendental functions with particular motivations from and application to the Biological Sciences. Special emphasis will be given to using the tools of calculus to build and analyze mathematical models, especially those arising in the life sciences.

Notes: Students completing this course may not also receive credit for MATH 1190. This course does not satisfy the prerequisite requirements for MATH 2202.

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MATH 1179 Calculus for Life Sciences

Expected Learning Outcomes:

Upon completing this course, students will be able to:

1. Evaluate problems in life sciences and demonstrate how derivatives or integrals can help find solutions.
2. Explain the fundamentals of and evaluate limits, derivatives, and integrals using tabular, graphical, and algebraic techniques and examples.
3. Use the calculus tools of limits, derivatives, and integrals to build and analyze mathematical models, including differential equations, of problems that arise in the life sciences.

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MATH 1179 Calculus for Life Sciences

Main Units of Content:

- Mathematical Modeling
- Applications of Derivatives and Antiderivatives
- Limits
- The Derivative
- Differentiation Rules* & Antiderivatives
- Integrals

*Derivatives of algebraic, trigonometric, and transcendental functions, sum/differences, products, quotients, compositions

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MATH 1179 Calculus for Life Sciences

What's Missing?

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MATH 1179 Calculus for Life Sciences

What's Missing? (Not much. It's more a matter of emphasis.)

- Thorough treatment of continuity
- Treatment of asymptotes/graphing
- Thorough treatment of inverse functions and logarithms
- Treatment of inverse trigonometric functions (aside from the arctangent function)
- Indeterminate forms and L'Hôpital's rule

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MATH 1179 Calculus for Life Sciences

This course will serve students in the following programs

- Biology B.S. and
- Environmental Science B.S.

The new course was deemed sufficient preparation for

- CHEM 2800 Quantitative Analytical Chemistry and
- BIOL 4500K:Bioinformatics I

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MATH 1189 Bridge to Calculus II

What if a student changes majors or decides she wants to take more mathematics?

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MATH 1189 Bridge to Calculus II

MATH 1189: Bridge to Calculus II

1 Class Hours 0 Laboratory Hours 1 Credit Hours

Prerequisite: MATH 1179

This 1-hour course is for students who have completed Calculus for Life Sciences and will prepare them to be successful in Calculus II. A brief review of Calculus I is provided with special emphasis on select topics that are not covered in MATH 1179. These include Continuity, Limits involving infinity, Calculus of Inverse Trigonometric functions, The Mean Value Theorem, and L'Hôpital's rule.

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MATH 1189 Bridge to Calculus II

Course Learning Outcomes: Upon completing this course, students will

- Evaluate limits, take derivatives, and evaluate integrals involving a broad range of functions, including inverse trigonometric function and logarithms.
- Determine whether a function is continuous at a point or on an interval and describe any horizontal or vertical asymptotes to the graph of a function.
- Take limits involving indeterminate forms including appropriate use of L'Hôpital's rule.

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MATH 1189 Bridge to Calculus II

Week	Text Sections[a]	Topic
1	2.2, 2.4	Limits, Limit Laws, One sided Limits
2	2.5[b]	Continuity (Includes IVT)
3	2.6	Limits involving infinity, Asymptotes
4	Assessment 1	Proficiency with limits & continuity
5	3.1, 3.2	The derivative at a point and as a function
6	3.3, 3.5	Differentiation rules, Derivative of Trigonometric Functions.
7	3.6, 3.7	Chain rule, Implicit Differentiation
8	3.8	Derivatives of inverse functions and logarithms
9	3.9	Inverse trigonometric functions
10	Assessment 2	Proficiency with derivatives & differentiation
11	4.2	The Mean Value Theorem
12	4.5	Indeterminate Forms & L'Hôpital's rule
13	5.1, 5.2	Areas, Sigma notation, Reimann sums
14	5.3, 5.4	The definite integral, Fundamental Theorem of Calculus
15	Assessment 3	Proficiency with L'Hôpital's rule & Integrals

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a Text: (Note this is the departmentally approved text required for MATH 2202)
Thomas' Calculus, Early Transcendentals, 14th edition, by Joel Hass, Christopher Heil, and Murice D. Wei

b Items Highlighted are those topics not covered or covered only superficially in MATH 1179.

References

Aikens, M. L. (2020). Meeting the needs of a changing landscape: Advances and challenges in undergraduate biology education. *Bulletin of mathematical biology*, *82*, 1-20.

Luque, A., Mullinix, J., Anderson, M., Williams, K. S., & Bowers, J. (2021). Aligning Calculus with Life Sciences Disciplines: The Argument for Integrating Statistical Reasoning. *PRIMUS*, 1-19.

Redish, E. F., Bauer, C., Carleton, K. L., Cooke, T. J., Cooper, M., Crouch, C. H., ... & Zia, R. K. P. (2014). NEXUS/Physics: An interdisciplinary repurposing of physics for biologists. *American Journal of Physics*, *82*(5), 368-377.

Robeva, R. S., Jungck, J. R., & Gross, L. J. (2020). Changing the nature of quantitative biology education: data science as a driver. *Bulletin of Mathematical Biology*, *82*(10), 1-30.

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