

## **Biomolecular Thermodynamics and Kinetics**

BME 4621 Section 22784 (24AB)

**Class Periods:** M W F, 6<sup>th</sup> Period, 12:50-1:40 PM

**Location:** LAR0310

**Academic Term:** Spring 2023

### ***Instructor:***

Ivana K. Parker

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352-846-3458

NEB 353

Office Hours: Fridays 12:50 -1:40; In person

### ***Teaching Assistants:***

- Suzanne Lightsey

[suzannelightsey@ufl.edu](mailto:suzannelightsey@ufl.edu)

Office Hours: Mondays 4-5 pm BMS J280

### ***Course Description***

Principles of thermodynamics and kinetics from a biomolecular perspective. The mathematics, analysis, and applications of classical thermodynamics, statistical thermodynamics, and reaction kinetics will be introduced in the context of molecular interactions, binding equilibria, metabolism, and biomolecular transport common to living systems.

***Course Pre-Requisites / Co-Requisites:*** BME 3060, BME 4311

### ***Course Objectives***

- Develop basic knowledge of classical thermodynamics, equilibrium, and reaction kinetics.
- Develop an understanding of the application of statistical thermodynamics to biomolecule behavior and interactions.
- Develop a competence in the fundamental analytical and computational tools used to describe energy transformation within living systems.

***Materials and Supply Fees:*** None

***Professional Component (ABET):*** 3 credits of engineering topics (no design component).

***Relation to Program Outcomes (ABET):***

ABET Outcome	Coverage*	
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High	Emphasized
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors		
3. an ability to communicate effectively with a range of audiences		
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts		
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives		
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions		
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies		

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

### **Recommended Materials**

Title: Physical Chemistry: Thermodynamics, Statistical Thermodynamics, and Kinetic

Author: Thomas Engel and Philip Reid

Publication date and Edition: 4e; Pearson

ISBN: 0-13-480458-9

Title: Biomolecular Thermodynamics: From Theory to Application

Author: Barrick, Douglas

Publication date and Edition: 2017, 1<sup>st</sup> edition; CRC Press

ISBN: 978-1-4398-0019-5

Title: *Biological Thermodynamics*

Author: Haynie, Donald T.

Publication date and edition: 2008, 2<sup>rd</sup> edition; Cambridge

ISBN number: 978-0-5217-1134-0

Title: *Molecular Driving Forces: Statistical Thermodynamics in Chemistry and Biology.*

Author: Dill, Ken A., and Bromberg, S.

Publication date: 2002, Routledge

ISBN: 978-0-8153-2051-7.

### **Course Schedule**

Week	Topic
<u>PART 1</u>	
1	Fundamental Concepts of Thermodynamics
2	First law of thermodynamics – Barrick 3
3	Second law of thermodynamics – Barrick 4
4	<b>Quiz Week (Module 1-3)</b>
5	Gibbs Free Energy – Theory I – Barrick 5

- 6 Metabolism and Chemical Coupling
- 7 **Quiz Week (Modules 5-6)**

PART 2

- 8 Statistical Thermodynamics - Barrick 8, 9
- 9 Binding Equilibria – Barrick 13, 14
- 10 **Quiz Week (Modules 8-9)**
- 11 Reaction Kinetics
- 12 Enzyme Kinetics
- 13 **Quiz Week (Modules 11-12)**
- 14 Final Project Prep
- 15 Final Projects/ Evaluations

**Assessment dates:**

- (A) Comprehension Points (To be completed after each online Lecture); **Will be Locked at the end of each Week.**
- (B) In class Problem Sets (Mondays): Uploaded on Canvas by the end of class.
- (C) Homework Problem sets (Due Wednesday, except March 13): Jan 18, Jan 25, Feb 1 (AT NOON), Feb 8, Feb 15, Mar 1, Mar 8, Mar 20 (MON), Mar 29, April 5
- (D) Quizzes: Feb 3, Feb 22, March 22 (24 ALTERNATE), April 12
- (D) Final Presentations: April 24 and April 26

**Flipped class format**

Students are expected to watch lectures PRIOR to the in-class meeting time. Comprehension points to be assessed after each lecture and will be locked at the end of the week to ensure students do not fall behind with class lectures.

In-class sessions will be used to work through problems in a group setting (In-class problems). In -class sessions can also be used for homework questions and to reinforce concepts introduced in the video lectures. The class time is primarily for group learning and therefore class participation will be assessed via In-class problem sets.

Quizzes and final presentations will be administered/ presented in person in the classroom.

***Attendance Policy, Class Expectations, and Make-Up Policy***

-Problem sets are to be submitted via Canvas on the Wednesday that they are due by midnight (With the exception of Feb 1, and Mar 20).

-You must let me know AS SOON AS POSSIBLE if you will be ABSENT on the SCHEDULED DATE of ANY quiz. If you know that you'll be absent for a QUIZ, a make-up **MUST** be taken **PRIOR TO** the date listed above. **No make-up quizzes or exams will be given for unexcused absences.** Excused absences are consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Comprehension Points (32*2)	64	14%
Class Participation (8*10) 9 total	80	18%
HW Problem Sets (10)	100 (10 each)	22%
Quizzes (4)	160 (40 each)	35%
Final Project	50	11%
<b>Total</b>	<b>450</b>	<b>100%</b>

### ***Grading Policy***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
94 - 100	A	4.00
90.0 - 93.99	A-	3.67
87 - 89.99	B+	3.33
83 - 86.99	B	3.00
80 - 82.99	B-	2.67
77 - 79.99	C+	2.33
73- 76.99	C	2.00
70 - 72.99	C-	1.67
67 - 69.99	D+	1.33
63 - 66.99	D	1.00
60 - 62.99	D-	0.67
0 - 59.99	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***Students Requiring Accommodations***

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### ***Course Evaluation***

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their

Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Commitment to a Safe and Inclusive Learning Environment***

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

### ***Campus Resources:***

#### *Health and Wellness*

##### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

**Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

**Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.