ORGANIC CHEMISTRY 2 — CHEMISTRY 232 LECTURE — SPRING 2026

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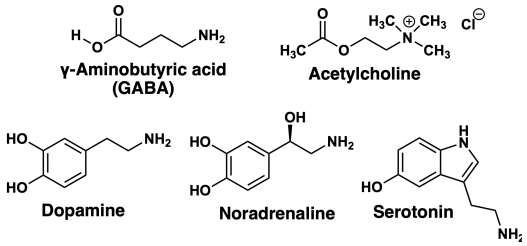


Some Neurotransmitters of Learning

OFFICE HOURS

Stop by 323 Caputo Hall, anytime *on…*

1. MWF (9:00 am to 9:50 am).
2. Thursdays (9:00 am to 11:30 am).

No appointment needed. Arrive with questions of consternation, curiosity, or clarification, related to lecture or laboratory course work or research-based learning strategies.

REQUIRED LECTURE CLASS MEETINGS

Plan to consistently (1) prepare for, (2) attend, (3) focus attention on, and (4) actively participate in all class meetings on MWF 10:00 am – 10:50 am, 149 Roddy Hall. If you are unable to attend a lecture class meeting, email me. See additional attendance policy details (on pages 7 & 8).

EXPECTATIONS, PARTICIPATION, & CLASSROOM NORMS

The value of actively taking part in class activities is hard to exaggerate; as research has consistently shown, students who actively participate learn more, and retain learning for longer than students who do not.[1] You won't learn deeply for transfer by passively listening to someone lecture at you; therefore, this class will ask a lot of you. Through completing (1) required readings with notetaking and (2) practice problems, you are expected to prepare for all class meetings. And you are expected to come to class ready to focus, take deep notes (as opposed to shallow notes), and engage with me and your fellow students on the topics of the day. You will practice skills through in-class exercises, often in groups. And you will play a vital role in your peer's education—you'll help them learn more, and they will, in turn, help you.

A portion of your participation will be evaluated based on your demonstrated ability to contribute to class activities, discussions, and informal group work *in ways that raise the level of dialogue and foster deeper learning of organic chemistry*. Talking all the time is not necessarily the same thing as great participation; indeed, talking too frequently (especially when off topic) can lead to imbalance and discomfort for others—and it is antithetical to the learning process. With a laser focus on organic chemistry: actively listening to classmates, responding with relevance to others' comments, reflecting on, building on, and generating questions related to your classmates' ideas leads to more authentic and meaningful participation and learning.

I am serious about helping to create a classroom environment in which anyone feels free to ask chemistry questions, raise concerns, make brilliant points related to problem-solving, and so on. This classroom is your classroom—as long as you are focused on learning chemistry. Please don't keep yourself from asking a chemistry related question because you fear it will sound silly

or unsophisticated or obvious. And becoming fluid in the art of asking chemistry questions (of clarification or curiosity) is one of the best ways to increase your learning and critical thinking.[2]

Although I am committed to chemistry related dialogue in which students exert a great measure of control, I recognize that I have bureaucratic institutional authority as the instructor. I choose to use that authority to forbid any behavior that would make anyone else in the class feel uncomfortable or the subject of ridicule. You are expected to behave courteously and respectfully to your classmates and to me. All need to feel that this is their classroom for learning chemistry without unnecessary distractions; I am committed to protecting those conditions.

LANGUAGE, CRITICAL THINKING, & LECTURE COURSE DESCRIPTION

"The limits of my language mean the limits of my world." – Ludwig Wittgenstein[3]

This course is designed to strengthen your use of a sophisticated graphic, textual, and verbal *scientific language*; and Organic chemistry—an active field of study, research, and scholarship—provides molecular level foundational knowledge and skills for better communication, deeper comprehension, better questioning, and better problem-solving in biochemistry, green chemistry, environmental chemistry, molecular biology, genetics, pharmaceuticals, medicine, biotechnology, toxicology, and numerous related fields. Organic and organometallic chemicals are everywhere and make up over 90% of the more than 273 million known chemicals.[4]

In this course, we will all work together—to increase your ability to ask elucidating questions & to think critically. We will accomplish this through deliberate practice, making lots of mistakes, questioning and adjusting your thinking (based on self-reflection, utilizing appropriate learning strategies, improving metacognition, generating more questions, and timely feedback.

This course is more than the memorization of a bunch of facts; and it is more than applying a few simple rules to get the correct answer. Through doing the work, you will know and understand many facts and you will be able to apply some rules; yet you *must think critically* (at the Bloom's Taxonomy levels of analysis, evaluation, and synthesis—especially in CHEM 232) to solve problems, which may occasionally have more than one reasonable answer. Therefore, you must learn to think like a detective and piece answers together with everything you know. We will help each other to learn these critical thinking skills.

And Chemistry 232 is a non-mathematical, yet an extremely logical, critical thinking and *problem-solving course*. It focuses on verbal, written and symbolic representation of molecular structure, functional groups, nomenclature, physical properties, reactivity, mechanisms, and synthesis of organic compounds. The examples presented contain underling principles and concepts that are applied repeatedly—both explicitly and implicitly—throughout this course, in future organic chemistry courses, and in biochemistry, molecular biology, and many other areas of science and applied science courses. Most of the examples have real-world application; yet the primary focus is learning to problem-solve via the application of chemistry fundamentals.

LECTURE COURSE LEARNING GOALS

As your learning progresses, you should be able to confidently demonstrate your ability to…

1. Stay on topic, focus, and actively participate in organic chemistry conversations.
2. Recognize, name, and draw organic compounds and organic functional groups.
3. Estimate, explain, and draw the attractive forces within and between molecules.
4. Analyze, explain, and draw structural conformations, configurations, and isomers.
5. Describe relationships between molecular structure, reactivity, and physical properties.
6. Apply acid and base chemistry concepts — ARIO (atom, resonance, induction, orbital) conjugate base stability method and the acid pKa value method — to analyze, draw, and explain a wide variety of reactions.
7. Describe reaction mechanism steps with elementary reaction names, and with Frontier-Molecular Orbital (FMO) notation, and by utilizing curved-arrow notation.
8. Analyze reactants to propose and draw plausible reaction mechanisms (using curved-arrow notation to represent electron flow).
9. Describe, apply, compare & contrast, and evaluate organic functional group reactions.
10. Predict plausible products, reactants, or reagents (based on an understanding of—and application of—acid-base chemistry and functional group reactivity analysis).
11. Design multi-step synthesis of organic products by using functional group transformation reactions and carbon-carbon bond forming reactions.
12. Read, understand, and predict molecular-level details of biosynthetic pathways (based on your knowledge, skills, and ability to apply, analyze, and evaluate functional group transformation reactions).

FOUR CHARACTER TRAITS OF INCREASED SUCCESS[5]

1. Proactive
2. Prosocial
3. Disciplined
4. Determined

SEVEN EFFECTIVE LEARNING STRATEGIES[6]

1. Spaced Practice (well-timed daily reading with notetaking and problem-solving)
2. Concrete Examples
3. Recall Practice
4. Interleaving
5. Dual Coding
6. Elaboration
7. Deliberate Questioning (curiosity & clarification)

GRADE DISTRIBUTION (in percentage points)

A	100 – 92.0	**B**	87.9 – 82.0	**C**	77.9 – 72.0	**D**	67.9 – 62.0
A-	91.9 – 90.0	**B-**	81.9 – 80.0	**C-**	71.9 – 70.0	**D-**	61.9 – 60.0
B+	89.9 – 88.0	**C+**	79.9 – 78.0	**D+**	69.9 – 68.0	**F**	< 59.9

LECTURE & LABORATORY COURSE EVALUATION SCHEME:

Lecture participation, group work, & practice*	+? %
Required end-of-chapter practice problems (50 points)	5 %
*Pre-lecture reading, notes, summary, questions, & problems (150 points)**	*15 %*
3 Quizzes (150 points)	15 %
Exam 1 (150 points)	15 %
Exam 2 (150 points)	15 %
Exam 3 (150 points)	15 %
ACS Final (200 points)	20 %
Laboratory (see lab syllabus for more details)	-? %
	∑ = 100 %

LECTURE COURSE, QUIZ, & EXAMS SCHEDULE OVERVIEW

Wednesday Midterm Exams (18-FEB, 25-MAR, & 22-APR): exam questions are closely aligned to course learning goals. And exam questions are closely related to homework problems, lecture examples, lecture practice problems, laboratory practice problems, and quiz problems.

Textbook	Chapter Topic	Quiz & Exam Schedule
Chapter 7 Chapter 8 & 9 Chapter 10 & 11	Eliminations & Substitutions (21-JAN – 26-JAN) Alkene & Alkyne Nucleophiles (28-JAN – 6-FEB) Radicals & Synthesis Design (11-FEB – 16-FEB)	QUIZ 1 (9-FEB) EXAM 1 (18-FEB)
Chapter 12 Chapter 13 Chapter 18	Alcohols (20-FEB – 25-FEB) Ethers, Epoxides, & Sulfur (27-FEB – 4-MAR) Aromatic Reactions (16-MAR – 20-MAR)	QUIZ 2 (6-MAR) EXAM 2 (25-MAR)
Chapter 19 Chapter 20 Chapter 21 Chapter 22	RCHO, R_2CO, & Derivatives (27-MAR – 3-APR) Carboxylic Acid Derivatives (6-APR – 10-APR) Enols & Enolates (15-APR – 20-APR) Amines & ACS Review (24-APR – 1-MAY)	QUIZ 3 (13-APR) EXAM 3 (22-APR) FINAL (4-MAY & 7-MAY)

Chapters 19 – 22 will be a review of CHEM 231 language, fundamentals, concepts, and problem-solving strategies—within the context of multi-step synthesis.

REQUIRED LECTURE MATERIALS

1. Daily access to our D2L course site and your Millersville email account.
2. Rent or purchase: Klein's Organic Chemistry 4th Edition (1) textbook & (2) study guide & solutions. See Millersville Univ. textbook store site for details: https://millersville.textbookx.com/institutional/index.php?action=browse#/books/4052492

Minimize use of AI, EdTech, & screens in your learning of language and fundamental skills.[7]

"People will come to adore the technologies that undo their capacities to think."

– Neil Postman, discussing Aldous Huxley's Brave New World

See page 5 (next page) for more details on notetaking, pre-lecture questions, & participation.

*Pre-lecture textbook reading, notes, problems, & participation:

- Paper copies turned in at the beginning of each lecture (except quiz and exam days).
- *Must use and follow notetaking template*; copies provided in lecture.
- For problems: must draw out all structures and write key words to earn full credit.
- And minus 3 points for every assignment not turned in on time. Late work *not* accepted.

Due date — **chapter section range** — pick 5 problems from each section:

☐ ***23-JAN* — 7.1 – 7.7** — 7.1, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.10, 7.12 – 7.17, 7.19.
☐ ***26-JAN* — 7.8 – 7.12** — 7.23, 7.25, 7.32, 7.33, 7.34, 7.35, 7.39.
☐ ***28-JAN* — 8.1 – 8.9** — 8.1g, 8.2a, 8.5bc, 8.10c, 8.11, 8.15b, 8.17, 8.19, 8.21.
☐ ***30-JAN* — 9.1 – 9.7** — 9.1d, 9.2b, 9.5ac, 9.7, 9.9a, 9.10b.
☐ ***2-FEB* — 8.10 – 8.15**— 8.25b, 8.26a, 8.28cf, 8.31b, 8.32e, 8.39, 8.41, 8.42, 8.43, 8.45.
☐ ***4-FEB* — 9.8 – 9.11** —9.16d, 9.17, 9.18b, 9.20a, 9.22, 9.29, 9.30, 9.31.
☐ ***6-FEB* — Re-read 8.14, 8.15, & 9.11** — pick 5 problems from these sections***.***
☐ ***11-FEB* — 11.1 – 11.4** — 11.1, 11.2, 11.3, 11.5bcf, 11.6.
☐ ***13-FEB* — 11.4 – 11.5** — 11.7ef, 11.8, 11.9aegj, 11.10.
☐ ***16-FEB* — 11.5 – 11.7** — pick 5 problems from Chapter 11***.***
☐ ***20-FEB* — 12.1 – 12.6** — 12.1bd, 12.2, 12.3, 12.4ad, 12.5c, 12.6cd, 12.7, 12.8, 12.9, 12.10bce, 12.11, 12.12cd, 12.13, 12.14cd, 12.15f, 12.17.

☐ ***23-FEB* — 12.7 – 12.10** — 12.18a, 12.19ac, 12.20, 12.21.
☐ ***25-FEB* — 12.10 – 12.13** — 12.22abe, 12.23, 12.24, 12.27, 12.28.
☐ ***27-FEB* — 13.1 – 13.6** — 13.1, 13.2, 13.3, 13.4a, 13.5bd, 13.7.
☐ ***2-MAR* — 13.7 – 13.10** — 13.11ab, 13.12a, 13.13b, 13.14, 1316abc, 13.18bc, 13.19.
☐ ***4-MAR* — 13.11 – 13.12** — 13.20a, 13.21abcd, 13.22abe, 13.23, 13.24abd, 13.25.
☐ ***16-MAR* — 18.1 – 18.9** — 18.1, 18.2, 18.5bc, 18.7, 18.10.
☐ ***18-MAR* —> Re-read 18.7 – 18.9, then 18.10 – 18.12** — 18.16ef, 18.17, 18.18ce, 18.19, 18.22c, 18.23, 18.24bgh, 18.25cf.

☐ ***20-MAR* —> 18.13 – 18.15** — 18.26bd, 18.30, 18.31, 18.35, 18.37.

☐ ***23-MAR* —>** pick any 5 synthesis problems from Chapters 12, 13, and 18.
☐ ***27-MAR* —> 19.1 – 19.11** — 19.1, 19.2, 19.3, 19.4, 19.5 (use table 19.2), 19.6, 19.15b, 19.16c, 19.20c, 19.21, 19.23e.

☐ ***30-MAR* —> 19.12** — 19.24, 19.30c, 19.37, 19.40, 19.41.
☐ ***1-APR* —> Re-read 8.15, 9.11, 12.13, 13.12, 18.12, & 19.12** — pick one problem from each.
☐ ***3-APR & beyond* —> *for* CHAPTERS 20 & 21 —>** Reading, notes, and problems still *required*; pick 5 problems per anticipated chapter sections covered, focused on a review of CHEM 231 & 232 content—within the context of *multi-step synthesis*. Pick your 5 daily problems from the following: 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 20.12, 20.13, 20.30, 20.31, 20.32, & 20.33. And 21.1, 21.2, 21.3, 21.5, 21.7, 21.13, 21.30, 21.31, 21.32, 21.33, 21.34, 21.35, 21.36, 21.38c, 21.44, & 21.46.

REQUIRED PRACTICE PROBLEMS

(Due dates for uploaded work into D2L)

- Work at least 20 problems per chapter; pick problems related to lecture and lab examples.
- Must draw out all structures and write key words to earn full credit.
- Use the study guide and solutions manual to check your work before turning it in.

❍ **CHAPTER 7 (11:59 pm on Monday, 27-JAN)**
7.47d, 7.48, 7.49, 7.54, 7.56, 7.61, 7.66, 7.73, 7.76, 7.79, 7.80, 7.81, 7.82, 7.83, 7.84, 7.85, 7.86, 7.87, 7.88, 7.89, 7.90, 7.92, 7.94, 7.98, 7.100, & 7.101.

❍ **CHAPTER 8 & 9** ***(11:59 pm on Friday, 7-FEB)***
8.47e, 8.49, 8.50, 8.57, 8.67bd, 8.70, 8.81, 8.82, 8.83, 8.84, 8.85, 8.86, 8.87, 8.88, 8.89, 8.90, 8.95a, & 8.98. **And** 9.32d, 9.33b, 9.37, 9.41, 9.48a, 9.58, 9.59, 9.60, 9.61, 9.62, 9.63, 9.64, & 9.74.

❍ **CHAPTER 11** ***(11:59 pm on Friday, 14-FEB)***
11.11, 11.12, 11.15, 11.18bc, 1.21e, 11.26, 11.27, 11.28, 11.29, 11.30, 11.31, 11.32, 11.34, 11.38, 11.39, 11.40, 11.41, 11.43, & 11.45.

❍ **CHAPTER 12** ***(11:59 pm on Friday, 28-FEB)***
12.29, 12.30, 12.32, 12.33ac, 12.34abegi, 12.35, 12.36de, 12.39bf, 12.40, 12.44b, 12.45ac, 12.47, 12.49, 12.53, 12.54, 12.55, 12.56, 12.57, 12.58, 12.59, 12.60, 12.61, 12.62, 12.65abegpq, 12.78, & 12.83.

❍ **CHAPTER 13** ***(11:59 pm on Friday, 7-MAR)***
13.26, 13.34, 13.35, 13.37, 13.38ace, 13.42b, 13.44, 13.45, 13.46, 13.47, 13.48, 13.49, 13.50, 13.51, 13.52, 13.53, 13.59, & 13.80.

❍ **CHAPTER 18** ***(11:59 pm Friday, 21-MAR)***
18.38, 18.39, 18.40, 18.42, 18.43, 18.44, 18.45bh, 18.46, 18.52ab, 18.73, 18.74, 18.75, 18.76, 18.77, 18.78, 18.79, 18.88, & 18.99.

❍ **CHAPTER 19** ***(11:59 pm Friday, 4-APR)***
19.43, 19.44, 19.45, 19.57, 19.62, 19.64, 19.67, 19.69, 19.73, 19.74, 19.75, 19.76, 19.77, 19.78, 19.79, 19.80, 19.81, 19.83, 19.84, 19.85, 19.93, 19.95, 19.96, 19.97, & 19.99.

❍ **CHAPTER 20 & 21** ***(11:59 pm Friday, 18-APR)***
20.35, 20.36, 20.37, 20.38, 20.50, 20.51, 20.53, 20.59, 20.60, 20.64, 20.69, 20.70, 20.71, 20.72, 20.73, 20.74, 20.75, 20.76, 20.77, 20.78, 20.89, 20.91, 20.92, 20.93, & 20.95. **And** 21.47, 21.48, 21.59, 21.66, 21.73, 21.77, 21.78, 21.88, 21.89 – 21.96, 21.110, & 21.123.

OUR EPPICC VALUES

Exploration, Professionalism, Public Mission, Inclusion, Integrity, and Compassion.[8]

AT THE COMPLETION OF CHEM 232 LABORATORY, YOU SHOULD BE ABLE TO…

- Demonstrate proper laboratory safety & waste disposal when working in the lab.
- Keep a neat and organized record of all laboratory work in a paper notebook.
- Set up apparatus for experimental techniques: reactions, distillations, filtrations, etc.
- Purify organic products by recrystallization (solids) and distillation (liquids).
- Characterize organic products by physical, chemical, and spectroscopic properties.
- Stay on topic, focus, and actively participate in organic chemistry conversations & lab work.
- Work in groups to solve all lab problems & turn in all completed work for each week of lab.

Week	**Activity** All weekly handouts will be provided in lab
1	Syllabus, safety, check-in, & mechanism workshop
2	Mechanism workshop and reaction review
3	IR, MS, Proton & Carbon NMR review & practice
4	Gold cat. Alkyne Hydration reaction & Thin-Layer-Chromatography (TLC)
5	Oxone oxidation of benzaldehyde
6	Beta-elimination (E1 dehydration) and fractional distillation
7	Finish weeks 1 — 6 work & practice problems
8	Spring break
9	Suzuki-Miyaura Cross-Coupling
10	Synthesis of limonene dioxide & CURE literature search
11	Rengyolone natural product synthesis & CURE literature search
12	Finish % Yield, IR, MP, NMR, data collection and analysis of weeks 9 – 11
13, 14, & 15	ACS Final (ACSFE) Practice Problems — Part 1, 2, & 3, Clean-up, Check-out

CHEMISTRY 232 LABORATORY ATTENDANCE STATEMENT & POLICY:

Make-up labs are not possible—due primarily to scheduling and space limitations. If you are planning to miss a lab due to an official Millersville University event, or due to a foreseeable life event absence, or if you miss a lab due to an emergency, please email, as soon as possible, to begin discussing options; failure to begin discussing options within a timely manner will lead to this course policy: missing the first lab equals minus 20 points, missing two labs equals minus 20 more points, *missing three (or more) labs equals failure of the entire course (lecture & lab).*

LAB GRADING

Missing a lab: minus 20 points per lab (see statement above). Late to lab: minus 10 points.
Leaving a lab more than 15 minutes early, if all work is not complete: minus 10 points per lab.
Lack of participation, inadequate group work, or off topic: minus 10 points per lab.
Failure to submit weekly lab work to D2L by due date: minus 10 points per lab.
Incomplete lab work submitted to D2L: minus 5 points per lab.
Incomplete weekly lab practice problems submitted to D2L: minus 5 points per lab.
Additional minus point categories may be added throughout the semester.

ADDITIONAL COURSE POLICIES

University approved class attendance policy: Students are expected to attend all classes [and lab meetings]. It is the student's responsibility to complete all course requirements even if a class is missed. If a student misses a class for an officially excused reason, then they are entitled to make up the missed work but only at the convenience of the faculty member. Responsibility for materials presented in, assignments made for, and tests/quizzes given in regularly scheduled classes lies solely with the student. **(1)** The University policy is that faculty will excuse absences for the following reasons: personal illness, bereavement or critical illness in the family, participation in a university-sponsored activity, jury duty, military duties, or religious holidays. **(2)** Faculty judge the validity of student absences from class within the University's approved guidelines and may require documentation for excused absences. Faculty will evaluate any reason, other than those listed above, for a student missing class and determine whether the absence is justified. In these circumstances, a student may make up missed work at the discretion of the instructor. (3) In the case of foreseeable absences, students are encouraged to notify the faculty member in advance. A student who will miss class due to participation in an official University activity must notify the instructor well in advance of the activity to assure that the absence is excused. **Additionally, course attendance policy, for CHEM 231 & 232 lectures (*also see lab attendance policy on previous page—page 7*):** Unexcused absences will result in minus 5 points for every missed lecture class meeting. And missing five (5) or more classes will result in removal from the course and award of a W or Z grade depending on the date of removal related to the Millersville University academic calendar.

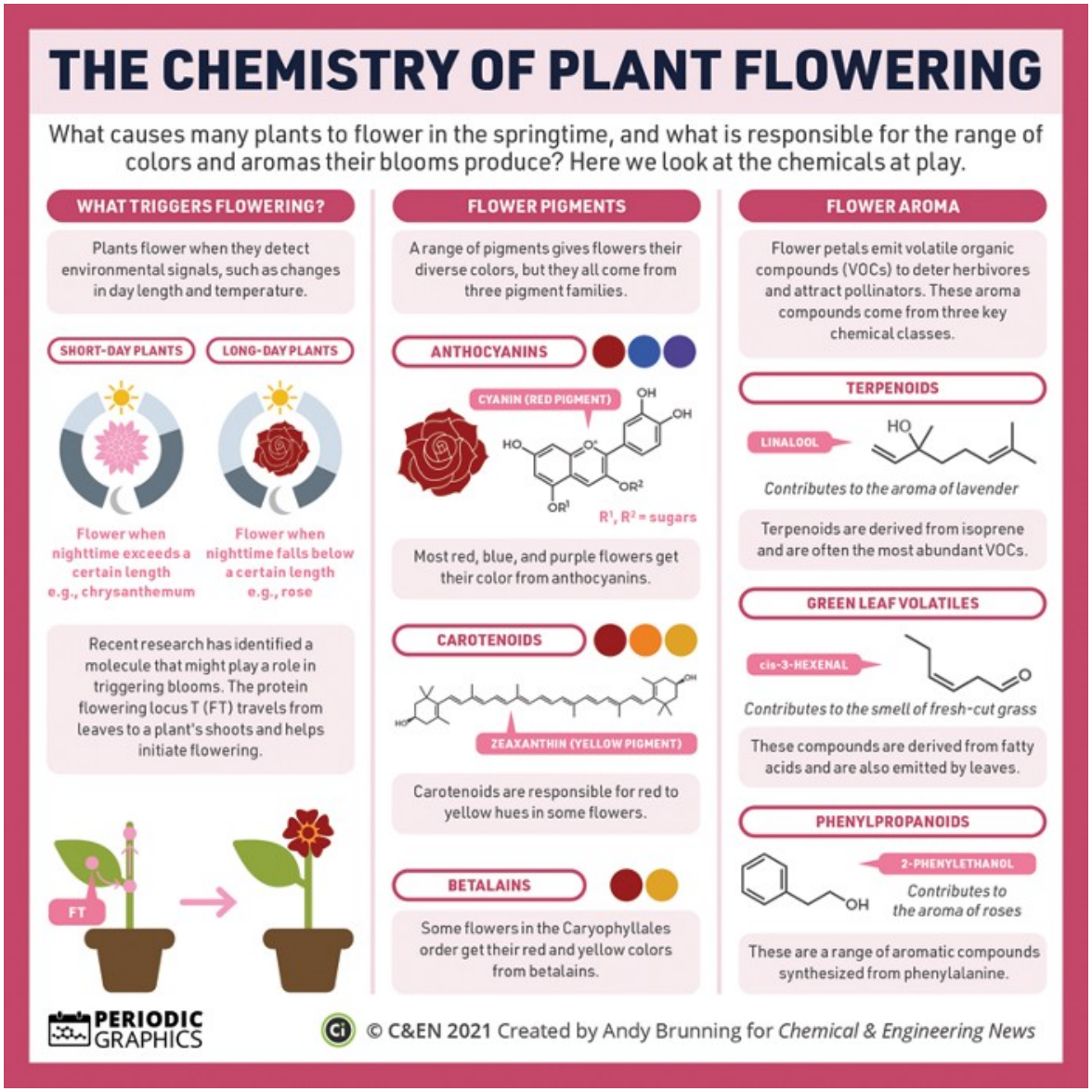
Inclusion Policy: This course is a judgement free learning environment. Our class includes students from a wide variety of life circumstances. Everyone will always treat one another with respect and consideration or be asked to leave the classroom.

Americans with Disabilities Act: Millersville University is committed to equality of opportunity and freedom from discrimination for all students, employees, applicants for admission or employment, and all participants in public University-sponsored activities. In keeping with this commitment, and in accordance with the Americans with Disabilities Act (ADA) the University will make every effort to provide equality of opportunity and freedom from discrimination for all members of the University community and visitors to the University, regardless of any disability an individual may have. Accordingly, the University has taken positive steps to make University facilities accessible to individuals with disabilities and has established procedures to provide reasonable accommodations to allow individuals with disabilities to participate in programs. The University administration and management are obligated to report any allegation of discrimination to the appropriate office as defined in this policy. If you have a condition that may impact your ability to perform laboratory exercises, to exit lab safely from the premises in an emergency, or which may cause an emergency during class, or lab, please discuss this in confidence with your instructor, as soon as possible; appropriate accommodations may then be provided.

Additional Resources & Counseling Reminder: Additional resources include Health Services (717-871-5250), Center for Health Education and Promotion (717-871-4141), Campus Ministries, and Learning Services (717-871-5554). Students sometimes face mental health or drug/alcohol challenges in their academic careers that interfere with their academic performance and goals. Millersville University is a caring community, and resources are available to assist students who are dealing with problems. The Counseling Center (717-871-7821) is an important resource for both mental health and substance abuse issues.

Title IX Statement: Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. To meet this commitment, comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, et seq., and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a university-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is available at www.millersville.edu/titleix.

[1] David Gooblar, *The Missing Course: Everything They Never Taught You About College Teaching* (Cambridge: Harvard University Press, 2019).
[2] Paul Hanstedt, *Creating Wicked Students: Designing Courses for a Complex World* (Sterling, Virginia: Stylus Publishing, 2018).
[3] Brené Brown, *Atlas of the Heart: Mapping Meaningful Connection and the Language of Human Experience* (New York, Random House, 2021).
[4] Chemical Abstract Services (CAS) website, accessed August 1, 2022, https://www.cas.org/about/cas-content.
[5] Adam Grant, *Hidden Potential — The Science of Achieving Greater Things* (New York: Viking, 2023).
[6] Yana Weinstein & Megan Sumeracki, *Understanding How We Learn* (New York: Routledge, 2019).
[7] Jared Cooney Horvath, The Digital Delusion: How Classroom Technology Harms Our Kids' Learning – And how to Help Then Thrive Again, (upcoming 7-DEC-2025). See other recent works for neuroscience and learning examples.
[8] Millersville University website, accessed December 15th, 2024, https://www.millersville.edu/about/eppiic-values/.



Chemical and Engineering News website, accessed December 17th, 2024, https://cen.acs.org/biological-chemistry/Periodic-Graphics-chemistry-plant-flowering/99/i9.