

ORGANIC CHEMISTRY 1 — CHEMISTRY 231 — FALL 2022

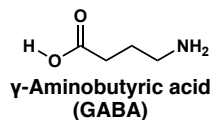
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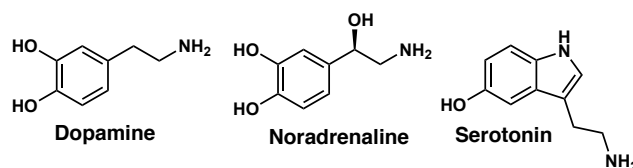
Some Neurotransmitters of Learning



OPEN OFFICE HOURS

Please stop by 318 Caputo Hall, anytime *on...*

1. Wednesdays from 3:30 pm to 4:30 pm.
2. Thursdays from 1:00 pm to 3:00 pm.
3. Fridays from 11:00 am to 1:00 pm.



No appointment needed—just stop by. *And please arrive with questions of curiosity or clarification, related to lecture or laboratory course work or learning strategies.* Meetings outside of my weekly office hours are possible; and they should be arranged via email.

REQUIRED CLASS MEETINGS

Please plan to attend and actively participate in all class meetings:

1. Lecture (CRN 4333): MWF 10:00 – 10:50 am, 149 Roddy Hall.
2. And Laboratory 01A (CRN 4334): Tuesday 9:00 am – 11:50 am, 331 Caputo Hall,
or Laboratory 01B (CRN 4335): Tuesday 1:10 pm – 4:00 pm, 331 Caputo Hall.

If you are unable to attend a required class meeting, then *please email me to let me know.*

EXPECTATIONS, PARTICIPATION, & CLASSROOM NORMS

The value of actively taking part in class activities is hard to exaggerate. 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 well by passively listening to someone lecture at you. Therefore, this class will ask a lot of you. Through completing required readings and practice problems, you are expected to prepare for all class meetings. And you are expected to come to class ready to focus, take good 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 small 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. Talking all the time is not necessarily the same thing as great participation; indeed, talking too frequently can even lead to imbalance and discomfort for others. Actively listening to classmates, responding with relevance to others' comments, reflecting on, building on, and generating questions related to your classmates' ideas lead to authentic and meaningful participation.

I am serious about helping to create a classroom environment in which anyone feels free to ask questions, raise concerns, make brilliant points, and so on. This classroom is your classroom. Please don't keep yourself from asking a question because you fear it will sound stupid or

unsophisticated or obvious. Sometimes, clichés are true: in here at least, there are no stupid questions. And becoming fluid in the art of asking questions (of clarification or curiosity) is one of the best ways to increase your learning and critical thinking.²

Although I am committed to classroom activities and 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 students need to feel that this is their classroom; I am committed to protecting those conditions. People first, learning second, bureaucracy last.

LANGUAGE, CRITICAL THINKING, & LECTURE COURSE DESCRIPTION

“The limits of my language mean the limits of my world.” – Ludwig Wittgenstein³

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 chemicals are everywhere and make up over 95% of the more than 193 million (and counting) known chemical substances.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) 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 231 is a non-mathematical, yet 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 underlying 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. Recognize, name, and draw organic compounds and organic functional groups.
2. Estimate, explain, and draw the attractive forces within and between molecules.
3. Analyze, explain, and draw structural conformations, configurations, and isomers.
4. Describe relationships between molecular structure, reactivity, and physical properties.
5. 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.
6. Describe reaction mechanism steps with elementary reaction names and with Frontier-Molecular Orbital (FMO) notation.
7. Draw plausible reaction mechanisms using curved-arrow notation to represent electron flow.
8. Describe, apply, compare & contrast, and evaluate organic functional group reactions.
9. Predict plausible products, reactants, or reagents based on functional group reactivity.
10. Design multi-step synthesis of organic products by using the organic reactions that you learn.

REQUIRED LECTURE MATERIALS

1. Daily access our D2L course site and your Millersville email account.
2. Klein's Organic Chemistry 4th Edition (1) textbook & (2) study guide & solutions. Please see Millersville University textbook store site for details: <https://bit.ly/3s5Xmh0>

LECTURE COURSE & EXAMS SCHEDULE OVERVIEW

Textbook	Chapter Topic (estimated days)	Exam Schedule
Chapter 1	Relevant General Chemistry (22-AUG – 26-AUG)	
Chapter 2	Functional Groups & Resonance (29-AUG – 31-AUG)	EXAM 1
Chapter 3	Acid-Base Reactions (2-SEPT – 12-SEPT)	Wed. 14-Sept
Chapter 4	Alkane Naming & Conformations (16-SEPT – 21-SEPT)	
Chapter 5	Stereoisomer Concepts (23-SEPT – 26-SEPT)	EXAM 2
Chapter 6	Reaction Mechanism Basics (28-SEPT – 3-OCT)	Wed. 5-Oct
Chapter 17	Aromaticity & Acid-Base Reactions (7-OCT)	
Chapter 19	Aldehydes, Ketones, & Derivatives (12-OCT – 21-OCT)	EXAM 3
Chapter 20	Carboxylic Acid Derivatives (24-OCT – 7-NOV)	Wed. 9-Nov
Chapter 21	Enols & Enolates (11-NOV – 28-NOV)	EXAM 4 & FINAL
Chapter 22	Amines & Review (30-NOV)	Fri. 2-Dec

Exam questions are closely aligned to course learning goals. And exam questions will be closely related to required homework problems, lecture participation and practice problems, laboratory practice problems, and lecture discussion examples.

LECTURE & LABORATORY COURSE EVALUATION SCHEME:

Lecture participation & practice (50 points)	5.0 %
Required chapter practice problems (150 points)	15.0 %
Exam 1 (100 points)	10.0 %
Exam 2 (135 points)	13.5 %
Exam 3 (165 points)	16.5 %
Exam 4 Final (200 points)	20.0 %
Laboratory (200 points)	<u>20.0 %</u>
	$\Sigma = 100.0 \%$

GRADE DISTRIBUTION (in percentage points)

A	100 – 92.0	B	87.9 – 82.0	C	77.9 – 70.0	D	61.9 – 60.0
A-	91.9 – 90.0	B-	81.9 – 80.0	C-	69.9 – 65.0	D-	59.9 – 57.0
B+	89.9 – 88.0	C+	79.9 – 78.0	D+	64.9 – 62.0	F	< 57.0

UNIVERSITY APPROVED CLASS ATTENDANCE POLICY

Students are expected to attend all classes [and laboratory 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:
 - a. personal illness
 - b. death or critical illness in the family
 - c. participation in a university-sponsored activity
 - d. jury duty
 - e. military duties
 - f. 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.

OUR EPPICC VALUES

Exploration, Professionalism, Public Mission, Inclusion, Integrity, and Compassion.⁵

REQUIRED READING

(Due dates—complete before our 10 am MWF class discussion, participation, & learning work)

24-AUG — CHAPTER 1 — Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, & 1.8 (*Wednesday, 24-AUG*).

26-AUG — CHAPTER 1 — Sections 1.9, 1.10, 1.11, 1.12, 1.13, & 1.14 (*Friday, 26-AUG*).

29-AUG — CHAPTER 2 — Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, & 2.8 (*Monday, 29-AUG*).

31-AUG — CHAPTER 2 — Sections 2.9, 2.10, 2.11, 2.12, & 2.13 (*Wednesday, 31-AUG*).

2-SEPT — CHAPTER 3 — Sections 3.1, 3.2, 3.3, & 3.4 (*Friday, 2-SEPT*).

7-SEPT — CHAPTER 3 — Sections 3.3 re-read, 3.4 re-read, 3.5, & 3.6 (*Wednesday, 7-SEPT*).

9-SEPT — CHAPTER 3 — Sections 3.7, 3.8, 3.9, & 3.10 (*Friday, 9-SEPT*).

12-SEPT — CHAPTER 3 — Sections 3.10 re-read (*Monday, 12-SEPT*).

16-SEPT — CHAPTER 4 — Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, & 4.8 (*Friday, 16-SEPT*).

19-SEPT — CHAPTER 4 — Sections 4.8 re-read, 4.9, 4.10, 4.11, 4.12, & 4.13 (*Monday, 19-SEPT*).

21-SEPT — CHAPTER 4 — Sections 4.13 re-read, 4.14, & 4.15 (*Wednesday, 21-SEPT*).

23-SEPT — CHAPTER 5 — Sections 5.1, 5.2, 5.3, 5.4, 5.5, & 5.6 (*Friday, 23-SEPT*).

26-SEPT — CHAPTER 5 — Sections 5.5 re-read, 5.7, 5.9, 5.10, & 5.11 (*Monday, 26-SEPT*).

28-SEPT — No reading assignment – skip sections 6.1 – 6.5 (*Wednesday, 28-SEPT*).

30-SEPT — CHAPTER 6 — Sections 6.6, 6.7, 6.8, 6.9, & 6.10 (*Friday, 30-SEPT*).

3-OCT — CHAPTER 6 — Sections 6.9 re-read, 6.10, 6.11, & 6.12 (*Monday, 3-OCT*).

7-OCT — CHAPTER 17 — Sections 17.1, 17.2, 17.3, 17.4, & 17.5 (*Friday, 7-OCT*).

12-OCT — CHAPTER 19 — Sections 19.1, 19.2, 19.3 & 19.4 (*Wednesday, 12-OCT*).

14-OCT — CHAPTER 19 — Sections 19.4 re-read, 19.5, & 19.6 (*Friday, 14-OCT*).

17-OCT — CHAPTER 19 — Sections 19.6 re-read, 19.7, 19.8, & 19.9 (*Monday, 17-OCT*).

19-OCT — CHAPTER 19 — Sections 19.9 re-read & 19.10 (*Wednesday, 19-OCT*).

21-OCT — CHAPTER 19 — Sections 19.10 re-read & 19.11 (*Friday, 21-OCT*).

24-OCT — CHAPTER 20 — Sections 20.1, 20.2, 20.3, & 20.4 (*Monday, 24-OCT*).

26-OCT — CHAPTER 20 — Sections 20.5, 20.6, & 20.7 (*Wednesday, 26-OCT*).

28-OCT — CHAPTER 20 — Sections 20.8, 20.9, & 20.10 (*Friday, 28-OCT*).

31-OCT — CHAPTER 20 — Sections 20.10 re-read & 20.11 (*Monday, 31-OCT*).

2-NOV — CHAPTER 20 — Sections 20.12 & 20.13 (*Wednesday, 2-NOV*).

4-NOV — CHAPTER 19 & 20 — Practice and review – No reading assignment (*Friday, 4-NOV*).

7-NOV — CHAPTER 19 & 20 — Practice and review – No reading assignment (*Monday, 7-NOV*).

11-NOV and beyond — for CHAPTER 21 & 22 — Reading is optional and strongly recommended; we will only cover about two new sections per class meeting, since Chapter 19 & 20 reactions will be reviewed.

REQUIRED CHAPTER PRACTICE PROBLEMS — 15 POINTS POSSIBLE PER CHAPTER

(Due dates for uploaded work into D2L)

- Must draw out all structures to earn full credit.
- Please use study guide and solutions manual to check your work before turning it in.
- Late required work accepted for 80% of total points possible.

CHAPTER 1 *(11:59 pm on Monday, 29-AUG)*

1.1d, 1.3de, 1.4, 1.5, 1.6, 1.7, 1.8bc, 1.9, & 1.10, 1.12, 1.13, 1.14, 1.19, 1.21, 1.22, 1.24, 1.25, 1.26, 1.27, 1.28bcfg, 1.29, 1.30, 1.31, & then read textbook section 1.14; then write a short paragraph briefly describing how soap works. Molecular structure is the foundation.

CHAPTER 2 *(11:59 pm on Tuesday, 6-SEPT)*

2.1 – 2.2, 2.4 – 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.18, 2.19, 2.20, 2.25, 2.26, 2.28, 2.31, 2.32, & 2.33. Functional groups, charges, and resonance help us organize, describe, and utilize structure.

CHAPTER 3 *(11:59 pm on Monday, 12-SEPT)*

3.1 – 3.36; and I suggest working all of them; because this is arguably the *most* important chapter in the entire textbook; you *must* learn to apply it all—accurately, quickly, and with confidence; or the rest of the course sequence will be much harder and less enjoyable.

CHAPTER 4 *(11:59 pm on Wednesday, 21-SEPT)*

4.1, 4.4 – 4.10, 4.12, 4.13, 4.16, 4.19cd, 4.20 – 4.23, 4.24, 4.25bc, 4.26, 4.28cd, 4.29, & 4.30c.

CHAPTER 5 *(11:59 pm on Wednesday, 28-SEPT)*

5.1, 5.4, 5.7, 5.9, 5.10, 5.11, 5.15, 5.19, 5.24, 5.27, 5.28ad, 5.29, & 5.30.

CHAPTER 6 *(11:59 pm on Monday, 3-OCT)*

6.8 – 6.10, 6.11, 6.13, 6.15, 6.17, & 6.18, and any others you like.

CHAPTER 17 *(11:59 pm on Thursday, 13-OCT)*

17.1, 17.2, 17.5, 17.8, 17.11, 17.13, 17.15, & 17.16.

CHAPTER 19 *(11:59 pm on Monday, 24-OCT)*

19.1, 19.2, 19.3, 19.4, 19.5 (use table 19.2), 19.6, 19.8b, 19.11, 19.13, 19.14b, 19.15d, 19.18, 19.20c, 19.24, 19.26a, 19.27, 19.28a, 19.30b, 19.32ab, 19.34a, 19.37, 19.38, & 19.39.

CHAPTER 20 *(11:59 pm Monday, 7-NOV)*

20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 20.10 (use table 20.1), 20.11a, 20.12abefh, 20.13bcd, 20.14, 20.16, 20.17, 20.19, 20.20, 20.21a, 20.22def, 20.24, 20.25, 20.26, & 20.27.

CHAPTER 21 *(11:59 pm Tuesday, 29-NOV)*

21.1, 21.2, 21.3, 21.4, 21.5, 21.6ab, 21.8c, 21.9, 21.10a, 21.11, 21.12c, 21.14ad, 21.16, 21.17ace, 21.18, 21.19be, 21.20, 21.21, 21.25a, 21.29, 21.31a, 21.33, 21.35, 21.36, & 21.38.

EXTRA CREDIT (EC) CHAPTER PRACTICE PROBLEMS — UP TO 5 EXTRA POINTS PER CHAPTER
(*Due dates for uploaded work into D2L*)

- Must draw out all structures to earn full credit.
- Please use study guide and solutions manual to check your work before turning it in.
- No late extra credit work accepted.

CHAPTER 1 EC (11:59 pm on Tuesday, 30-AUG)

1.32 – 1.38all, 1.45, 1.46 – 1.50all, 1.53, 1.54, 1.55, 1.56, 1.62, 1.63 – 1.72all, 1.73, 1.82, & 1.83.

CHAPTER 2 EC (11:59 pm on Wednesday, 7-SEPT)

2.37, 2.40, 2.45, 2.46 – 2.48, 2.53, 2.54, 2.55, 2.57, 2.58, 2.59, 2.60, 2.61, 2.63, 2.64 – 2.72, 2.74, 2.87, & 2.89.

CHAPTER 3 EC (11:59 pm on Tuesday, 13-SEPT)

3.37 – 3.84; once again, all of them; because this really is the *most* important chapter in the entire textbook; you *must* learn to apply it all—accurately, quickly, and with confidence; or the rest of the course sequence will be much harder and less enjoyable.

CHAPTER 4 EC (11:59 pm on Thursday, 22-SEPT)

4.47 – 4.48, 4.50 – 4.54, 4.58, 4.61 – 4.69, 4.70, 4.72, 4.77, 4.79, & 4.82.

CHAPTER 5 EC (11:59 pm on Thursday, 29-SEPT)

5.31 – 5.34, 5.39, 5.50, 5.53, 5.57 – 5.63, 5.65a, 5.67a, & 5.76.

CHAPTER 6 EC (11:59 pm on Tuesday, 4-OCT)

6.42 – 6.49, 6.54, 6.60, 6.62, & 6.64, & any others you like.

CHAPTER 17 EC (11:59 pm on Friday, 14-OCT)

17.24, 17.25, 17.31, 17.32, 17.33, 17.36, 17.39, 17.48, 17.52, & 17.53.

CHAPTER 19 EC (11:59 pm Tuesday, 25-OCT)

19.43, 19.44, 19.50, 19.54, 19.55, 19.57, 19.59c, 19.60b, 19.61bd, 19.68, 19.74 – 19.81, 19.95, 19.99.

CHAPTER 20 EC (11:59 pm Tuesday, 8-NOV)

20.35, 20.36, 20.37, 20.38, 20.44, 20.46, 20.48, 20.58, 20.70 – 20.74, 20.76, 20.77, 20.80, & 20.98.

CHAPTER 21 EC (11:59 pm Wednesday, 30-NOV)

21.70, 20.75, 21.76, 21.83, 21.84, 21.87, 21.89 – 21.96.

LABORATORY — CHEMISTRY 231 — ORGANIC CHEMISTRY 1 — FALL 2022

All weekly handouts will be provided in lab.

AT THE COMPLETION OF CHEM 231 OR CHEM 235 LABORATORY, YOU SHOULD BE ABLE TO...

1. Demonstrate proper laboratory safety & waste disposal when working in the lab.
2. Keep a neat and organized record of laboratory data in a notebook.
3. Set up apparatus for experimental techniques: reactions, distillations, filtrations, etc.
4. Purify organic products by recrystallization (solids) and distillation (liquids).
5. Characterize organic products by physical, chemical, and spectroscopic properties

LABORATORY SCHEDULE

Week	Activity
1	Pre-Test, Safety, Check-In, Core Concepts
2	Recrystallization, Functional Groups, & IR Spectroscopy
3	Thin-Layer-Chromatography (TLC)
4	Limonene Extraction via Steam Distillation
5	Acid-Base Reactions & Acid-Base Extraction
6	Conformational Analysis, Chirality, & Stereochemistry
7	Gold(III)-Catalyzed Hydration of Phenylacetylene & TLC
8	Proton & Carbon NMR or Fall Break
9	Proton & Carbon NMR or More Proton & Carbon NMR
10	Oxone oxidation of an aldehyde into a carboxylic acid
11	Acid cat. cyclic acetal formation from benzaldehyde and pentaerythritol
12	Imine Formation from an Aldehyde (Multi-Step Synthesis – Step 1)
13	Imine Reduction & Amide Formation (Multi-Step Synthesis – Steps 2 & 3)
14	More Proton & Carbon NMR or Thanksgiving Break
15	Post-Test, Clean-up, Check-out, & Reaction Review

CHEMISTRY 231 LABORATORY ATTENDANCE STATEMENT

Make-up labs are not an easy option—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 a zero for the lab activity, missing two labs equals a zero for the second lab activity, missing three or more labs equals failure of the entire course.

ADDITIONAL COURSE POLICIES

Diversity, Inclusion, and Anti-Racism Policy

This course is a judgement free and anti-racist learning environment. Our class includes students from a wide variety of social identities and 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. In order 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.

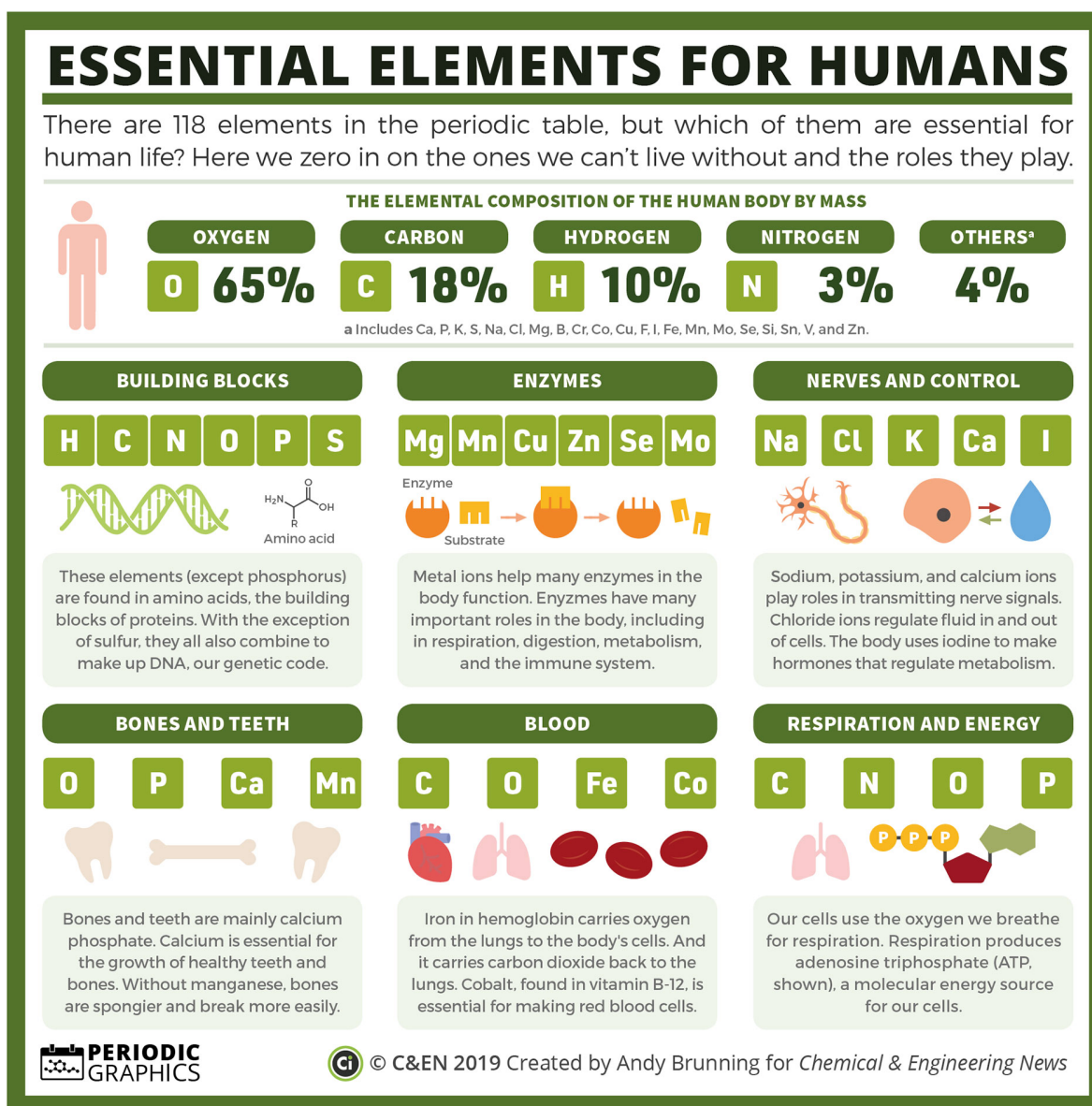
¹ David Gooblar, *The Missing Course: Everything They Never Taught You About College Teaching* (Cambridge: Harvard University Press, 2019).

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 Millersville University website, accessed August 1st, 2022, <https://www.millersville.edu/about/eppic-values/>.



Chemical and Engineering News website, accessed August 4th, 2022, <https://cen.acs.org/physical-chemistry/periodic-table/IYPT-Periodic-Graphics-Essential-elements-humans/97/i13>.