Biological Chemistry and Metabolism for Students of Pharmacy
BIOC 1040.06/CRN 14222 (October 28th – December 13th, 2019)

Course Description

Class and Laboratory Instructor:
Dr. Kathryn Vanya Ewart (vewart@dal.ca, 902-494-3149, Tupper 9-S1)

I. Introduction and Objectives

Biochemistry is the study of life at the chemical level, in particular the structure, function and metabolism of biomolecules (proteins, nucleic acids, lipids and carbohydrates). Biochemistry provides the most direct connection between our genetic complement (“genome”), our environment, and our physiology and health.

The goal of this class is to provide a solid foundation in biochemistry, including knowledge and principles, and to help you acquire the ability to independently draw upon and apply this knowledge and understanding in your professional career as a Pharmacist.

At the end of this course, you will be able to:

1. Use your knowledge of fundamental principles of chemistry and physics (e.g. molecular bonding, thermodynamics, kinetics) to explain important concepts in biochemistry.
2. Describe the physical and chemical structure of the human genome, and provide examples of technologies currently used to elucidate and manipulate its content.
3. Outline in molecular detail the processes by which genetic information is replicated and expressed, leading to protein synthesis, targeting and turnover.
4. Describe and interrelate the hierarchical levels of protein structure (1° to 4°) and provide examples of how this structure relates to the function (or dysfunction) of various classes of proteins.
5. Explain how enzymes can increase the rates of biochemical reactions at the molecular level and how they may be inhibited or regulated by drugs and toxins.
6. Describe the basic principles of intracellular signal transduction and discuss how these processes may alter gene expression, protein function and cellular fate.
7. Outline the major metabolic pathways by which biomolecules (carbohydrates, lipids, amino acids) are synthesized, degraded and transported, and identify the key points at which these pathways are regulated.
8. Explain how metabolic pathways are controlled to maintain homeostasis of organisms under normal physiological conditions, and give examples of how this may be influenced by nutrition, drugs, and certain pathological states such as diabetes and obesity.
9. Describe how humans obtain, store and utilize energy through metabolic transformations of biomolecules, and outline the fundamental principles of nutritional balance.
10. List the major macro- and micronutrients essential for human health and explain their actions at the biochemical level.

11. Demonstrate basic skills in a biochemistry laboratory, including the awareness of chemical and biological safety, the practice of experimental techniques, and the recording, interpretation and written communication of laboratory observations.

12. Use the scientific literature and other available resources to research topics in human biochemistry and, in a small group tutorial setting, to answer guided questions and attain learning objectives.

II. Course Organization

There are several complementary components to this course:

1. **Case Studies** *(Case Coordinator – Ms. Dianne Cox, College of Pharmacy)*: Problem-based cases are discussed in small groups each week, under the direction of a tutor. Case tutorials are held Monday, Wednesday and Friday from 9:35 to 11:25 in the Burbidge seminar rooms. To prepare for each week's case, it is recommended that you familiarize yourself with the textbook chapters associated with that week's lectures (see Schedule below). Additional reading may be recommended on a weekly basis. It will be necessary to consult a variety of other sources of information in addition to the textbook in order to explain all aspects of each case.

2. **Lectures**: There are a total of 24 one-hour lectures, which are held in Burbidge Room 109 on Monday, Wednesday, Thursdays and Friday at 8:35, and on Wednesday at 12:35 in the Collaborative Health Education Building (CHEB) Room C170. See schedule or academic timetable for timing and location details. The lectures cover a broad range of biochemical topics, some of which are related to the problems presented in the cases or laboratory exercises. Most topics are well covered in the recommended text, although some areas (e.g. genomics, cell signaling) may require other sources. Lecture files will be posted on PharmX prior to each lecture.

3. **Laboratory**: There are five 3-hour laboratory exercises on Tuesdays or Thursdays from 10:35-1:25 in Tupper room 8-J1 (eighth floor, turn right and go to end of hall). Each lab highlights a relevant aspect of Biochemistry. Refer to your course textbook for background information. The laboratory manual will be available for $10 in 9-S1 Tupper on either **Tuesday, October 15th** (10:00 -5:00) or **Thursday, October 17th** (10:00 -5:00). Students must also sign up for their preferred Tuesday or Thursday lab section at this time. Please be sure to read over the laboratory exercises and prepare flow charts as required before coming to the lab.

   **Note: Students who have obtained a grade of B- or higher in BIOC 2300 and BIOC 2610, or equivalent courses, may apply for a laboratory exemption by e-mailing the class instructor no later than October 1st.**

4. **Private study**: This class requires a significant amount of self-directed study in order to (a) find answers to questions raised in the case tutorials and (b) develop a broad general knowledge of biochemistry. Your main resource will be the assigned textbook supplemented by other references and class handouts as well as library and Internet sources (see Section III below).
Communications and assistance: any questions regarding course organization or content should be directed to the class instructor, preferably by e-mail. Depending on the nature of the question, the reply may be distributed in a separate message to the entire class. Office hours are the instructor is also available for consultation by appointment.

III. Textbook and Other Resources

The recommended textbook for BIOC 1040 is “Lippincott’s Illustrated Reviews: Biochemistry, Seventh Edition” by Denise Ferrier. This textbook is available from the Dalhousie Bookstore.

Editions of the above book from the past few years (5th to 6th editions) are also acceptable, but earlier editions (4th and lower) should be avoided, as much of the information in those ones is out of date. The major focus of this text is on clinically relevant biochemistry, and each chapter ends with a helpful review and “concept map” of the material covered.

Other textbook that might be helpful are “Essential Biochemistry” (3rd edition, 2014) by Pratt & Cornely; this is the textbook used in BIOC 2300, which some students in BIOC 1040 have taken and “Molecular Biology of the Cell” (6th edition, 2015) by Bruce Alberts et al., which deals with cell biology.

These textbooks, along with several other biochemistry/molecular biology texts providing related and complementary information, are also available in the W.K. Kellogg Health Sciences library (Sir Charles Tupper Building). A list of suggested reference books for this course can be found on the Library guide for Pharmacy: go to http://dal.ca.libguides.com/content.php?pid=233089&sid=1929455. The call numbers of these books are also listed.

A number of free resources on biochemistry, cell and molecular biology are also available on the Internet, including:

Ahern K, Rajagopal I “Biochemistry Free and Easy” (full service biochemistry textbook with bonus songbook; downloadable for iPad or as PDF)
http://biochem.science.oregonstate.edu/biochemistry-free-and-easy

Interactive Concepts in Biochemistry (games and animations from Wiley):
http://www.wiley.com/legacy/college/boyer/047003790/animations/animations.htm

Khan Academy: short YouTube videos on many topics (https://www.khanacademy.org)

Inner Life of the Cell (narrated): http://www.youtube.com/watch?v=P1UaTkI6k6s

University of Utah Genetics site: http://learn.genetics.utah.edu/

Cold Spring Harbor DNA Centre: http://www.dnalc.org/websites/labcenter.html

Virtual Cell Animation Collection: http://vcell.ndsu.edu/animations/
**IV. Class Assessment**

Ongoing assessment of your participation in **tutorials** will be done by your tutors, and is **Pass/Fail**. Attendance is mandatory and satisfactory performance is required. **Laboratory** participation and completion of all the lab reports is also mandatory unless you have been granted an exemption.

Formal assessment of your knowledge and understanding of biochemistry will be determined as follows:

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<th>% of final grade</th>
<th>with lab exemption</th>
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<tr>
<td>20%</td>
<td>25%</td>
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1. **Midterm test:** one midterm test, worth 20% of the final grade, will be held during class hours on:

   Friday, November 22nd, 8:35 – 9:25 am (Location TBA)

   This test will include approximately 30 multiple choice questions and will cover lecture and case (but not lab) material up to that point.

2. **Final exam:** (Dalplex, December 13th, time TBA)

   This three-hour exam will consist of 80 multiple choice questions covering the whole course, including all lectures and case studies.

3. **Lab reports:** (see Lab Manual for details and deadlines)

   Laboratory reports. Lab reports must be submitted as described in the lab manual. Extension of the due date will normally be granted only in the case of illness, and will not exceed seven calendar days. Other reasons, such as excessive workload, are not acceptable. Please contact Dr. Ewart as soon as possible for any other lab issues. Lab periods missed due to illness will not be repeated, but you will be responsible for the content.

   **Missed examinations or labs.** A student who misses a test, examination or lab due to illness, family problems, etc. must notify Dr. Ewart and the Pharmacy Department office within 48 hours. Absence for other reasons is not normally acceptable unless prearranged with the course coordinator. A mark of zero will be given if no satisfactory arrangement has been made. A signed medical certificate will only be required for a missed final exam, but two or more missed tests and/or labs may be reported to the Associate Director of Student Affairs for follow-up.

   There will be **no makeup midterm test**. If you miss the midterm for excused medical or personal reasons, the results of the final exam will be prorated to be worth 75% of the total course grade (or 100% if you have a lab exemption). If necessary, a **makeup final examination** will be held after the end of the course. Students who need to write a makeup exam for medical/personal reasons are expected to be available during this period.

   If the instructor indicates that calculators are allowed on an exam, only use of **non-RAM calculators** will be permitted.
Letter grades. The following University-wide grading scheme will be used:

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<th>Grade</th>
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<tr>
<td>A+</td>
<td>90 – 100</td>
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<td>A</td>
<td>85 – 89</td>
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<td>A-</td>
<td>80 – 84</td>
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<td>B+</td>
<td>77 – 79</td>
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<td>B</td>
<td>73 – 76</td>
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<tr>
<td>B-</td>
<td>70 – 72</td>
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<tr>
<td>C+</td>
<td>65 – 69</td>
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<td>C</td>
<td>60 – 64</td>
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<td>C-</td>
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<td>D</td>
<td>50 – 54</td>
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<td>F</td>
<td>0 – 49</td>
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A final mark of **50%** is required to pass the course.

**Formative questions** (i.e. practice, self-testing) will be posted on PharmX every week or so; these will be the same style and format as the exam questions, and answers will be provided. You are strongly advised to attempt these questions soon after they are posted, because they will consolidate your comprehension of the material and let you know how well you understand it.

As preparation for each week’s lectures and case study, it is highly recommended that you read the textbook chapters related to that week (indicated in the Schedule), and also review your lecture and case notes at the end of each week. **It is important to keep up your understanding of the material, as this is an intense course and later material will build on concepts introduced early on.**

**V. Policies**

1. **Policy on Plagiarism – Dept. of Biochemistry & Molecular Biology**

What is plagiarism?

“Dalhousie University defines plagiarism as the presentation of the work of another as if it were one’s own”\(^*\). Plagiarism is a form of academic fraud. The Department is committed to protecting honest students against the devaluation of their work by students who resort to plagiarism.

Some examples of plagiarism include (but are not restricted to):

- Submitting as your own work any material created, in whole or in part, by someone else, **including material created in collaboration with other students**, unless specifically allowed by the course instructor and credited appropriately.
- Paraphrasing extensively or copying from sources such as the Internet, journal articles, or books (including textbooks) without crediting the original author or source.
- Using another student’s laboratory data, unless specifically allowed by the course instructor and credited appropriately.
- Submitting, in whole or in part, any work that has been submitted in another course, or re-submitting the same work in different years of the same course.

How can plagiarism be detected?

If required by the Instructor, work submitted for credit must be submitted in electronic as well as hard copy form. Submissions may be screened by one or both of the following methods:

- A pattern recognition program that compares all submissions with one another as well as submissions from previous years. Every individual has a unique pattern of writing. This program will detect submissions that are derived from a common source, even if words or phrases have been changed.
A third-party computer-based assessment system that compares submissions against a large database including previous submissions and Internet sources.

**What are the consequences of plagiarism?**

“Plagiarism is a serious academic offence which may lead to loss of credit [‘F’ in a course], suspension or expulsion from the University, or even the revocation of a degree.”† At Dalhousie University, the Department is obligated to refer any cases of suspected plagiarism to the Senate Discipline Committee, which will then conduct a hearing to evaluate the innocence or guilt of students alleged to have committed an act of plagiarism.

**How can accusations of plagiarism be avoided?**

You can avoid accusations of plagiarism by:

- Preparing all submissions independently and ensuring that they are expressed in your own unique writing style.
- Never sharing any written or electronic material with other students. You may discuss ideas with other students but you may not work with another student while preparing materials you are planning to hand in.
- Acknowledging any material paraphrased extensively or copied from sources such as the Internet, journal articles or textbooks. Paraphrasing of short phrases from the course textbook need not be acknowledged.
- Guarding all your work, both drafts and final submissions, to ensure that no one else can copy it. If you provide access to your work and someone copies it, then you may have to appear before the Senate Discipline Committee to establish that you are the original creator of the work. If you suspect that someone has taken any of your work, notify your course instructor immediately.
- Using only actual laboratory data that has been collected in the lab. Altering laboratory data is not permitted.

†Dalhousie University Undergraduate Calendar, 2016/2017, p. 55

2. **Academic Accommodation – Dalhousie University**

For more detail, see p. 53-54 in the Calendar or visit

http://www.dal.ca/campus_life/student_services/academic-support.html

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic under the human rights legislation. Students who require academic accommodation for either classroom participation or the writing of tests and exams should make their request to Dalhousie Academic Support (https://www.dal.ca/campus_life/academic-support/accessibility/accommodations-.html) prior to or at the outset of the regular academic year. Please note that your classroom may contain specialized accessible furniture and equipment. It is important that these items remain in the classroom, untouched, so that students who require their usage will be able to fully participate in the class.
University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity
At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility
The Advising and Access Services Centre is Dalhousie’s centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct
Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don’t follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can’t be reached, or would be inappropriate, procedures exist for formal dispute resolution.


Diversity and Inclusion – Culture of Respect
Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: http://www.dal.ca/cultureofrespect.html

Recognition of Mi’kmaq Territory
Dalhousie University would like to acknowledge that the University is on Traditional Mi’kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St.) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)
https://www.dal.ca/academics/important_dates.html

University Grading Practices
https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Missed or Late Academic Requirements due to Student Absence (policy)
https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html
Student Resources and Support

Advising

General Advising: https://www.dal.ca/campus_life/academic-support/advising.html
Science Program Advisors: https://www.dal.ca/faculty/science/current-students/academic-advising.html
Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html
Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html
International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: https://libraries.dal.ca/
Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html
Student Advocacy: https://dsu.ca/dsas

Safety

Biosafety: https://www.dal.ca/dept/safety/programs-services/biosafety.html
Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html
Radiation Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety.html
Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html
### VI. Schedule for BIOC 1040, fall term 2019

<table>
<thead>
<tr>
<th>Week #</th>
<th>Date / Day</th>
<th>Lecture # and Topic</th>
<th>Laboratory</th>
<th>Tutorial Case</th>
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<td><strong>Lecture # and Topic</strong></td>
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<td>1</td>
<td>Oct 28 Mon</td>
<td>1 Introduction to Biochemistry</td>
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<td>2 Proteins - amino acids &amp; 1° structure</td>
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<td>30 Wed</td>
<td>3 Globular and fibrous proteins</td>
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<td>30 Wed</td>
<td>4 Introduction to enzymes</td>
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<td>31 Thurs</td>
<td>5 Protein &amp; Enzymes in action</td>
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<td>Nov 1 Fri</td>
<td>6 Genomes: DNA replication and repair</td>
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<td>2</td>
<td>7 Transcription and translation</td>
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<td>6 Wed</td>
<td>8 Gene expression</td>
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<td>7 Thurs</td>
<td>9 Biotechnology and human disease</td>
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<td>8 Fri</td>
<td>10 Metabolism and Bioenergetics</td>
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<td><strong>Study Break (Nov 11-15)</strong></td>
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<td><strong>MIDTERM in CHEB C170</strong></td>
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<td>3</td>
<td>18 Mon</td>
<td>11 Glycogen metabolism and regulation</td>
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<td>20 Wed</td>
<td>12 Glycolysis</td>
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<td>20 Wed</td>
<td>13 TCA cycle</td>
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<td>21 Thurs</td>
<td>14 Gluconeogenesis</td>
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<td>22 Fri</td>
<td>15 Lipids: structures, properties and roles</td>
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<td></td>
<td>25 Mon</td>
<td>16 Cholesterol and steroid metabolism</td>
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<td>27 Wed</td>
<td>17 Fatty acid and phospholipid metabolism</td>
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<td>28 Thurs</td>
<td>18 Amino acid and nitrogen metabolism</td>
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<td>29 Fri</td>
<td>19 Nutritional Biochemistry</td>
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<td>Dec 2 Mon</td>
<td>20 Micronutrients</td>
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<td>4 Wed</td>
<td>21 Signal transduction and cellular fate</td>
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<td>4 Wed</td>
<td>22 Insulin and glucagon</td>
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<td>5 Thurs</td>
<td>23 Integration of metabolism</td>
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<td>6 Fri</td>
<td>24 Diabetes and obesity</td>
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<td>5</td>
<td>9 Mon</td>
<td><strong>Question &amp; answer session</strong></td>
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<td>11 Wed</td>
<td><em>No class</em></td>
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<td>11 Wed</td>
<td><em>No class</em></td>
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<td>12 Thurs</td>
<td><em>No class</em></td>
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<td></td>
<td>13 Fri</td>
<td><strong>FINAL EXAM (Dalplex, time TBA)</strong></td>
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<td><strong>Tutorial Case</strong> Mon, Wed, Fri 9:35-11:25 Seminar rooms</td>
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<td><strong>Laboratory</strong> Tues OR Thurs 10:35-1:25 Tupper 8-J1</td>
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<td><strong>Laboratory</strong> Tupper 8-J1</td>
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<td>Aaliyah's Abdominal Pain</td>
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<td>The Schwartz's Terrible Holiday</td>
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