In biology, there are two fundamental conflicts: between organisms and between organisms and viruses. In addition, environmental stresses also play roles with both conflicts. During the conflicts, various offensive and defensive weaponry are employed for survival. This course will mainly focus on the conflicts between bacteria and environment, the conflicts between bacteria, and the conflicts between bacteria and viruses (phages). In this course, we will learn, from biochemical and structural points of view, how these offensive and defensive weaponry work. We will also learn biological processes employed by organisms to cope with environmental stresses.

In addition to providing molecular understanding of offensive and defensive weaponry employed during the conflicts, the course may inspire students in their future careers to invent new applications of the weaponry in biotechnology and medicine. This is because many powerful tools in biotechnology and medicine are the harvests of offensive and defensive weaponry employed for the conflicts. Among offensive weaponry, several small molecule biological toxins have been adopted as antibiotics. Among defensive weaponry, restriction enzymes employed in biotechnology are from R-M defensive systems, tools of genome editing are from CRISPR-Cas defensive systems, and RNA ligases essential for high throughput RNA sequencing are from RNA repair defensive systems.

Course Prerequisites
MCB 300 and credit or concurrent registration in MCB 354, or consent of instructor.

Student Learning Outcomes
At the end of the course, through assignments, discussions, and assessments, students will be able to:
- Understand the basic principles of nucleic acids and protein as well as their building blocks.
- Understand why the building blocks of nucleic acids have been employed to synthesize second messengers employed for the conflicts.
• Understand the mechanisms why nucleic acids are explored as the targets for the conflicts.
• Understand biochemistry and structures of protein employed as the effectors for the conflicts.

Course Text/Materials Information
Most of the materials for the lectures, and all materials for discussions will be from primary literature (see enclosed list of papers), which will be provided to the students. In addition, a general biochemistry textbook is useful. The following Biochemistry book is recommended.

W. H. Freeman Publishing, 2021

Course Website, Course Tools (Canvas, Moodle, LON-CAPA, Zoom, etc.)
Moodle, address TBD
Moodle, login TBD

Grading Information and Breakdown
Homework Submission & Discussion Participate on Fridays 20%
Exam 1 40%
Exam 1 will cover the materials for the first half of the class.
Exam 2 40%
Exam 2 will cover the materials for the second half of the class.
Exams will be taken place in person in the classroom.

Course Calendar with Daily Schedule of Topics, Readings and Assignment Due Dates

<table>
<thead>
<tr>
<th>Dates</th>
<th>Topics</th>
<th>Assigned Reading</th>
<th>Homework</th>
<th>Exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 Jan-W</td>
<td>Introduction to MCB 430; definition of microbes; major differences between microbes and higher organisms</td>
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<tr>
<td>21 Jan-F</td>
<td>Molecular basis of important biological processes in bacteria, including DNA replication, RNA transcription, and protein translation</td>
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<tr>
<td>24, Jan-M</td>
<td>Building blocks of DNA and RNA: Are they the inevitable consequence of biological evolution? or might they have had alternative choices over the course of evolution?</td>
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<tr>
<td>26 Jan-W</td>
<td>The same questions for the building block of protein</td>
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<tr>
<td>Date</td>
<td>Topic</td>
<td>Assignment</td>
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<tr>
<td>28 Jan-F</td>
<td>Becoming an expert of visualizing macromolecule structures and making professional structural figures</td>
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<tr>
<td>31 Jan-M</td>
<td>Responses based on the signaling molecules cAMP and (p)ppGpp</td>
<td>Paper 1</td>
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<tr>
<td>2 Feb-W</td>
<td>Responses based on the TA (toxin-antitoxin) systems</td>
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<tr>
<td>4 Feb-F</td>
<td>Discussion: On a special TA system</td>
<td>HW 1</td>
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<tr>
<td>7 Feb-M</td>
<td>Molecular basis of bacterial quorum sensing</td>
<td>Paper 2</td>
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<td>9 Feb-W</td>
<td>Molecular basis of bacterial biofilm formation</td>
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<tr>
<td>11 Feb-F</td>
<td>Discussion: TBD</td>
<td>HW 2</td>
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<tr>
<td>14 Feb-M</td>
<td>Small-molecule toxins as offensive weaponry</td>
<td>Paper 3</td>
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<tr>
<td>16 Feb-W</td>
<td>Protein toxins as offensive weaponry</td>
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<tr>
<td>18 Feb-F</td>
<td>Discussion: TBD</td>
<td>HW 3</td>
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<tr>
<td>21 Feb-M</td>
<td>Molecular structures of bacterial cell wall</td>
<td>Paper 4</td>
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<tr>
<td>23 Feb-W</td>
<td>Bacterial secretion systems</td>
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<tr>
<td>25 Feb-F</td>
<td>Discussion: TBD</td>
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<tr>
<td>28 Feb-M</td>
<td>Plasmid-based delivery systems</td>
<td>Paper 5</td>
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<td>2 March-W</td>
<td>Contact-dependent growth inhibition (CDI) system</td>
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<td>4 Mar-F</td>
<td>Discussion: TBD</td>
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<tr>
<td>7 Mar-M</td>
<td>Direct inhibitions of the invading biological toxins</td>
<td>Paper 6</td>
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<tr>
<td>9 Mar-W</td>
<td>Indirect inhibitions of the invading biological toxins</td>
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<tr>
<td>11 Mar-F</td>
<td>Discussion: TBD</td>
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<tr>
<td><strong>Spring Break</strong></td>
<td>14-18 March</td>
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<tr>
<td>21 Mar-M</td>
<td>Exam 1, no class, evening exam</td>
<td>Paper 7</td>
<td>Exam I</td>
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<tr>
<td>23 Mar-W</td>
<td>Primary antiphage system-1: DNA restriction-modification (R-M) systems</td>
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<td>25 Mar-F</td>
<td>Discussion: TBD</td>
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<tr>
<td>28 Mar-M</td>
<td>CRISPR-Cas lecture 1</td>
<td>Paper 8</td>
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<tr>
<td>30 Mar-W</td>
<td>CRISPR-Cas lecture 2</td>
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<tr>
<td>1 April-F</td>
<td>Discussion: Developing CRISPR-Cas technologies in genome editing</td>
<td>HW 8</td>
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<tr>
<td>4 Apr-M</td>
<td>Possibly evolutionary origin of CRISPR-Cas</td>
<td>Paper 9</td>
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<tr>
<td>6 Apr-W</td>
<td>RNAi-like systems in bacteria</td>
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<td>8 Apr-F</td>
<td>Discussion: TBD</td>
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<tr>
<td>11 Apr-M</td>
<td>Bacterial antiphage systems based on small molecule toxins</td>
<td>Paper 10</td>
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<tr>
<td>13 Apr-W</td>
<td>AbiA-to-AbiZ and PrrC</td>
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<td>15 Apr-F</td>
<td>Discussion: TBD</td>
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<tr>
<td>18 Apr-M</td>
<td>CRISPR-Cas associated CBASS systems</td>
<td>Paper 11</td>
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<tr>
<td>Date</td>
<td>Event</td>
<td>Assignment</td>
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<tr>
<td>20 Apr-W</td>
<td>Independent CBASS systems</td>
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<tr>
<td>22 Apr-F</td>
<td>Discussion: TBD</td>
<td>HW 11</td>
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<tr>
<td>25 Apr-M</td>
<td>Adenosine deaminase acting on RNA (RADAR) antiphage systems</td>
<td>Paper 12</td>
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<tr>
<td>27 Apr-W</td>
<td>Retron-based antiphage systems</td>
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<tr>
<td>29 Apr-F</td>
<td>Discussion: TBD</td>
<td>HW 12</td>
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<tr>
<td>2 May-M</td>
<td>Phages employing dG+-containing DNA as genome</td>
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<td>4 May-W</td>
<td>Phages with DNA genome where base A is replaced by base Z</td>
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<td>5 May-Th</td>
<td>Reading Day</td>
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<tr>
<td>6-13 May</td>
<td>Exam 2</td>
<td>Exam II</td>
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</table>

Academic Integrity:
- The Code of Policies and Regulations Applying to All Students will be applied in all instances of academic misconduct committed by students. This applies to all exams, presentations, assignments and materials distributed or used in this course. You can review these policies at the following website: [http://admin.illinois.edu/policy/code/index.html](http://admin.illinois.edu/policy/code/index.html) and specifically here: [http://studentcode.illinois.edu/article1/part4/1-401/](http://studentcode.illinois.edu/article1/part4/1-401/)
- Science cannot exist without honesty. The faculty and staff in MCB require students, as scientists-in-the-making, to hold the highest standards of scientific and academic conduct. Any form of cheating on any graded work in courses is unacceptable.
- We require that all graded work be entirely your own, and that anything you write using the words of other writers be correctly attributed. Some specific points follow.
- On exams, the answers that your turn in for grading must be your own, formulated during the exam from your own understanding of the material and without any supporting information, be it written, verbal or electronic. Copying the work of another student, or allowing another to copy your work, or copying work from any other source, is unacceptable. Since we cannot always monitor you as you complete your work, we must rely upon appearance of your work from which to judge. If the work you submit resembles that of another student or another source too closely, we may conclude that it was not your original work. Always make a conscious effort to complete your work on your own and to protect it from the view of others, in order to ensure that it will be seen as your own. Failure to adhere to these standards for any portion of an exam may result in a grade of zero for the entire exam or quiz for all persons involved.
- Texting, or the use of a cell phone or any other device for any purpose, during an exam is prohibited. Doing so may earn you a zero or a more extreme penalty on the exam at the discretion of the instructor.

Religious Observances and Practices:
- Students are required to submit the Request for Accommodation for Religious Observances Form (which can be found at [www.odos.illinois.edu/.../Religious_Observance_Accommodation_Request_](http://www.odos.illinois.edu/.../Religious_Observance_Accommodation_Request_))
Form.docx) to their instructors and the Office of the Dean of Students requesting accommodation by the end of the second week of the course. Requests that are not submitted within this time frame may not be granted. Information about accommodations can be found in the Student Code: http://studentcode.illinois.edu/.

DRES Accommodations:
• We are committed to providing a learning environment where our students can succeed. If you require special accommodations, please contact us and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak Street, Champaign, call 217.333.4603, or email disability@illinois.edu. We will try to meet all accommodations once the process has started. Please note that accommodations are not retroactive to the beginning of the semester, but begin the day you contact your professor, instructor or coordinator with a current letter of accommodation from DRES.
• If a student believes that they need DRES accommodations, they should contact DRES at disability@illinois.edu.

Exam Absences:
• If you must miss an exam due to unforeseen circumstances, you are required to contact your instructor within 24 hours of the absence. You will then have 48 hours from the absence in which to submit documentation to your instructor or course coordinator. Failure to follow this procedure may result in a zero for the exam.

University Information of Student Safety - Active Threats:
• General Emergency Response Recommendations (Emergency Response Guide):
• Security Threat. The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: RUN > HIDE > FIGHT

• Only follow these actions if safe to do so. When in doubt, follow your instincts - you are your best advocate!

• RUN — Action taken to leave an area for personal safety.
  o Take the time to learn the different ways to leave your building before there is an emergency.
  o Evacuations are mandatory for fire alarms and when directed by authorities! No exceptions!
  o Evacuate immediately. Pull manual fire alarm to prompt a response for others to evacuate.
  o Take critical personal items only (keys, purse, and outerwear) and close doors behind you.
  o Assist those who need help, but carefully consider whether you may put yourself at risk.
  o Look for Exit signs indicating potential egress/escape routes.
  o If you are not able to evacuate, go to an Area of Rescue Assistance, as indicated on the front page of this plan.
  o Evacuate to Evacuation Assembly Area, as indicated on front page of this plan.
  o Remain at Evacuation Assembly Area until additional instructions are given.
  o Alert authorities to those who may need assistance.
o Do not re-enter building until informed by emergency response personnel that it is safe to return.
o Active Threat: IF it is safe to do so, run out of the building. Get as far away as possible. Do NOT go to the Evacuation Assembly Area.

• **HIDE** — Action taken to seek immediate shelter indoors when emergency conditions do not warrant or allow evacuation.
  o Severe Weather:
    • If you are outside, proceed to the nearest protective building.
    • If sheltering-in-place due to severe weather, proceed to the identified Storm Refuge Area or to the lowest, most interior area of the building away from windows or hazardous equipment or materials.
  o Active Threat:
    • Lock or barricade your area.
    • Get to a place where the threat cannot see you.
    • Place cell phones on silent.
    • Do not make any noise.
    • Do not come out until you receive an Illini-Alert advising you it is safe.

• **FIGHT** — Action taken as a last resort to increase your odds of survival.
  o Active Threat: If you cannot run away safely or hide, be prepared to fight with anything available to increase your odds for survival.

**Student Resources/Where to go for Help:**
**We Care at Illinois**
- For sexual misconduct support, response and prevention visit: wecare.illinois.edu

*Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here: [http://oiir.illinois.edu/sites/prod/files/SexualMisconduct_ResourceGuide.pdf](http://oiir.illinois.edu/sites/prod/files/SexualMisconduct_ResourceGuide.pdf)*

**Safety and Emergency**
**University Police Department, Emergency, 9-911; Non-emergency, 217-333-8911**
University Fire Department Emergency, 9-911
Crisis Line, 217-359-4141
Emergency Dean, 300 Turner Student Services Bldg., 610 E. John St., 217-333-0050
Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704
McKinley Health Center, General Information, 217-333-2701
McKinley Mental Health Center, 1109 S. Lincoln, 217-333-2705
Dean of Students, 300 Turner Students Services Bldg, 610 E. John St., 217-333-0050
Local Sexual Assault Center, RACES, 217-384-4444
Women’s Resources Center, 703 South Wright Street, 2nd Floor, 217-333-3137
Rape Crisis 24-hour Hotline, 217-384-4444
Suicide & Psychological Emergency, Suicide Prevention Team, 217-333-3704
SafeRides (free nighttime campus ride program), 217-265-RIDE (265-7433)
SafeWalks (free walking escort service by Student Patrol), 217-333-1216

**Student Services and Advocacy**
Office of the Dean of Students, 300 Student Services Bldg., 610 E. John St., 217-333-0050
Classroom Support, Teaching Skills, and Instructional Strategies
Center for Innovation in Teaching & Learning, 249 Armory Building, 217-333-1462

Counseling Services
Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704
McKinley Mental Health Center, 1109 S. Lincoln Ave., 217-333-2701
Psychological Services Center, 3rd Floor, 505 E. Green St., 217-333-0041

Disability Services
Disability Resources and Educational Services (DRES), 1207 S. Oak St., 217-333-1970

Lesbian, Gay, Bisexual, Transgender Resource Center
LGBT Resource Center, 323 Illini Union, 1401 W. Green St., 217-244-8863

Veterans Services
Veteran Student Support Services, Office of the Dean of Students, 610 E. John St., 217-333-0050
Center for Wounded Veterans in Higher Education, 908 W. Nevada St., 217-300-3515

General Study Skills Assistance
Office of Minority Student Affairs, 130 Student Services Bldg., 610 E. John St, 217-333-0054
Office of Minority Student Affairs Tutoring Services, 701 S. Gregory Dr., Suite 1, 217-333-7547
Writer’s Workshop, 251 Undergraduate Library, 1402 W. Gregory Dr., 217-333-8796
**Additional academic assistance may be available through individual departments

Health Resources
Health Education, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2701
Alcohol & Other Drug Office, 2nd Floor Counseling Center, 610 E. John St., 217-333-7557
Sexual Health Educator, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2714
Dial-A-Nurse, McKinley Health Center (24-hour), 1109 S. Lincoln Ave., 217-333-2700
Health Resource Center, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-6000
Health Resource Center, Room 40 Illini Union, 1401 W. Green St., 217-244-5994
McKinley Health Center, General Information, 1109 S. Lincoln Ave., 217-333-2701

Sexual Harassment/Assault & Acts of Intolerance/Hate Crimes
Office of the Dean of Students, 300 Students Services Bldg., 610 E. John St., 217-333-0050

The Office of Diversity, Equity and Access (ODEA):
• For non-academic support visit: diversity.illinois.edu
  o Discrimination & Harassment Prevention
  o Title IX
  o Accessibility & Accommodations
  o Inclusive Illinois