



Middlebury Institute of International Studies at Monterey

Graduate School of International Policy & Management

COURSE SYLLABUS – FALL 2019

Science and Technology for Nonproliferation and Terrorism Studies

NPTG 8559/4 Credits

2:00 pm-3:50 pm on Monday and Wednesday / McGowan MG100

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Dr. Paul Jackson

Mr. Mark Bishop

Office Hours (or by appointment) TBD

COURSE DESCRIPTION

The primary objective of the Science and Technology for Nonproliferation Studies course is to provide students with a solid foundation in scientific and technical fundamentals critical to nonproliferation and terrorism policy analysis. The course begins with an introduction to science and the scientific method and then moves into the three main areas: the chemistry of chemical weapons and explosives, the physics of radioactivity and nuclear weapons, and the biology of dangerous pathogens and biological weapons. Topics covered in the chemistry component include fundamental concepts related to atomic structure, elements, compounds, chemical bonding, representations of chemical structures, and energy as it relates to chemical changes. An understanding of these fundamental topics leads to a description of chemical weapons and explosives. The chemistry module also includes a brief description of the history of the use of chemical weapons and a description of the Chemical Weapons Convention and its enforcement. Topics covered in the nuclear component part of the course includes radioactivity, uranium, nuclear weapons, radiation detection instrumentation and applications, environmental plumes, and various instrumentation and analysis techniques. Topics covered in the biological component include fundamental concepts related to microorganisms, DNA, RNA, proteins, processes of infection, disease and epidemiology and possible targets for bioterrorism and biological warfare. Upon completion of this course students will have a deeper appreciation for the debate on various verification solutions that have been proposed for compliance under the Biological and Toxin Weapons Convention (BWC), Chemical Weapons Convention (CWC), and nuclear treaties.

By the end of the course, students will be well-prepared to undertake advanced policy-related nonproliferation and terrorism studies, including more advanced seminars here at MIIS. The philosophy of the course is that learning science is similar to learning a new language - something you all experience at MIIS. You will gain basic tools to “speak” this new language, beginning with scientific vocabulary, advancing to practical terminology, so that you become more comfortable in engaging in constructive dialogue with technical experts.

COURSE OBJECTIVES

Students successfully completing this course will be able to:

- Understand and be able to use many of the terms used in science.
- Understand the fundamental models that chemists use to describe the nature of matter, and use these models to describe chemical weapons and explosives.
- Understand the different conventions used to describe chemical structures, and use them to describe the structures of chemical agents and explosives.
- Describe some of the more important chemical weapons, including descriptions of the way they are dispersed, their effects, and treatments for exposure.
- Describe the fundamental components of the Chemical Weapons Convention (CWC) and describe the role of the Organization for the Prohibition of Chemical Weapons (OPCW) in the enforcement of the CWC.
- Understand the fundamental concepts and terms relating to energy, and use them to describe why chemical and nuclear explosives release energy.
- Describe some of the more common chemical explosives, including their relative explosive power.
- Understand the concepts of kinetic and potential energy, momentum, and force, and use them to explain how rockets and missiles work.
- Describe the different forms of radioactivity.
- Describe the fission and fusion processes, and explain how they relate to nuclear weapons.
- Describe nuclear reactors and the issues relating to the disposal of nuclear fuel.
- Describe the interaction of radiation and matter.
- Describe dirty bombs and their potential for use by terrorists.
- Describe radiation detectors, and explain their limitations and sensitivities.
- Understand the strengths and weaknesses of the current Biological Weapons Convention.
- Understand the different types of pathogens that can cause disease.
- Understand the sources of diseases and by what avenues they are transmitted.
- Understand the different therapeutic strategies used to prevent and treat diseases.
- Understand the impact of antibiotic and vaccine resistance in pathogens.
- Understand the different methods used to detect and track diseases and the strengths and weaknesses of each.
- Develop an understanding of which pathogens and which avenues of attack might be used by bioterrorists and how these would be detected and responded to.
- Appreciate different technical, social, ethical and political aspects of a disease outbreak and how these must be balanced against one another.

TEXTBOOKS AND OTHER MATERIALS

Note: we will NOT be covering every topic these resources describe. We will select some sources for homework activities, select certain sections for you to read on your own, or point you to helpful study guides as we go through the course.

For Physics, see:

R. Muller, *Physics for Future Presidents* (PffP), Thompson, 2006. (on reserve in library)

P. P. Craig and J. A. Jungerman, "Nuclear Arms Race", McGraw-Hill Publishing Company, 1990.

D. Wright, L. Greco and Lisbeth Gronlund, "The Physics of Space Security", American Academy of Arts and Sciences, 2005.

J. E. Doyle, "Nuclear Safeguards, Security and Nonproliferation: Achieving Security with Technology and Policy", Butterworth-Heinemann, 2008.

<http://www.learner.org/courses/physics/index.html> - basic and advanced topics, history, etc.

<http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html> - an extremely useful resource showing vocab/concepts and how they interconnect.

<http://muller.lbl.gov/teaching/Physics10/PffP.html> - great lecture series by Richard Muller.

For Chemistry, see:

An Introduction to Chemistry, Atoms First by Mark Bishop ISBN 978-0-9778105-9-8 (on reserve in library)

I will bring some textbooks to loan for the duration of the course to the first class meeting.

Online versions of the text and study guide can be found at

http://preparatorychemistry.com/Bishop_Atoms_First.htm

You can download chapters of the text in iBook form for iPad at

http://preparatorychemistry.com/Bishop_iBook.htm

War of Nerves – Chemical Warfare from World War I to Al-Qaeda by Jonathan B. Tucker
ISBN 978-1-4000-3233-4

You can get a preview at

http://books.google.com/books?id=DYu4XOKdTyYC&printsec=frontcover&dq=War+of+Nerves+%E2%80%93+Chemical+Warfare+from+World+War+I+to+Al-Qaeda&hl=en&ei=KApYTrzmAcfmiAKQ2-imCQ&sa=X&oi=book_result&ct=result&resnum=2&ved=0CDAQ6AEwAQ#v=onepage&q&f=false

Toxic Terror by Jonathan B. Tucker ISBN 978-0262700719

You can get a preview at

<http://books.google.com/books?id=MrPyPP7gkHYC&printsec=frontcover&dq=Terrorist&client=internal-uds&source=uds#v=onepage&q&f=false>

Chemical Weapons Convention (CWC) website

<http://www.cwc.gov/>

Organization for the Prevention of Chemical Weapons (OPCW)

<http://www.opcw.org>

<http://www.opcw.org/about-opcw/>

<http://www.opcw.org/chemical-weapons-convention/>

<http://www.opcw.org/news-publications/publications/facts-and-figures/>

Others

<http://www.nti.org/country-profiles/>

http://cns.miis.edu/multimedia/interactive_files/cw_dumping.htm

<https://www.cma.army.mil/Pages/CMA-Home.aspx>

http://www.armscontrol.org/act/2010_11/Walker

<http://www.fas.org/programs/bio/chemweapons/cwagents.html>

<http://www.nti.org/country-profiles/libya/>

<http://www.opcw.org/news/article/captured-chemical-weapons-in-libya-were-declared-to-the-opcw-by-former-government/>

For Life Sciences, see:

- K.A. Alexander, C.E. Sanderson, M. Marathe, B.L. Lewis, C.M. Rivers, J. Shaman, J.M. Drake, E. Lofgren, V.M. Dato, M.C. Eisenberg, and S. Eubank (2015) What Factors Might Have Led to the Emergence of Ebola in West Africa? PLOS Neglected Tropical Diseases (<http://blogs.plos.org/speakingofmedicine/2014/11/11/factors-might-led-emergence-ebola-west-africa/>)
- What is MERS – What you need to know. (<http://www.medicalnewstoday.com/articles/262538.php>)
- Latest Avian/Bird Flu News (<http://www.thepoultrysite.com/bird-flu/bird-flu-news.php?country=us>)
- USDA Questions and Answers: Avian Influenza Outbreaks in the United States April 2015 (<http://www.usda.gov/documents/avian-influenza-united-states-qa.pdf>)
- Avian Influenza Disease, USDA Animal and Plant Health Inspection Service (http://www.aphis.usda.gov/wps/portal/aphis/ourfocus/animalhealth/sa_animal_disease_information/sa_avian_health/ct_avian_influenza_disease!/ut/p/a1/1VFNc4IwEP0tHnrMJAbk4-hHK1jRtkyrcGHWAJIpBAaiHfvrDWo79iBtc9vd97L73sMhXuNQwJ5vQfJSQN7WoRHNlg7tjwh1p759T9zF24NnzU1t6egKECgAufGG5Cd_egaLf-FjJxJn_gaXuEQh0zISmY4gCrjTeRKIRMho5xvaqgPd6SBqNzVUVqyXXOqQPAC8ihLIJfZdSfmTQJNEnGRInVxEnEe7zmIbzyTl4aC5btEfMIXsT2mYjzGwYbaKTFogjSrD0hnGw3BAaAIDuI0jhkzNc28iO9Q94t5J_EKMP4OHd2cK8N0ixJ3ouim7RHIGhdAh7-BusG8ucTWsf9PUbM_RE5rb-xt1bcgM9SajdedIZzHVyHgdUcIq5E6wX-O8w9cFa-FpR3Qe7pYoDB4coe93hE4pfgb/?1dmy&urile=wcm%3apath%3a%2Faphis_content_library%2Fsa_our_focus%2Fsa_animal_health%2Fsa_animal_disease_information%2Fsa_avian_health%2Fct_ai_pacific_flyway)
- José E. Hagan, Steven G.F. Wassilak, Allen S. Craig, Rudolf H. Tangermann, Ousmane M. Diop, Cara C. Burns, Arshad Quddus (2015) Progress Toward Polio Eradication — Worldwide, 2014–2015 Morbidity and Mortality Weekly Report (MMWR) 64(19); 527-531. (<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6419a5.htm>)
- Outbreak of Whooping Cough Continues in North America (<https://www.passporthealthusa.com/2014/09/outbreak-of-whooping-cough-continues-in-north-america/>)
- 1918 Flu Pandemic (<http://www.history.com/topics/1918-flu-pandemic>)
- Amerithrax Investigative Summary – U.S. Dept. of Justice (<http://www.justice.gov/archive/amerithrax/docs/amx-investigative-summary.pdf>)
- A Guide to the Amerithrax Documents: I. Amount of Attack Materials and Requirements for Production (<http://fas.org:8080/irp/eprint/furmanski.pdf>)
- For a review of the Former Soviet Union’s bioweapons program: Leitenberg, M. and R.A. Zilinskas (2012) The Soviet Biological Weapons Program: A History (Note: It’s a long read but very good for information on this topic – If this is a primary focus of your degree, you should purchase and read this book)

Useful text for all modules:

U.S. Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction* (1993); download from: http://www.princeton.edu/~ota/ns20/alpha_f.html.

Additional readings for each module will be posted as the class progresses.

METHODOLOGY AND POLICIES

The course is divided into three modules (chemistry, physics, and biology), each taught by a different instructor. The format will be lecture/discussion. Students are expected to prepare for class participation by reading the suggested material and watching the assigned videos and lectures. Students will also plan and execute an out-of-class exercises relating to a simulated chemical weapons attack in the Chemistry Module, and there will be similar exercises or assignments in the other modules. Please note that we have 3 different instructors teaching the course. Mr. Bishop will provide supporting material for his part of the course on his website (http://institutebishop.org/science_technology.htm). Dr. Dalnoki-Veress will use the Canvas platform which will be available 1 week before his lectures start, and Dr. Jackson will likely email the lectures to the students as a group. Much communication will be by email so make sure you check your email often. If you have a reason why you can't attend a quiz or exam, you must let us know well ahead of time by notifying Dr. Dalnoki-Veress and the relevant instructor by email with a relevant heading. If you have missed the exam due to medical or personal reasons, please let Dr. Dalnoki-Veress know by email so that he will be able to organize an alternate time for the exam, but you must provide proof of the reason for the absence.

ACADEMIC CONDUCT

All students will be held to all policies and procedures listed in the most current Policies and Standards Manual (PSM). This includes but is not limited to our Student Honor Code and regulations on plagiarism. A complete copy of the Policies and Standards Manual (PSM) can be found here: (<http://www.miis.edu/offices/records/policies>).

REQUIREMENTS AND GRADING

There will be quizzes and written assignments throughout the course. The final exam will be focused on concepts and in the form of short written answers to questions to ascertain understanding. Very simple numerical calculations may be on the quizzes or the final exam for the physics section. Students will get several surprise quizzes in the physics module which may or may not count towards your grade.

Grading will be based on the following scheme:

| | |
|--------------------------------------|-----|
| Class work (including short quizzes) | 30% |
| Quizzes | 30% |
| Final Exam | 40% |

Grades will be awarded with plus and minus designations when the student's numerical score is in the very top or bottom end of the grade ranges described above. As noted in the APSM, quality points are assigned as follows:

| LETTER GRADE | GRADE POINTS / SEMESTER UNIT |
|--------------|------------------------------|
| A+ | 4.00 |
| A | 4.00 |
| A- | 3.67 |
| B+ | 3.33 |
| B | 3.00 |
| B- * | 2.67 |
| C+ * | 2.33 |

* Please note that grades below "B" will not count towards seminar credit

Except for grades of "I" and "IP" (see Sections 4.3 and 4.5 in the [Academic Policies & Standards Manual](#)), all grades are considered final when reported by a Faculty Member at the end of a semester or marking period. A change of grade may be requested **only** when a calculation or recording error is discovered in the original assignment of a course grade or when a decision is made by the faculty member to change the grade as a result of the disputed academic evaluation procedure (set forth in Section 4.1.1 of the [Academic Policies & Standards Manual](#)). Grade changes necessitated by a calculation or recording error must be reported within a period of six months from the time the grade is awarded. **No grade may be changed as the result of a re-evaluation of a student's work or the submission of supplemental work** following the close of a semester or marking period.

POLICY ON MISSED EXAM/QUIZ

If a student misses an in-class exam or quiz, the opportunity to make up the exam or quiz at a later date is at the discretion of the instructors. If you know in advance of a valid reason why you can't attend a quiz or exam, you must let us know as far ahead as possible by notifying Dr. Dalnoki-Veress and the relevant instructor by email with a relevant heading. If you miss an exam or quiz due to emergency last-minute medical or personal reasons, please let Dr. Dalnoki-Veress know by email as soon as it is realistically possible with a relevant subject heading. In order to take a make-up exam or quiz for full credit, you must provide proof of the reason for the absence. If a student misses an exam or quiz and cannot provide documentation of a valid reason for being absent, there will be a grade markdown on any permitted makeup exam or quiz.

INTRO MODULE

Aug 26 - ½ Intro Lecture

- Focus of the course
- How the course is structured
- What is science? Why is it important for NPTS students?

CHEMISTRY MODULE

In order to get to the description of chemical weapons and explosives as soon as possible, I'm hoping that I can avoid lecturing on some fundamental topics and assume that to you can learn as much as you need to know from reading some sections in my text. These are not topics that I test on specifically, but they do support some of the other more important topics. I'd be glad to discuss these topics in class if necessary, so before the first lecture of the chemistry module, read the following and be prepared to ask questions if you have them.

http://preparatorychemistry.com/Bishop_Book_atoms_1.pdf (Sections 1.3-1.5)

http://preparatorychemistry.com/Appendix_B_atoms.pdf

http://preparatorychemistry.com/Bishop_Book_atoms_3.pdf (Section 3.1)

http://preparatorychemistry.com/KMT_flash.htm

Aug 26 - ½ Chemistry Lecture 1

Introduction to the class

“Why do you want to know some chemistry?”

How some knowledge of chemistry will help you to analyze news stories that relate to chemical weapons, understand technical documents, and make policy decisions.

A very quick description of the fundamental chemistry topics that you should know but that you'll need to learn from my text or some other source.

Measurement and Units - Section 1.4 **An Introduction to Chemistry - Atoms First** (pages 9-19 of Chapter 1)

Scientific notation - Appendix B **An Introduction to Chemistry - Atoms First** (pages A-4 and A-5)

Solids, liquids and gases - Section 3.1 **An Introduction to Chemistry - Atoms First** (pages 76-79 of Chapter 3)

Chemical Elements - Section 3.1 **An Introduction to Chemistry - Atoms First** (pages 80-83 of Chapter 3)

Periodic table - Section 3.3 **An Introduction to Chemistry - Atoms First** (pages 84-87 of Chapter 3)

Elements and atoms **An Introduction to Chemistry - Atoms First** (pages 87-92 of Chapter 3)

http://preparatorychemistry.com/Bishop_Book_atoms_3.pdf

Aug 28 - Chemistry Lecture 2

Modern Atomic Theory (Just to get the basic ideas) **An Introduction to Chemistry - Atoms First** (pages 120-145 of Chapter 4)

http://preparatorychemistry.com/Bishop_Book_atoms_4.pdf

Chemical bonds **An Introduction to Chemistry - Atoms First** (pages 175-179 of Chapter 5)

Classifying Compounds **An Introduction to Chemistry - Atoms First** (page 180 of Chapter 5)

http://preparatorychemistry.com/Bishop_Book_atoms_5.pdf

Sept 2 – Labor Day Holiday

Sept 4 - Chemistry Lecture 3

Valence Bond Model for Covalent Bonding **An Introduction to Chemistry - Atoms First** (pages 188-195 of Chapter 5)

Drawing Lewis Structures, Simple Procedure **An Introduction to Chemistry - Atoms First** (pages 195-197)

http://preparatorychemistry.com/Bishop_Book_atoms_5.pdf

Chlorine as a Chemical Weapon in WWI - **War of Nerves** (pages 12-18)

Phosgene - **War of Nerves** (page 18)

Begin In-class exercise:

You will divide yourselves into groups of four.

Two people in each group will pretend to be terrorists or members of a country's government and plan a simulated chemical weapons attack...choosing the target, the chemical weapon, the means of delivery, the source of the chemical weapon, and the means of transporting the chemicals.

Two people in each group will act as the security team attempting to stop the attack.

The **CW-use planners** will provide subtle clues to the **security people**.

The **security pair** will tell the terrorists what they are looking for, and the **CW-use planners** will provide clues based on these searches.

Based on the clues they have received, the security team will develop a plan to stop the attack, and failing that, a plan to minimize the effects of the attack.

Near the end of the chemistry module, each group of four will make a 5-minute presentation describing their experience.

Sept 9 - Chemistry Lecture 4

Types of Chemical Weapons

Choking Agents, Chlorine and Phosgene

Blister Agents: Sulfur Mustard **War of Nerves** (page 18-20...see index for more information)

Ways to describe organic structures **An Introduction to Chemistry - Atoms First** (page 636)

Sept 11 - Chemistry Lecture 5

Blood Agents: Hydrogen Cyanide

Proteins and Enzymes **An Introduction to Chemistry - Atoms First** (pages 637-647)

Nerve Agents and Antidotes **War of Nerves** (see index for each nerve gas mentioned)

[Nerve agent animation](#)

[Nerve agent animation \(with audio\)](#)

Sept 16 - Chemistry Lecture 6

Incapacitants (Moscow Theater Hostage Crisis)

Toxins - Ricin and Saxitoxin

1925 Geneva Protocol **War of Nerves** (page 21-22...see index for more information)

Chemical Weapons Convention (CWC) and the Organization for the Prohibition of Chemical Weapons (OPCW)

<http://www.cwc.gov>

<https://www.opcw.org>

<https://www.opcw.org/about-opcw/>

<https://www.opcw.org/chemical-weapons-convention/>

<https://www.opcw.org/news-publications/publications/facts-and-figures/>

Sept 18 - Chemistry Lecture 7

Australia Group

OPCW fact-finding missions

OPCW identification of sarin use in Syria

Detection of chemical weapons

Sept 23 Chemistry Lecture 8

Class Presentations: Chemical weapons attack and response exercise

Sept 25 - Chemistry Lecture 9

Chemistry module quiz

PHYSICS MODULE

The Foundations/Missiles/Explosions: This section deals with the fundamentals of physics. It is the most mathematically intensive section of the course, but you must understand the basics before we get to missiles etc. It is less about understanding all the mathematical details but more about realizing how certain concepts in physics (observables such as speed and acceleration) fit in with the mathematics. This section is designed to make use of your intuition as much as possible.

Sept 30 - Physics Lecture 1

Must Watch: Web Video on Moodle before coming to class

-Constant Velocity and Acceleration

-Kinematics and Forces

- **Short quiz on web lecture**
- **Discussion on concept map of the course**
- In Class: Review of the web lecture
- See: <http://hyperphysics.phy-astr.gsu.edu/hbase/mot.html#motcon>

Oct 2 - Physics Lecture 2

Must Watch: Web Video on Moodle before coming to class

-Conservation of Energy

-Explosions

- **Short quiz on web lecture**
- In Class: Review of the web lecture as well as introduction to concept and forms of energy (KE+PE) & Satellites and weightlessness
- See: <https://www.khanacademy.org/science/physics/work-and-energy/work-and-energy-tutorial/v/conservation-of-energy>

Oct 7 - Physics Lecture 3

In Class: Why was the September 11 Plot so Successful? (application of kinematics and other physics)

In Class: How do explosives work?

- Review of web lectures
- Relevant references will be provided in the lecture.

Oct 9 - Physics Lecture 4

- **Short quiz on in-class lectures**
- In class: All about shaped charges, blast waves, power law plots
- Why is the radius of destruction of a blast wave not linear, that is, why is the radius of the same effect of a 10 kiloton bomb not $1/100^{\text{th}}$ of the radius of a 1 megaton bomb?

FRIDAY Oct 11 - Physics Lecture 5 AT 10AM WILL BE RECORDED

- **Must Watch: Web Video on Moodle before coming to class**
 - *All about missiles: How do they work? The Ideal Rocket Equation*
- **Short quiz on web lecture**
- Review of the web lecture
- In class: Application of rocket equation
- Must do homework: Carefully review the NTI delivery systems tutorial. You are responsible for the missiles part of the tutorial.

NO CLASSES ON OCTOBER 14 AND 16: Will travel to Ukraine and visit Chernobyl Exclusion Zone

Nuclear radiation – impact and dosage: In this section we focus on a completely different topic which is very relevant for anyone interested in nuclear weapons or radiological dispersive devices, or the dual use nature of radiological and nuclear materials. This section is not mathematically intensive but does apply what we have learned in the previous sections.

The next series of online lectures will be about nuclear energy, nuclear weapons, radioactive materials etc. The videos are a little bit more user friendly because they were produced for an innovative project which CNS conducted called the Virtual Science Challenge. Again, I emphasize, the videos are like your text book, you must watch the videos and carefully take notes. You will be tested on them.

Oct 21 - Physics Lecture 6

Must Watch: Web Video on Moodle before coming to class

- *Introduction to atoms and how it relates to nuclear science*
- *Radioactive decay, half-life etc.*
- *Radiation, dose, linear no-threshold model*

- **Short quiz on web lecture**
- Review of the web lecture
- Must do homework: review the NTI tutorial “Nuclear 101” at: <http://tutorials.nti.org/nuclear-101/overview/> Note that not all is relevant now but will be covered later in the course.

Besides the videos on radioactivity in the previous class you are expected to have viewed and taken notes on the following nuclear weapons videos. There are several that you must watch that cover a lot of the same material but it would be important for you to see both. The first is a lecture (divided into two parts) that I gave at the CTBTO Advanced Science course in 2012. Especially, study the section on multi-stage weapons. You are responsible for knowing the difference between a primary and a secondary and the type of energy production (fission or fusion) occurs in these and other relevant details.

Must Watch: Web Video on Moodle before coming to class

- *Introduction to Nuclear Weapons –Part 1 (CTBTO Advanced Science Course)*
- *Introduction to Nuclear Weapons –Part 2 (CTBTO Advanced Science Course)*
- *Fission and Military Applications – Part 1 (Virtual Science Challenge)*
- *Fission and Military Applications – Part 2 (Virtual Science Challenge)*
- *Fission and Military Applications – Part 3 (Virtual Science Challenge)*

- **Short quiz on web lecture**
- Review of the web lecture

Oct 23 - Physics Lecture 7

Must Watch: Web Video on Moodle before coming to class

- *Peaceful Use of Nuclear Weapons – Part 1 (Virtual Science Challenge)*
- *Peaceful Use of Nuclear Weapons – Part 2 (Virtual Science Challenge)*
- *Fission and Military Applications – Part 3 (Virtual Science Challenge)*

- **Short quiz on web lecture**
- Review of the web lecture

In Class : Lecture

- Enrichment
- Radiological Dispersal Devices
- Review of web lectures

Oct 28 - Physics Lecture 8

In Class : Lecture

- Conversion of research reactors
- Detection of nuclear materials

Oct 30 - Physics Lecture 9

- **Loose Ends**

FRIDAY NOVEMBER 1 CLASS WILL BE RECORDED - ½ lecture 10 – Loose Ends

- **PHYSICS MODULE QUIZ**

LIFE SCIENCES MODULE

Nov 4 - Life Science Session 1: Some Basics of Biology and Genetics

- Microorganisms and non-living infectious entities
 - The spectrum of biological threats
 - Bacteria
 - Viruses
 - DNA viruses
 - RNA viruses
 - Polio Virus
 - Influenza Viruses
 - Prions
 - Biological toxins

Nov 6 – Life Science Session 2: Some bacteria form spores

- *Bacillus anthracis* spores – the secret to long-term survival
- *Bacillus anthracis* causes four different types of disease depending on its route of entry
 - Cutaneous anthrax
 - Gastrointestinal anthrax
 - Inhalation anthrax
 - Anthrax in drug users
- Some examples of recent illnesses and outbreaks caused by pathogenic bacteria
- Some human diseases caused by bacterial pathogens

Nov 11 – Life Science Session 3: Epidemiology

- The dawn of epidemiology – a little history
 - Puerperal Fever – The Doctor’s Plague
 - An early epidemiologic study – John Snow
 - Definitions in communicable disease control
 - Epidemiology: Epidemic Theory
 - Epidemics
 - The steps in an outbreak investigation
 - Preliminary assessment in outbreak investigation
 - Case definition and identification
 - Descriptive study
 - Analytical study of an outbreak
 - Verify hypothesis
 - Institute control measures
 - Communicate
 - Sources of Outbreak
- Tools to understand an outbreak
 - Epi Curves

Nov 13 – Life Science Session 4: Principles of Disease

- Understanding infectious diseases – a history
 - Concepts of Contagion and Epidemics
 - Explaining Disease Transmission Before the Germ Theory
- Smallpox inoculation in China – 1000
 - Vaccine history – variolation
 - Protection by Cowpox Infection – 1770
 - Smallpox Becomes a Weapon of War – 1776
 - Low Vaccination Rates Lead to Outbreak – 1893
- Louis Pasteur – 1822-1895
- Ferdinand Cohn
 - The germ theory of disease
- Robert Koch
 - Koch's postulates
- Intentional contamination of food/drugs
- Newly emerging, re-emerging and resurging diseases

Nov 18 – Life Science Session 5: Quiz to cover first 4 lectures, first hour

Genetics, Metabolism, Physiology & Nucleic Acid Chemistry

- The Central Dogma of Biology
- Metabolic pathways
- An organism's genome
 - DNA and RNA structure
 - Ribose and deoxyribose – the sugars in DNA & RNA 5' and 3' carbons
 - The DNA sugar-phosphate backbone
 - DNA primary structure – the DNA sequence
 - How DNA primary structure relates to protein sequences
 - A nucleotide, a building block of DNA/RNA
- An amino acid, a building block of protein
 - Amino acids are joined together by peptide bonds to produce long chains of amino acids called polypeptides
 - Some proteins are modified after they are transcribed - Human Insulin

Nov 20 – Life Science Session 6: Methods of Microbial forensics

- What is forensics?
- Why DNA as a target?
- DNA-based detection & forensic methods
 - Restriction Endonucleases
 - Restriction enzymes cutting sites
 - Cutting frequencies of restriction enzymes
 - Pulsed-field Gel Electrophoresis (PFGE)
 - Amplified Fragment Length Polymorphism (AFLP)
 - Variable Number Tandem Number Repeats (VNTR)
 - Multiple-locus Variable Number Tandem Repeats (MLVA)
 - The Polymerase Chain Reaction – PCR
 - Single nucleotide polymorphisms (SNPs)
 - Multi-locus Sequence Typing (MLST)
- Genomic technologies for pathogen detection
 - Microarrays
 - Next generation sequencing for pathogen discovery and forensics
- Limits on these methods for identification and forensics

Nov 23-Dec 1 – Thanksgiving Recess

Dec 2 – Life Science Session 7: Biowarfare, Bioterrorism and Biosecurity

- Biowarfare --- Bioterrorism --- Biosecurity, what's the difference
 - Biowarfare
 - Bioterrorism
 - Biosecurity Issues
- The BWC - The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction
 - What's permitted, what's not permitted and how this impacts dual use
 - Concerns about the BWC and its enforcement
 - Treaty Compliance Input
 - Do you think that "punji sticks" are forbidden by international treaty?
- War and disease
 - Infectious disease and wars
 - Disease – A major impact on wars
 - Influenza pandemic – 1918
 - The impact on the U.S. military
- Examples of Influence of Infectious Diseases on Military Campaigns
- Biowarfare is not new
 - Rinderpest
 - American Indians infected with small pox?
 - World War I German biological warfare program
 - Japanese germ warfare
 - Examples of diseases often mentioned in the context of biological warfare & terrorism
 - Sverdlovsk (Ekaterinburg), April 1979
 - Iraq's Anthrax Weapons: A Cause for War
 - Iraqi Biological Weapons program
- Contemporary acts of bioterrorism, biological warfare and suspicious events
 - Amerithrax letters
 - Key factors to remember

Dec 4 – Life Science Session 8: Biosecurity Examples

- Biosecurity issues playing out now
 - Highly pathogenic avian influenza in the United States
 - The Economic Impact of the 2015 Avian Influenza Outbreak in the U.S. Today
 - Highly pathogenic avian influenza – 2017
 - Bird flu in humans – China
 - Avian influenza cases in China – 2016
 - Avian influenza cases in China – 2017
 - Avian influenza in humans in the USA?
- What changes are necessary for H5N1 or H7N9 avian influenza to be contagious among humans?
 - Experiments to expand the host range of Avian Influenza
- The CRISPR technology
 - What is it?
 - Examples
 - Concerns

Dec 9 - Life Sciences Session 9: Biosecurity issues playing out today

- The World's Nine Deadliest Viruses Infecting Humans
- Middle East Respiratory Syndrome - MERS-CoV
 - MERS-CoV Epidemiology
 - MERS spread
 - MERS Vaccine Development
- Ebola virus disease outbreak in Western Africa
 - Ebola Signs & Symptoms
 - The WHO response
 - 2014-15 Ebola virus disease outbreak
 - Ebola situation – February 2016 West Africa
 - Latest update
 - Declaring the outbreak over
 - Potential Long-term problems
- The Zika Virus
 - History
 - The spread of Zika Virus
 - Zika Virus – serious issues
 - Evidence that Zika can lead to birth defects
 - Zika Virus Infection Among U.S. Pregnant Travelers
 - Screening blood for Zika Virus
 - Environmental Concerns
 - Zika virus – the first STD that is also transmitted by mosquitoes
 - The spread of Zika Virus
 - Zika update
 - DNA Vaccine Protects Monkeys Against Zika Virus Infection
- Legionnaires' disease – Legionellosis
 - Legionellosis - Late Summer – Fall 2016
 - Cases of Legionnaires' disease nearly quadrupled in the United States over a 15-year period

Dec 11 - Life Sciences Session 10: Social & Political Aspects of Major Disease Outbreaks

- Social and Political Issues
- Economic issues
 - Ebola update and summary – November 3, 2016
 - Zika virus and microcephaly
 - New legionellosis cases occurring in new environments

One or more review lectures will be provided to cover the Life Sciences material. Reviews will be scheduled outside of regularly scheduled class lectures and will be based on when the majority of students are available for the reviews.

Dec 13 - FINAL EXAM

COURSE SCHEDULE AT A GLANCE: FALL 2019

| Chemistry for NPTS Module | | Physics for NPTS Module | | Life Sciences for NPTS Module | |
|---------------------------|------------------------------|-------------------------|-----------------|-------------------------------|-------------------|
| Aug 26 | ½ lecture Intro ½ Chem L1 | Sept 30 | Physics L1 | Nov 4 | Life Sci. L1 |
| Aug 28 | Chem L2 | Oct 2 | Physics L2 | Nov 6 | Life Sci. L2 |
| Sept 2 | Labor Day Holiday | Oct 7 | Physics L3 | Nov 11 | Life Sci. L3 |
| Sept 4 | Chem L3 | Oct 9 | Physics L4 | Nov 13 | Life Sci. L4 |
| Sept 9 | Chem L4 | FRIDAY Oct 11 | Physics L5 | Nov 18 | ½ Life Sci. L5 |
| Sept 11 | Chem L5 | Oct 21 | Physics L6 | Nov 20 | Life Sci. L6 |
| Sept 16 | Chem L6 | Oct 22 | Physics L7 | Nov 23-Dec 1 | Thanksgiving |
| Sept 18 | Chem L7 | Oct 28 | Physics L8 | Dec 2 | Life Sci. L7 |
| Sept 23 | Chem L8 | Oct 30 | Physics L9 | Dec 4 | Life Sci. L8 |
| Sept 25 | Chem L9 + Quiz | FRIDAY Nov 1 | Physics L9/Quiz | Dec 9 | Life Sci. L9 |
| | | | | Dec 11 | Life Sci. L10 |
| | | | | Dec 13 | FINAL EXAM |