



Monterey Institute of International Studies

A Graduate School of Middlebury College

COURSE SYLLABUS – SPRING 2016

Science and Technology for Nonproliferation and Terrorism Studies

NPTG 8559/4 Credits

MW/10:00AM-11:50AM/ B-104 Morse

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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.

If you want a textbook to keep after the course is over, you can purchase one at

http://preparatorychemistry.com/Bishop_Payment_MIIS.htm

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 (on reserve in library)

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 (on reserve in library)

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>

The Chemistry of Explosives by Jacqueline Akhavan ISBN 978-1-84973-330-4 (on reserve in library)

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/history-of-the-chemical-weapons-convention/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/a-guidelines-for-schedules-of-chemicals/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-1/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-2/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-3/>

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

Others

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

http://www.idsa.in/cbwmagazine/Myanmar_pbaruah_0410

<http://www.globalsecurity.org/wmd/world/syria/cw.htm>

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

<http://www.cma.army.mil/>

<http://www.opcw.org/the-opcw-and-libya/libya-fact-and-figures/>

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/the-opcw-and-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_gaXuEQh0zISmY4gCrjTcRKIRMho5xvaqgPd6SBqNzVUVqyXXOqQPAC8ihLIJfZdSfmTOJNE nGRInVxEnEe7zmlbzyTl4aC5btEfMIXsT2mYjzGwYbaKTFogjSrD0hnGw3BAAaIDuI0jhkzNc28iO9Q94t5J_EKMp4OHd2cK8N0ixJ3ouim7RHiGhdAh7-BusG8ucTWsf9PUBM_RE5rb-xtlbcgM9SajdedlZzHVyHgdUcIq5E6wX-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_flyw ay\)](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6419a5.htm)

- 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. Students will also plan and execute an out-of-class exercise relating to a simulated terrorist attack in the Chemistry Module and there may be additional assignments in the other modules.

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/media/view/23925/original/policy_and_standards_manual_update.pdf).

ABSENCES

For your own benefit, you must come to all classes. If you are unable to come to a quiz or exam then contact your instructor well ahead of time and we will try to make other arrangements.

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. Students will get several surprise quizzes in the Physics Module.

Grading will be based on the following scheme:

Class work (including short quizzes)	30%
Quiz	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.

COURSE OUTLINE

INTRO MODULE

Feb 2: ½ Intro Lecture

- Focus of the course
- How the course is structured
- What is science? Why is it important for NPTS students? The scientific method. Practical science: observables, measurement, error

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

Feb 2: ½ Chemistry Lecture 1

“Why do you want to know some chemistry?”

Chemical weapons in WWI and attitudes toward chemical weapons

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

Textbook only?

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)

Feb 4: - Chemistry Lecture 2

Isotopes *An Introduction to Chemistry - Atoms First* (pages 92-94 of Chapter 3)

http://preparatorychemistry.com/Bishop_Book_atoms_3.pdf

Nuclide Symbols, nuclear stability, and radioactivity...brief...more to come in the physics module *An Introduction to Chemistry - Atoms First* (pages 692-698 of Chapter 16)

http://preparatorychemistry.com/Bishop_Book_atoms_16.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)

Ionic Compounds *An Introduction to Chemistry - Atoms First* (pages 181-185 of Chapter 5)

Polyatomic Ions *An Introduction to Chemistry - Atoms First* (pages 185-186 of Chapter 5)

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

http://preparatorychemistry.com/Bishop_Book_atoms_5.pdf

Textbook only?

Atomic mass and molar mass calculations (This material will come up in a minor way in the physics module. Let me know if you want me to lecture on it.) *An Introduction to Chemistry - Atoms First* (pages 100-105 of Chapter 3)

Modern Atomic Theory (Just to get the basic ideas...not memorize the details) *An Introduction to Chemistry - Atoms First* (pages 132-145 of Chapter 4)

http://preparatorychemistry.com/Bishop_Book_atoms_4.pdf

Feb 9- Chemistry Lecture 3

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

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

Production of Ammonia, Nitric Acid, and Chemical Explosives in WWI - *War of Nerves* (pages 11-12)

Ammonium Nitrate and the Oklahoma City Bombing

Molecular Geometry *An Introduction to Chemistry - Atoms First* (pages 209-215)

Phosgene - *War of Nerves* (page 18)

Textbook only?

More molar mass calculations (This material will come up in a minor way in the physics module. Let me know if you want me to lecture on it.) *An Introduction to Chemistry - Atoms First* (pages 262-266)

Begin In-class exercise:

You will divide yourselves into groups of four.

Two people in each group will pretend to be *terrorists* 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 *terrorists* will provide subtle clues to the *security people*.

The *security pair* will tell the *terrorists* what they are looking for, and the *terrorists* 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.

Feb 11 - Chemistry Lecture 4

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

Textbook only?

Types of Organic Compounds *An Introduction to Chemistry - Atoms First* (pages 637-647)

Types of Chemical Weapons

Choking Agents, Chlorine and Phosgene

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

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

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 animaiton \(with audio\)](#)

Incapacitants (Moscow Theater Hostage Crisis)

Feb 16 - Chemistry Lecture 5

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

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

<http://www.opcw.org>

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

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

<http://www.opcw.org/news-publications/publications/history-of-the-chemical-weapons-convention/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/a-guidelines-for-schedules-of-chemicals/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-1/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-2/>

<http://www.opcw.org/chemical-weapons-convention/annex-on-chemicals/b-schedules-of-chemicals/schedule-3/>

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

Destruction of Chemical Weapons (U.S., Russia, Libya, etc.)

Factors affecting the ability to make chemical weapons

Feb 18- Chemistry Lecture 6

Detection of chemical weapons production

Energy [An Introduction to Chemistry - Atoms First Chapter 4](#) (pages 120-131)

Chemical reactions and chemical equations [An Introduction to Chemistry - Atoms First Chapter 7](#) (pages 300-302)

Energy and chemical reactions [An Introduction to Chemistry - Atoms First Chapter 7](#) (pages 321-323)

Gases [An Introduction to Chemistry - Atoms First Chapter 11](#) (pages 460-467)

Feb 23 - Chemistry Lecture 7

Oxidation-reduction reactions [An Introduction to Chemistry - Atoms First Chapter 9](#) (pages 372-375)

Chemical explosives

Chemistry module review

[Glossary of Terms](#)

[Chemistry Module Exam Possibilities](#)

[Sample Exam](#)

[Sample Exam Key](#)

Feb 25 - Chemistry Lecture 8

Class Presentations: Chemical weapons attack and response exercise

March 1 - Chemistry Lecture 9

Chemistry module quiz

LIFE SCIENCES MODULE

March 3: Life Sciences Session 1: Introduction

- Biowarfare, Bioterrorism, Biosecurity – What's the difference?
 - Biowarfare
 - Bioterrorism
 - Biosecurity Issues
 - Biosecurity issues playing out today
 - Avian influenza
 - Bird flu as a pandemic threat to humans
 - Middle East Respiratory Syndrome - MERS-CoV
 - Ebola virus outbreak in western Africa
 - Ebola signs and symptoms
 - Progression of the epidemic
 - Current conditions
 - Tracking the outbreak
 - Latest news
 - Ebola Hemorrhagic Fever – its sources
 - Social impacts of the disease

March 8: Life Sciences Session 2: Ebola - Social Issues, Food Safety, the BWC

- Social and political issues of the Ebola outbreak

- Food safety in the recent news
- The Biological Weapons Convention
 - BWC summary
 - BWC signatories
 - What's permitted, what's not permitted and how this impacts dual use
 - Areas of uncertainty
 - Concerns about the BWC and its enforcement
 - Treaty Compliance Input
 - Are “pungi sticks” biological weapons?
- Human zoonotic diseases
 - What kind of animals transmit zoonoses?
 - Domestic animals
 - Wild animals
 - How are zoonotic diseases spread?
 - Campylobacter
 - Salmonella
 - Lyme Disease
 - Encephalitis
 - Hantavirus pulmonary syndrome
 - Rabies
 - Plague – caused by *Yersinia pestis*
 - Plague today
 - Multi-drug resistance in *Y. pestis*
 - Plague in the U.S.

March 10: Life Sciences Session 3: War and Disease

- U.S. Casualties in Selected Wars and Conflicts
- Disease – A major impact on wars
- The Influenza pandemic – 1918
 - The impact on the U.S. military
 - Scientists recreate the 1918 flu virus
- Hospitalization for different causes - WWI, Korea, Vietnam, Desert Storm
- Examples of the influence of infectious diseases on military campaigns in Afghanistan
- The Spaniards unwittingly deployed powerful biological weapons, including smallpox in defeating South American civilizations
- Bioterrorism
 - Bioterrorism is not new
 - Rinderpest
 - History of Rinderpest
 - Rinderpest as a bio-weapon
 - Other examples of bioterrorism
 - Tartar siege of Kaffa
 - Native Americans infected with small pox?
- More recent examples of biological warfare
 - World War I – use of *Bacillus anthracis* (anthrax) and *Burkholderia mallei* (glanders) in biowarfare
 - The Japanese biological agent program in World War II
- Examples of diseases often mentioned in the context of biological warfare & terrorism
- The U.S. Biological Weapons program – 1949 – 1969
- Biological weapons programs in the former Soviet Union
 - The Sverdlovsk release
 - Analysis of evidence
 - Analysis of samples
 - The significance of releasing multiple strains of the same pathogen
 - The Soviet Bio-Weapons program was “huge”
 - Vozrozhdeniya (Voz) Island – the site of extensive biological weapons testing

- Contemporary acts of bioterrorism, biological warfare and suspicious events
 - Assassination of Georgi Markov
 - Rajneeshees contamination of salad bars
 - Other examples
 - Attempts by the Aum Shinrikyo to develop and use biological agents
- Iraq's Anthrax Weapons: A Cause for War
- The Amerithrax letters
 - Time Line - 2001 US Postal Anthrax Attacks
 - FBI: Bioforensics and the 2001 anthrax letters
 - Bruce Edward Ivins, 1946-2008
 - How were the spores in letters tied to the RMR-1029 flask?
 - Breaking news - Head of the FBI's anthrax investigation says the whole thing was a sham
 - Key factors to remember
- Recent examples of contemporary bioterrorism
- Extremists and the ricin threat

March 15: Life Sciences Session 4: Microorganisms and non-living infectious entities

- The spectrum of biological threats
- The tree of life
- Eukaryotic vs. Prokaryotic cell structure
- Plant vs. animal cell structure
- Bacteria
 - Present in most environments
 - Gram staining
 - Pathogenic bacteria fall into Gram-positive and Gram-negative classes
- Viruses
 - Classification – groups and families
 - DNA viruses
 - RNA viruses
 - How are they spread?
- Prions
- Biological toxins
 - Botulinum toxin
 - Ricin
 - Other biological toxins
 - The impact of advances in synthetic biology on the ability to produce large amounts of biological toxins

Many human diseases are caused by bacteria or viruses – many others by our immune system's reaction to these

- Some bacteria can 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
 - There are four kinds of anthrax
 - Cutaneous
 - Gastrointestinal
 - Inhalation
 - Injected (into veins)
 - Some examples of recent illnesses and outbreaks caused by pathogenic bacteria

March 17: Life Sciences Session 5: Quiz to cover first 4 lectures – 1st hour

Lecture: Viruses

- Bacteriophage – viruses that infect bacteria
- A “Generic” Virus
- DNA viruses
 - Polio virus
- RNA viruses

- Negative strand vs. Positive strand RNA viruses
- Plant viruses
- HIV
- SARS
- Hepatitis C
- West Nile Virus
- Measles
- Influenza
 - Why is Influenza so potentially dangerous?
 - DNA polymerase vs. RNA polymerase
 - Influenza genome structure - reassortment
 - Emergence of a new influenza virus – 2009
 - 2013-2014 Flu cases
 - Avian Influenza – its extensive spread
 - Emergence of new influenza viruses
 - Human infection with avian influenza
 - Avian influenza – USA, 2015
 - Migratory bird flyways
 - The flu vaccine
 - Modification every year
 - Information needed to develop an effective flu vaccine
 - The question: What changes are necessary for H5N1 avian influenza to be contagious among humans?
 - Experiments to intentionally expand the host range of avian influenza
 - The science
 - The policy
 - The National Science Advisory Board for Biosecurity

March 29: Life Sciences Session 6: Principles of Disease

- Understanding infectious diseases – a history
- Concepts of Contagion and Epidemics
 - Explaining Disease Transmission Before the Germ Theory
 - Knowledge helps protect
 - People understood that diseases were contagious before they understood what caused them
- Vaccination
 - Smallpox inoculation in China - 1000
 - Royal Support of Inoculation - 1661
 - Early medical pamphlet on smallpox - 1678
 - 17th Century smallpox treatment
 - African Use of Variolation
 - Vaccine history - variolation
 - Protection by Cowpox Infection - 1770
 - Low Vaccination Rates Lead to Outbreak - 1893
 - Variola virus – the agent responsible for smallpox - discovered 1906
- Determining the cause of diseases
 - Puerperal Fever – The Doctor’s Plague
 - An early epidemiologic study – John Snow

March 31: Life Sciences Session 7: Identifying the underlying causes of infectious diseases

- The germ theory of disease
 - A theory that proposes that microorganisms are the cause of many diseases
- Anton van Leeuwenhoek – 1632-1723
 - Considered the father of microbiology
 - Developed primitive microscopes and magnifying lenses

- Was the first to observe bacteria and protozoa.
- His research refuted the doctrine of spontaneous generation
- His observations helped lay the foundations for the sciences of bacteriology and protozoology
- Louis Pasteur – 1822-1895
 - The germ theory of disease
 - Pasteur's swan-neck flask experiments
 - Pasteurization
- Ferdinand Cohn – 1828-1898
 - Classification of bacteria based into four categories based on shape
- Robert Koch – 1843-1910
 - Famous for isolating *Bacillus anthracis* (1877), the *Tuberculosis bacillus* (1882) and *Vibrio cholerae* (1883) and for his development of Koch's postulates.
 - Awarded the Nobel Prize in Physiology or Medicine for his tuberculosis findings in 1905.
 - Koch's pupils found the organisms responsible for diphtheria, typhoid, pneumonia, *gonorrhoea*, cerebrospinal meningitis, leprosy, bubonic plague, tetanus, and syphilis, among others, by using his methods.
 - Koch's postulates
 - The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms
 - The microorganism must be isolated from a diseased organism and grown in pure culture
 - The cultured microorganism should cause disease when introduced into a healthy organism
 - The microorganism must be re-isolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent
 - Koch's postulates for the 21st Century

April 5: Life Sciences Session 8: Contaminated food and foodborne illnesses; contaminated and counterfeit drugs

- Intentionally contaminated food
 - Examples
 - Real and potential targets
- Unintentionally contaminated food
 - Examples
 - Tracking foodborne illness
- Contaminated and counterfeit drugs
- Newly emerging, re-emerging and resurging diseases
 - Sources
 - Resulting from human activities and social/political policies

April 7: Life Sciences Session 9: Finish up & review

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.

We have developed NTI tutorials with you in mind. Everything in the following tutorial should be seen as part of the course materials: <http://tutorials.nti.org/delivery-system/introduction/>

April 12 - Physics Lecture 1

Must Watch: Web Video on Moodle before coming to class (Web Lecture 2 - Part 1 - Constant Velocity and Acceleration + Part 2 – Kinematics and forces)

- Will not have a short quiz on web lecture
- Review of the web lecture

Objectives:

*Syllabi are subject to change by the instructor with advance notice to students

- Understand motion where there is constant velocity and constant acceleration
- Know what is acceleration and velocity
- How are the graphs of motion different for the two types of motion?
- Which type of motion does an object exhibit?
- What is the relationship between distance and time for constant acceleration

April 14- Physics Lecture 2

Must Watch: Web Video on Moodle before coming to class (Part 2 – Kinematics and forces)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Connected acceleration to a force (Second Law)
- Force to a motion that is changing (First Law)
- Force of gravity acts only vertically on Earth and acceleration is the same (ie. g)
- Projectile velocity is divided up into 2 components (vertically is constant acceleration, horizontally is constant velocity)
- Forces occur in pairs (Newton's Third Law) and we know that a force is really change the rate change in momentum from Newton's Second
- Connecting the forces occurring in pairs before and after allows us to derive momentum conservation and the Rifle Equation which is fundamental to rockets!

April 19- Physics Lecture 3

Must Watch: Web Video on Moodle before coming to class (Web Lecture 3 - Concept of Energy +)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Understand what explosions are and effects. Concepts such as pressure, detonation, static and dynamic overpressure, shock waves, brisance, etc
- Shaped charges
- Blast waves and how yield, standoff distance and pressure are related.

April 21- Physics Lecture 4

Must Watch: Web Video on Moodle before coming to class (Web Lecture 4 - What is an Explosion- A Physics Perspective)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Continue relationship between standoff distance, effect and TNT yield
- Power laws and terrorist events
- Investigate why was the 9/11 plot so successful?

April 26- Physics Lecture 5

Must Watch: Web Video on Moodle before coming to class (Web Lecture 5 - Rockets and Missiles + Video of ICBM launch)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Phases of missile flight and types of trajectories, burnout speed and angle and range.
- Different missile classifications and $\frac{1}{2}$ rule
- What is telemetry?
- Must know about complications with reentry vehicles
- What is CEP?

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.

We have developed NTI tutorials with you in mind. Everything in the following tutorial should be seen as part of the course materials: <http://tutorials.nti.org/nuclear-101/overview/>

April 28- Physics Lecture 6

Must Watch: Web Video on Moodle before coming to class (Nuclear And Radiological Weapons Module: Part 1: Nature of Radiological Threat / Part 2: Detection of Radiological Materials / Part 3: Radiological Weapons / Part 4: Radiological Weapons)

- Review of the web lecture

Objectives:

- Introduction to atoms and how it relates to nuclear science
- Radioactive decay, half-life etc
- Radiation, dose, linear no-threshold model
- Fission weapons: gun-type

Will have a quiz for ½ of the lecture today covering everything up until Lecture 5 (includes missiles)

May 3 - Physics Lecture 7

Must Watch: Web Video on Moodle before coming to class (CTBTO Advanced Science Course Lecture on Nuclear Weapons Part 1 and Part 2 and Nuclear And Radiological Weapons Module: Part 5)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Implosion weapons
- Plutonium production
- Boosted and multi-stage weapons

May 5- Physics Lecture 8

Must Watch: Web Video on Moodle before coming to class (Peaceful Use of Nuclear Technology Parts 1 and 2)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Nuclear power and research reactors
- Enrichment technology
- Radiological Dispersal Devices (note this is covered in web lecture)

May 10- Physics Lecture 9

Must Watch: Web Video on Moodle before coming to class (Lecture from Virtual Science Challenge)

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

May 12 - Physics Lecture 10

Must Watch: There is no web lecture but there are suggested video's to watch

- May or may not have a short quiz on web lecture
- Review of the web lecture

Objectives:

- Conversion of research reactors
- Detection of nuclear materials

- Loose ends

May 17 2016: FINAL EXAM

COURSE SCHEDULE AT A GLANCE : FALL 2015

Chemistry for NPTS Module		Life Sciences for NPTS Module		Physics for NPTS Module	
Feb 2	½ lecture Intro ½ Chem L1	March 3	Life Sciences L1	April 12	Physics L1
Feb 4	Chem L2	March 8	Life Sciences L2	April 14	Physics L2
Feb 9	Chem L3	March 10	Life Sciences L3	April 19	Physics L3
Feb 11	Chem L4	March 15	Life Sciences L4	April 21	Physics L4
Feb 16	Chem L5	March 17	Life Sciences L5	April 26	Physics L5
Feb 18	Chem L6	March 19-27 Spring Break		April 28	Physics L6 + Quiz
Feb 23	Chem L7	March 29	Life Sciences L6	May 3	Physics L7
Feb 25	Chem L8	March 31	Life Sciences L7	May 5	Physics L8
March 1	Chem L9 + Quiz	April 5	Life Sciences L8	May 10	Physics L9
		April 7	Life Sciences L9	May 12	Physics L10
				May 17	FINAL EXAM