

# UNIT 12- Option Medicines and Drugs

Content Area: **Science**  
 Course(s): **IB Chemistry, HL**  
 Time Period: **Fourth Marking Period**  
 Length: **5 Weeks**  
 Status: **Published**

## Unit Overview

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Medicines and drugs go through a variety of tests to determine their effectiveness and safety before they are made commercially available. Pharmaceutical products are classified for their use and abuse potential.

## STAGE 1- DESIRED RESULTS

### 2020 New Jersey Student Learning Standards- Science

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SCI.9-12.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
SCI.9-12.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
SCI.9-12.HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

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SCI.6-8.MS-PS4-1	Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
SCI.6-8.MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

## Science and Engineering Practices

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- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence

- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Information
- Using Mathematics and Computational Thinking

## **Cross Cutting Concepts**

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- Cause and Effect
- Energy and Matter
- Influence of Engineering, Technology, and Science on Society and the Natural World
- Interdependence of Science, Engineering, and Technology
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Functions
- Systems and System Models

## **Disciplinary Core Ideas**

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### **Physical Sciences**

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- PS1A: Structure and Properties of Matter
- PS1B: Chemical Reactions
- PS1C: Nuclear Processes
- PS2A: Forces and Motion
- PS2B: Types of Interaction
- PS3A: Definitions of Energy
- PS3B: Conservation of Energy and Energy Transfer
- PS3C: Relationship Between Energy and Forces
- PS3D: Energy in Chemical Processes and Everyday Life
- PS4A: Wave Properties
- PS4B: Electromagnetic Radiation
- PS4C: Information Technologies and Instrumentation

### **Life Sciences**

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- LS1A: Structure and Functions

- LS1B: Growth and Development of Organisms
- LS1C: Organization for Matter and Energy Flow in Organisms
- LS1D: Information Processing
- LS2A: Interdependent Relationships in Ecosystems
- LS2B: Cycles of Matter and Energy Transfer in Ecosystems
- LS2C: Ecosystems Dynamics, Functioning, and Resilience
- LS2D: Social Interactions and Group Behavior
- LS3A: Inheritance of Traits
- LS3B: Variation of traits
- LS4A: Evidence of Common Ancestry and Diversity
- LS4B: Natural Selection
- LS4C: Adaptation
- LS4D: Biodiversity and Humans

## **Earth and Space Sciences**

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- ESS1A: The Universe and its Stars
- ESS1B: Earth and the Solar System
- ESS1C: The History of Planet Earth
- ESS2A: Earth Materials and Systems
- ESS2B: Plate Tectonics and Large-Scale Systems
- ESS2C: The Role of Water in Earth's Surface Processes
- ESS2D: Weather and Climate
- ESS2E: Biogeology
- ESS3A: Natural Resources
- ESS3B: Natural Hazards
- ESS3C: Human Impacts on Earth Systems
- ESS3D: Global Climate Change

## **Engineering. Technology. and Applications of Science**

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- ETS1A: Defining and Delimiting an Engineering Problem
- ETS1B: Developing Possible Solutions
- ETS1C: Optimizing the Design Solution

## **Essential Questions**

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How do medicines and drugs affects the functioning of the body?

How can natural products be chemically altered to produce more potent or safer medicines, and analyze the disadvantages of the process?

How can excess stomach acid be alleviated by compounds that increase the stomach pH by neutralizing or reducing its secretion?

What is the effect of the synthesis, isolation, and administration of medications have on the environment?

## Enduring Understanding

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Medicines and drugs go through a variety of tests to determine their effectiveness and safety before they are made commercially available.

Pharmaceutical products are classified for their use and abuse potential.

## Students will know...

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- In animal studies, the therapeutic index is the lethal dose of a drug for 50% of the population ( $LD_{50}$ ) divided by the minimum effective dose for 50% of the population ( $ED_{50}$ ).
- In humans, the therapeutic index is the toxic dose of a drug for 50% of the population ( $TD_{50}$ ) divided by the minimum effective dose for 50% of the population ( $ED_{50}$ ).
- The therapeutic window is the range of dosages between the minimum amounts of the drug that produce the desired effect and a medically unacceptable adverse effect.
- Dosage, tolerance, addiction and side effects are considerations of drug administration.
- Bioavailability is the fraction of the administered dosage that reaches the target part of the human body.
- The main steps in the development of synthetic drugs include identifying the need and structure, synthesis, yield and extraction.
- Drug–receptor interactions are based on the structure of the drug and the site of activity.
- *Aspirin:*
  - Mild analgesics function by intercepting the pain stimulus at the source, often by interfering with the production of substances that cause pain, swelling or fever.
  - Aspirin is prepared from salicylic acid.
  - Aspirin can be used as an anticoagulant, in prevention of the recurrence of heart attacks and strokes and as a prophylactic.
- *Penicillin:*
  - Penicillins are antibiotics produced by fungi.
  - A beta-lactam ring is a part of the core structure of penicillins.
  - Some antibiotics work by preventing cross-linking of the bacterial cell walls.
  - Modifying the side-chain results in penicillins that are more resistant to the penicillinase enzyme
- The ability of a drug to cross the blood–brain barrier depends on its chemical structure and solubility in water and lipids.
- Opiates are natural narcotic analgesics that are derived from the opium poppy.
- Morphine and codeine are used as strong analgesics. Strong analgesics work by temporarily bonding to receptor sites in the brain, preventing the transmission of pain impulses without depressing the central nervous system.
- Medical use and addictive properties of opiate compounds are related to the presence of opioid receptors in the brain.
- Non-specific reactions, such as the use of antacids, are those that work to reduce the excess stomach acid.

- Active metabolites are the active forms of a drug after it has been processed by the body.
- Viruses lack a cell structure and so are more difficult to target with drugs than bacteria.
- Antiviral drugs may work by altering the cell's genetic material so that the virus cannot use it to multiply. Alternatively, they may prevent the viruses from multiplying by blocking enzyme activity within the host cell.
- High-level waste (HLW) is waste that gives off large amounts of ionizing radiation for a long time.
- Low-level waste (LLW) is waste that gives off small amounts of ionizing radiation for a short time.
- Antibiotic resistance occurs when micro-organisms become resistant to antibacterials.
- Alpha, beta, gamma, proton, neutron and positron emissions are all used for medical treatment.
- Magnetic resonance imaging (MRI) is an application of NMR technology.
- Radiotherapy can be internal and/or external.
- Targeted Alpha Therapy (TAT) and Boron Neutron Capture Therapy (BNCT) are two methods which are used in cancer treatment.
- Organic structures can be analysed and identified through the use of infrared spectroscopy, mass spectroscopy and proton NMR.
- The presence of alcohol in a sample of breath can be detected through the use of either a redox reaction or a fuel cell type of breathalyser.
- **Misconceptions:**
- If it's a prescription, it must be safe; you can't get addicted to something your doctor prescribes.
- "Natural" drugs are safer than synthetic ones.
- If you have a high alcohol tolerance, you don't have a drinking problem.

### Students will be able to...

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- Discuss experimental foundations for therapeutic index and therapeutic window through both animal and human studies.
- Discuss drug administration methods.
- Compare how functional groups, polarity and medicinal administration can affect bioavailability.
- Describe the use of salicylic acid and its derivatives as mild analgesics.
- Explain the synthesis of aspirin from salicylic acid, including yield, purity by recrystallization and characterization using IR and melting point.
- Discuss the synergistic effects of aspirin with alcohol.
- Discuss how the aspirin can be chemically modified into a salt to increase its aqueous solubility and how this facilitates its bioavailability.
- Discuss the effects of chemically modifying the side-chain of penicillins.
- Discuss the importance of patient compliance and the effects of the over-prescription of penicillin.
- Explain the importance of the beta-lactam ring on the action of penicillin.
- Explain the synthesis of codeine and diamorphine from morphine.
- Describe and explain the use of strong analgesics.
- Compare the structures of morphine, codeine and diamorphine (heroin).
- Discuss the advantages and disadvantages of using morphine and its derivatives as strong analgesics.
- Discuss the side effects and addiction to opiate compounds.
- Explain the increased potency of diamorphine compared to morphine based on their chemical structure and solubility.
- Explain how excess acidity in the stomach can be reduced by the use of different bases.
- Construct and balance equations for neutralization reactions and the stoichiometric application of these equations.
- Solve buffer problems using the Henderson-Hasselbalch equation.
- Explain how compounds such as ranitidine (Zantac) can be used to inhibit stomach acid production.
- Explain how compounds like omeprazole (Prilosec) and esomeprazole (Nexium) can be used to suppress acid secretion in the stomach

- Explain the different ways in which antiviral medications work.
- Describe how viruses differ from bacteria.
- Explain how oseltamivir (Tamiflu) and zanamivir (Relenza) work as a preventative agent against flu viruses.
- Compare the structures of oseltamivir and zanamivir.
- Discuss the difficulties associated with solving the AIDS problem.
- Interpret a variety of analytical spectra to determine an organic structure including infrared spectroscopy, mass spectroscopy and proton NMR.
- Describe the environmental impact of medical nuclear waste disposal.
- Discuss environmental issues related to left-over solvents.
- Explain the dangers of antibiotic waste, from improper drug disposal and animal waste, and the development of antibiotic resistance.
- Discuss the basics of green chemistry (sustainable chemistry) processes.
- Explain how green chemistry was used to develop the precursor for Tamiflu (oseltamivir).
- Describe the process of extraction and purification of an organic product. Consider the use of fractional distillation, Raoult's law, the properties on which extractions are based and explaining the relationship between organic structure and solubility.
- Describe the process of steroid detection in sport utilizing chromatography and mass spectroscopy.
- Explain how alcohol can be detected with the use of a breathalyser.
- Discuss common side effects from radiotherapy.
- Explain why technetium-99m is the most common radioisotope used in nuclear medicine based on its half-life, emission type and chemistry.
- Explain why lutetium-177 and yttrium-90 are common isotopes used for radiotherapy based on the type of radiation emitted. Balance nuclear equations involving alpha and beta particles.
- Calculate the percentage and amount of radioactive material decayed and remaining after a certain period of time using the nuclear half-life equation.
- Explain TAT and how it might be used to treat diseases that have spread throughout the body.

## STAGE 2- EVIDENCE OF LEARNING

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### Formative Assessment

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- 3- Minute Pause
- A-B-C Summaries
- Analogy Prompt
- Choral Response
- Debriefing
- Exit Card / Ticket
- Hand Signals
- Idea Spinner
- Index Card Summaries

- Inside-Outside Circle Discussion (Fishbowl)
- Journal Entry
- Misconception Check
- Observation
- One Minute Essay
- One Word Summary
- Portfolio Check
- Questions & Answers
- Quiz
- Self-Assessment
- Student Conference
- Think-Pair-Share
- Web or Concept Map

## **Authentic Assessments**

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Synthesis of Aspirin Lab

## **Benchmark Assessments**

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IB Option D Test

## **STAGE 3- LEARNING PLAN**

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## **Instructional Map**

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Students will work in groups to prepare a presentation to include all important concepts, and test questions on each section of topic.

Students will present and quiz each other after each presentation.

## **Modification/Differentiation of Instruction**

### Differentiation Strategies for Special Education Students

- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

### Differentiation Strategies for Gifted and Talented Students

- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials



- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

### Differentiated Strategies for ELL Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials, including visuals
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Allow students to work at their own pace
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Role play
- Provide graphic organizers, highlighted materials
- Strategy and flexible groups based on formative assessment

### Differentiation Strategies for At Risk Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials

- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment

## 504 Plans

Students can qualify for 504 plans if they have physical or mental impairments that affect or limit any of their abilities to:

- walk, breathe, eat, or sleep
- communicate, see, hear, or speak
- read, concentrate, think, or learn
- stand, bend, lift, or work

Examples of accommodations in 504 plans include:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- behavior management support
- adjusted class schedules or grading
- verbal testing
- excused lateness, absence, or missed classwork
- pre-approved nurse's office visits and accompaniment to visits
- occupational or physical therapy

## **Modification Strategies**

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- Cooperative Grouping
- Extended Time
- Frequent Breaks
- Highlighted Text
- Interactive Notebook
- Modified Test
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Re-direct
- Repeated Drill and Practice
- Shortened Assignment
- Teacher Notes
- Tutorials
- Use of Additional Reference Materials
- Use of Audio Resources

## **Differentiation Strategies**

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### **High Preparation**

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- Alternative Assessments
- Choice Boards
- Games and Tournaments
- Group Investigations
- Guided Reading
- Independent Research / Project
- Interest Groups
- Learning Contracts
- Leveled Rubrics
- Literature Circles
- Multiple Intelligence Options
- Multiple Texts
- Personal Agendas

- Project Based Learning (PBL)
- Stations / Centers
- Think-Tac-Toe
- Tiered Activities / Assignments
- Varying Graphic Organizers

## **Low Preparation**

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- Choice of Book / Activity
- Cubing Activities
- Exploration by Interest (using interest inventories)
- Flexible Grouping
- Goal Setting With Student
- Homework Options
- Jigsaw
- Mini Workshops to Re-teach or Extend Skills
- Open-ended Activities
- Think-Pair-Share by Readiness, Interest, or Learning Style
- Use of Collaboration
- Use of Reading Buddies
- Varied Journal Prompts
- Varied Product Choice
- Varied Supplemental Materials
- Work Alone / Together

## **Horizontal Intergration- Interdisciplinary Connections**

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See Appendix

## **Vertical Integration- Discipline Mapping**

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Eighth grade Chemical Interactions

Tenth grade Honors Chemistry

**Additional Materials**

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Pearson IB Chemistry, Catrin Brown&Mike Ford

[www.ibchem.com](http://www.ibchem.com)

Richard Tornley Video Lessons