

 **Rapid Learning Center**
Chemistry :: Biology :: Physics :: Math 

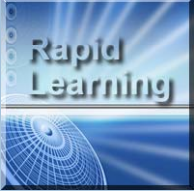
Rapid Learning Center Presents ...

Teach Yourself
Pharmacology in 24 Hours




1/63

Disclaimer: All contents in this tutorial are for informational purposes only and not intended to be a substitute for professional medical advice, diagnosis, or treatment. Reliance on any information provided by this tutorial is solely at your own risk. 

 **Introduction to Pharmacology**

Pharmacology Rapid Learning Series

Wayne Huang, Ph.D.
Tobi Limke, Ph.D.
Andrew Graham, Ph.D.
Dan Kiel, Ph.D.

Rapid Learning Center
www.RapidLearningCenter.com/
© Rapid Learning Inc. All rights reserved. 

2/63



Learning Objectives

By completing this tutorial, you will learn about:

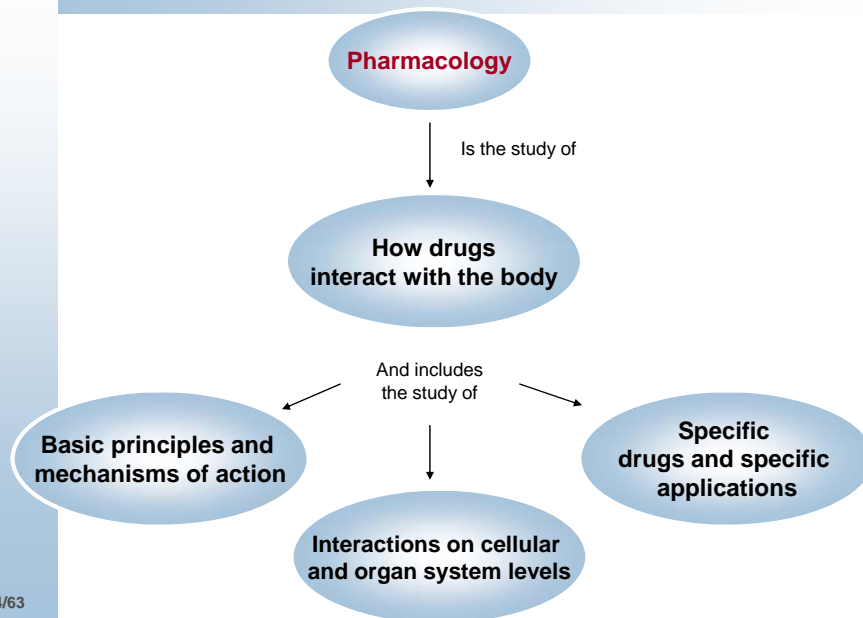


- History of pharmacology
- Introduction to pharmacology terminology
- Physical nature of drugs
- Types of drug interactions
- Dose-response

3/63




Pharmacology Concept Map

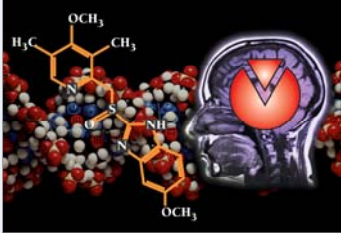


4/63






Overview of Pharmacology Course




5/63 





Overview of Pharmacology Course

In this **Pharmacology course**, various topics will be covered, such as pharmacokinetics and pharmacodynamics. Included with each tutorial is a summary cheat sheet, as shown here, and a problem sheet. The problem sheet includes questions based on the concepts in the tutorial. The following slides will preview the units covered in this course.

Pharmacology - Core Concept Cheat Sheet

02: Pharmacokinetics	
Key Terms	Subcutaneous Route of Administration
<ul style="list-style-type: none"> • Pharmacokinetics: Pharmacokinetics is the study of what occurs to externally administered substances or drugs to a living organism. • Pharmacokinetics is the study of the movement of drugs in the body. • Onset of Action: how fast the drug starts to work. • Duration of Action: how long the drug works. • Site of Action: the location in the body where the drug causes its effect. • Routes of Administration: how a drug is delivered to its site of action. • Systemic Routes of Administration: these routes require the drug to be carried to its site of action by the bloodstream. • Local Routes of Administration: the drug is administered directly to its site of action without utilizing the bloodstream. • Drug Absorption: the movement of drug molecules from the site of administration into the systemic circulation. • Hydrophilic water-soluble <ul style="list-style-type: none"> • Lipophilic: fat-soluble • Passive Diffusion: movement of a drug from an area of high concentration to an area of low concentration. • Drug Distribution: movement of free drug from circulation into tissues. • Blood Brain Barrier: a layer of tightly packed endothelial cells in the capillaries of the brain that limits the ability of most drugs to distribute into the brain. • Transporter Proteins: some drugs are transported into cells or out of cells via specialized transport proteins. Located in membranes of capillary endothelial cells, these proteins can transport drugs into and out of cells. Even though lipophilic drugs readily diffuse into cells, they get pumped out of the cell by transporters. • Excretion of Drugs: when drugs pass through the liver (hepatic) circulation, they are metabolized. This makes the drug more hydrophilic and increases their excretion from the body. Larger drugs and drugs with both polar and lipophilic groups are more likely to be excreted in bile through the gastrointestinal tract. This usually takes place when the drug conjugates with glucuronic acid. 	 <p style="font-size: small; text-align: center;">Subcutaneous Layer Muscle Layer A subcutaneous injection into the fatty layer of tissue under the skin.</p> <hr/> <p style="text-align: center; font-size: small;">Henderson-Hasselbalch Equation</p> $\text{pH} = \text{pK}_a + \log \frac{[\text{un-ionized species}]}{[\text{ionized species}]}$ <p style="font-size: x-small;">The Henderson-Hasselbalch equation can be used to calculate the percentage of ionized and un-ionized molecules. The pKa of a drug indicates whether it is a base or an acid. Weak acids have a pKa < 7. Weak bases have a pKa > 7.</p> <p style="font-size: x-small;">Drugs that are weak acids are more likely to be absorbed from the stomach since it is the un-ionized fraction of drug that is able to cross membranes and be absorbed. Conversely, drugs that are weak bases are more ionized in the intestine and they are more likely to be absorbed from the intestine.</p>



6/63 



Unit 1: Introduction to Pharmacology

In Unit 1, the fundamentals of pharmacology are introduced, including:

Pharmacokinetics – the study of what happens to drugs when administered to living organisms.

Pharmacodynamics - the study of how drugs affect the human body, including the relationship between the concentration of the drug and its effects.

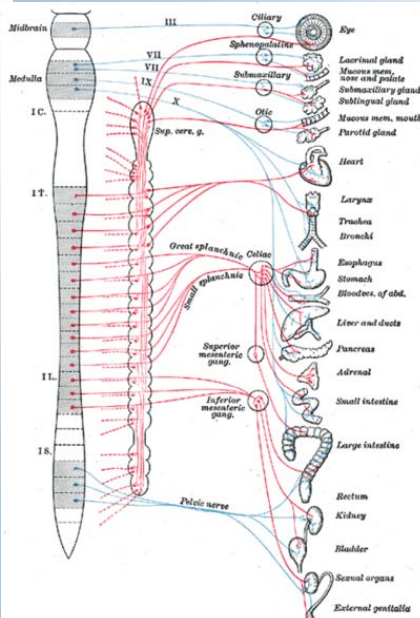
Biotransformation – how an organism modifies or metabolizes an externally administered drug or medication.



7/63



Unit 2: Autonomic Pharmacology



In Unit 2, **autonomic pharmacology** is reviewed, including drugs that impact the adrenergic and cholinergic systems. Specific drugs and their mechanisms of actions will be presented.

8/63





Unit 3 – Cardiovascular and Renal Pharmacology

Unit 3 covers **cardiovascular and renal pharmacology**. Drugs that are used to treat hypertension, arrhythmias and heart disease, along with their mechanisms of action, are included.

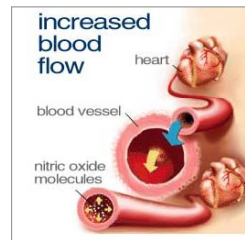
Nephron



9/63



Unit 4 – Smooth Muscle Pharmacology



Unit 4 describes the drugs that are used clinically to stimulate the contraction and relaxation of **smooth muscle**. These drugs are used in patients with asthma and cardiovascular diseases.

10/63





Question: Challenge

What are some of the topics covered in the rapid learning pharmacology course?

In the **Pharmacology course**, various topics will be covered, such as pharmacokinetics and pharmacodynamics. In Unit 1, the fundamentals of pharmacology are introduced, including: **Pharmacokinetics** – the study of what happens to drugs when administered to living organisms. In Unit 2, **autonomic pharmacology** is reviewed, including drugs that impact the adrenergic and cholinergic systems.



11/63



Unit 5 – Endocrine Pharmacology



Endocrine Pharmacology is included in Unit 5. Drug treatments for diabetes, thyroid disorders and osteoporosis are in this section.

12/63





Unit 6 – Central Nervous System Pharmacology

Drugs that are used to treat **depression and other conditions of the central nervous system**, as well as drugs that are used as anesthetics, are presented in Unit 6.

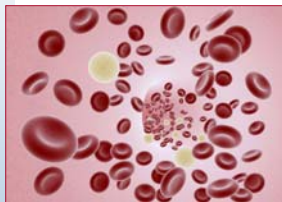


13/63



Unit 7 – Pharmacology of Pain, Inflammation, GI Tract, and Blood Disorders

In Unit 7, the **pharmacology of pain and inflammation** are included, along with drugs used to treat disorders of the blood and gastrointestinal tract.



14/63





Pharmacology in Ancient Egypt and China

The **study of pharmacology** dates many centuries back. There are written records that have been found in China and Egypt. Pharmacology at that time was based on natural products. Pharmacology today deals with both natural and synthetic products.

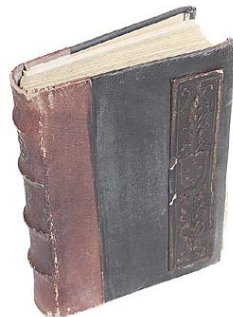


17/63



Materia Medica

Materia medica: the science of drug preparation and medical use of drugs; it began to develop around the 17th century. Modern day pharmacological studies were developed from *materia medica*.



18/63





Magendie and Bernard



Francois Magendie

Francois Magendie and Claude Bernard laid the foundations for animal physiology and pharmacology in the 18th and 19th centuries. They are considered the founding fathers of experimental physiology.

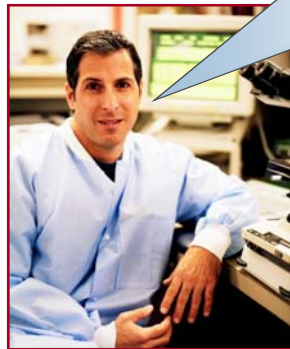
19/63



Modern History of Pharmacology

The initial studies were based on the activity of drug at the receptor sites.

Pharmacogenomics: the study of how an individual's genetic make-up affects his or her response to a drug.



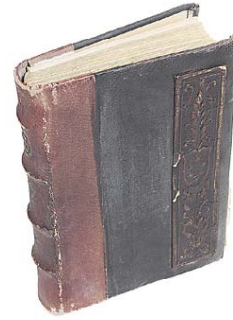
20/63





Summary: History of Pharmacology

In **summary**, the study of pharmacology dates many centuries back. Written records have been found in China and Egypt from long ago. Initially, pharmacology was based on natural products. Today, pharmacology today deals with both natural and synthetic products.



21/63



Question: Challenge

How did *materia medica* influence modern pharmacology?

The studies that contributed to modern pharmacology came from *materia medica*. Beginning in the 17th century, the science of drug preparation and the medical use of drugs was organized as *materia medica*.



22/63



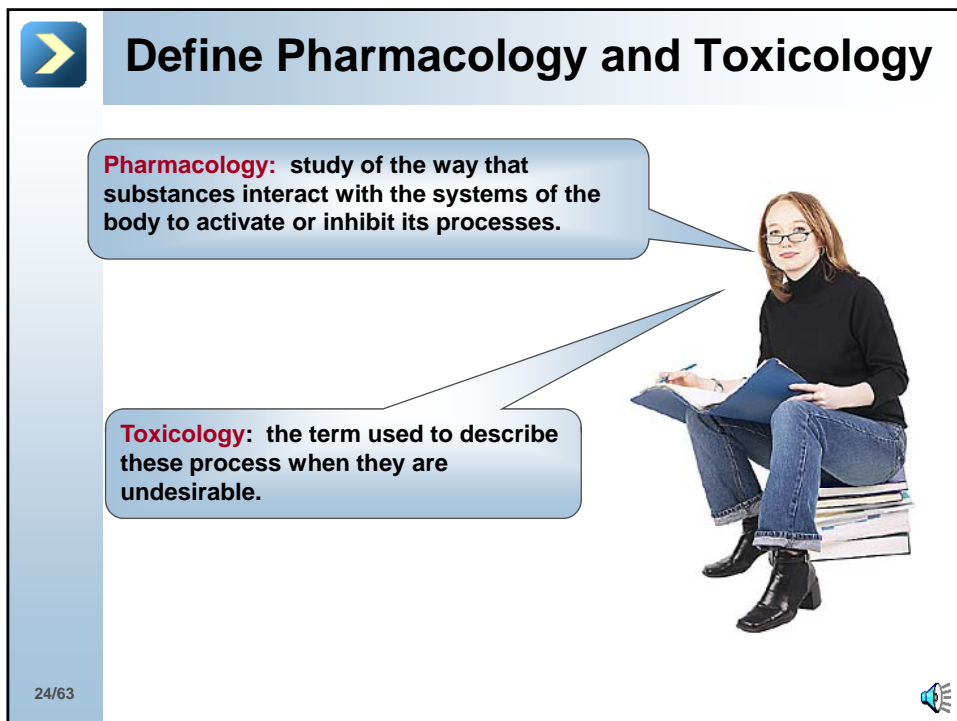


Introduction to Pharmacology Terminology

Pro Drug
drug is inactive before metabolism
METABOLISM (LIVER)
drug becomes active after metabolism

Active Drug
drug takes effect directly


23/63




Define Pharmacology and Toxicology

Pharmacology: study of the way that substances interact with the systems of the body to activate or inhibit its processes.

Toxicology: the term used to describe these process when they are undesirable.



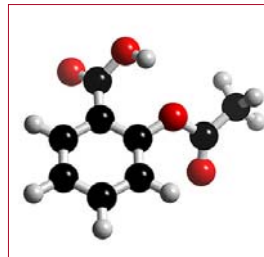
24/63





Drug and Pro-drug

A **drug** is defined as any substance that brings about a change in biological function through its chemical actions. A **pro-drug** is a substance that is administered in its inactive form but, once absorbed, is converted into an active drug molecule.



25/63



Xenobiotic, Poison and Toxin

A **xenobiotic** is a drug molecule that is a chemical not synthesized by the body. A **poison** is defined as a drug that causes harmful and undesirable effects. **Toxins** are poisons that are of biological origin.



26/63





Summary: Pharmacology Terminology

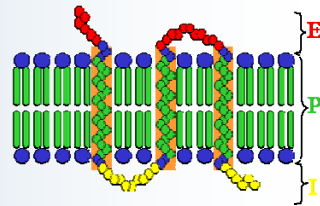
To **summarize**, pharmacology is the study of the way that substances interact with the systems of the body to activate or inhibit its processes. A drug is any substance that brings about a change in biological function through its chemical actions. A xenobiotic is a drug molecule that is a chemical not synthesized by the body.



27/63



Physical Nature of Drugs



28/63





Physical Nature of Drugs

The **physical nature of drugs** includes:

- Drug size
- Drug reactivity and drug-receptor bonds
- Drug shape
- Degree of ionization



29/63



Drug Size

The actual **molecular size of a drug** will affect the following:

- Binding to receptors
- Permeability through membranes
- Smaller drugs will diffuse more readily
- Drug size has to fit the receptor molecule well to have its maximal effect

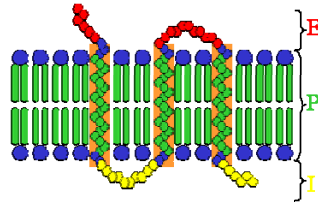


30/63





Drug Reactivity and Drug-Receptor Bonds



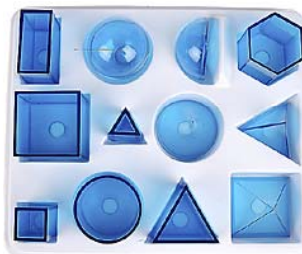
Drugs may bind with receptor molecules through covalent, electrostatic and hydrophobic bonds. The covalent bonds tend to be stronger and, hence, result in irreversible interactions. Hydrophobic bonds, on the other hand, are relatively weak.

31/63



Drug Shape

Drugs must fit into the receptor molecule, bind to it and then cause their effect. The **shape of the drug molecule** is an important factor in determining how well it will fit into the drug receptor.



32/63



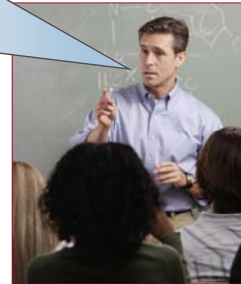


Question: Challenge

How does the size of a drug impact its effectiveness?

The actual **molecular size of a drug** will affect the following:

- (1) Binding to receptors
- (2) Permeability through membranes
- (3) Smaller drugs will diffuse more readily
- (4) Drug size has to fit the receptor molecule well to have its maximal effect



33/63



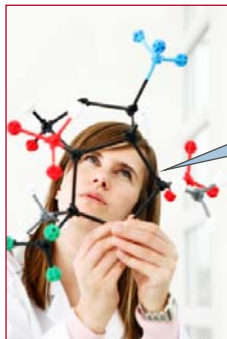
Ionization State of a Drug - 1

Drug molecules exist in ionized and unionized forms. Drugs are weak acids or weak bases. In physiological solution, they exist in ionized and unionized forms.

Ionized = charged

Un-ionized = uncharged

The degree of ionization will affect how well a drug is absorbed across the membrane.



34/63





Ionization State of a Drug - 2

Drugs are weak acids or weak bases. The **pKa of a drug** indicates whether it is a base or an acid.
 Weak acids have a pKa < 7
 Weak bases have a pKa > 7
 In physiological solution, they exist in ionized and un-ionized forms.
 The Henderson-Hasselbalch equation calculates the percentage of ionized and un-ionized drug at any pH.



35/63



Henderson-Hasselbalch Equation

The **Henderson-Hasselbalch equation** can be used to calculate the percentage of ionized & un-ionized molecules.

$$\text{pH} = \text{pKa} + \log \frac{[\text{un-ionized species}]}{[\text{ionized species}]}$$

A weak acid is more un-ionized in the stomach. Drugs that are weak acids are more likely to be absorbed from stomach. A weak base is more un-ionized in the intestine. Drugs that are weak bases are more likely to be absorbed from the intestine.

36/63





Summary: Physical Nature of Drugs

In summary, there are **four characteristics of drugs** that affect how they interact with the body. These are:

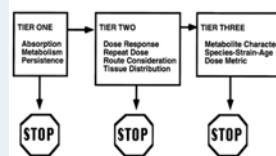
- Drug size
- Drug reactivity and drug-receptor bonds
- Drug shape
- Degree of ionization



37/63



Types of Drug Interactions



38/63





Types of Drug Interactions

Drug interactions can be divided into:

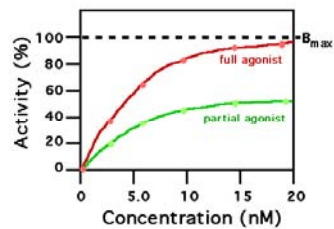
- (1) Pharmacodynamic: the actions of the drug on the body, which can either be an agonist or an antagonist
- (2) Pharmacokinetic: the actions of the body on the drug.



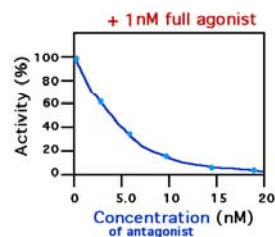
39/63



Types of Interactions



Agonists bind to a receptor and induce a biological response in the cell.



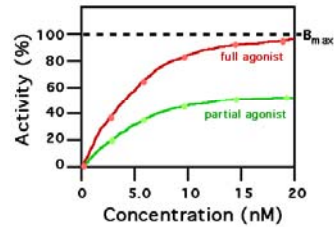
Antagonists block or dampen the biological actions at the receptor.

40/63





Agonists



Agonists initiate changes in cell function, producing effects of various types. Their potency depends upon their:

Affinity: the tendency to bind to receptors

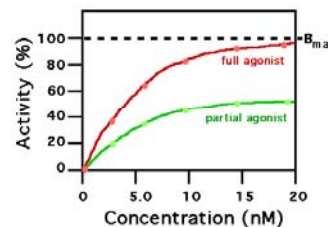
Efficacy: the ability to initiate changes once bound

41/63



Full and Partial Agonists

Full agonists produce maximal effects; they have high efficacy. A **partial agonist** produces a lower response at full receptor occupancy than full agonists, and they have intermediate efficacy.

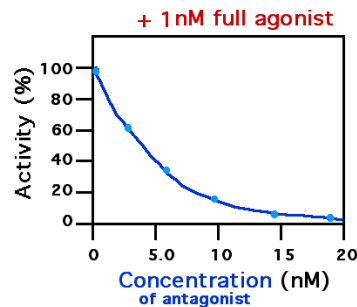


42/63





Antagonists



Antagonists prevent agonists from activating receptors. Reversible competitive antagonism is defined as progressively inhibiting the agonist response; at maximal concentrations, they completely prevent the response. Irreversible competitive antagonism depends on the number of unbound receptors remaining. Non-competitive antagonism blocks the chain of events that leads to the production of a response by the agonist.

43/63



Non-Receptor Antagonists

There are also **non-receptor antagonists**, such as:

- Chemical antagonism - interaction of two substances in solution so that the effect of the active drug is lost.
- Pharmacokinetic antagonism - one drug affecting the absorption, metabolism or excretion of another drug.
- Physiological antagonism - two agents producing opposing physiological effects.



44/63





Pharmacodynamics

Pharmacodynamic effect is defined as the duration of drug action. It depends upon how long the drug occupies the receptor and, in some cases, the drug is inactivated by metabolism, resulting in termination of action.



45/63



Question: Challenge

What are some examples of non-receptor antagonists?

Non-receptor antagonists, include:
Chemical antagonism - interaction of two substances in solution so that the effect of the active drug is lost. **Pharmacokinetic antagonism** - one drug affecting the absorption, metabolism or excretion of another drug. **Physiological antagonism** - two agents producing opposing physiological effects.



46/63





Principle of ADME

Absorption
Distribution
Metabolism
Excretion



ADME is an acronym used in pharmacokinetics to describe the fate of a drug administered to an organism. The principles of ADME influence the level and kinetics of drug exposure to the administered drug.

47/63



Summary: Types of Drug Interactions

In **summary**, drug interactions can be divided into:

- **Pharmacodynamic:** includes the actions of the drug on the body, such as agonist or antagonist
- **Pharmacokinetic:** the actions of the body on the drug




48/63



Dose-Response


49/63



What is Dose-Response?

Dose-response is defined as the relationship between exposure to a chemical and the magnitude of the response. The dose typically determines the response in a consistent, predictable way that can be measured.

50/63





The Dose-Response Relationship

The **basic premise underlying pharmacology** is that, for a given dose of a drug, there will be a given biological response that is directly proportional to the given dose.

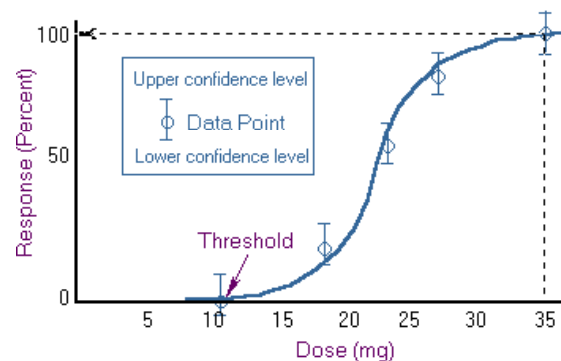
The effect of a drug will increase as the concentration increases. As the dose increases, the response increment reduces until a point where no additional increase in drug effect is seen with an increased concentration.



51/63



Shape of the Dose-Response Curve



The **dose-response curve** is typically a sigmoid curve with a wide enough range to cover both low doses at which there is no observable response; the threshold level, at which a response is first evident; and the plateau at the top of the curve, which indicates the dose at which the maximum effect of the chemical is evident.

52/63





Summary: Dose-Response

In **summary**, the basic premise underlying pharmacology is that, for a given dose of a drug, there will be a given biological response that is directly proportional to the given dose. The effect of a drug will increase as the concentration increases.



53/63



How to Study Pharmacology



54/63





Study Tips

Actively watch and listen to the tutorial, take notes and pause where necessary. Memorize basic information to save time later, and review basic biology where necessary. It is helpful to learn vocabulary quickly for understanding in-depth topics later in the series. In order to do this, make flash cards if necessary.



55/63



Additional Study Tips

Some **additional study tips** are: Look for patterns and connect information to topics learned in earlier tutorials. Each tutorial builds on earlier tutorials!



Ask for help when you need it! Don't be afraid to seek out help early. Tutors, teaching assistants, and knowledgeable friends can all help.

56/63





Mnemonics

Mnemonics are a great way to memorize lists. You can create them with the following simple 3-step process:

- (1) List key words in logical order.
- (2) Write down the first letter of each keyword.
- (3) Create an easy-to-remember word, phrase, or sentence from the first letters of these keywords.



Example:

symptoms of organophosphate poisoning = **DUDE SLOP**

(diarrhea, urination, decreased consciousness, emesis, salivation, lacrimation, ocular miosis, and paralysis)

57/63



Learning Drugs by Type

A useful way to study pharmacology is to **learn drugs by type**. For example, antibiotics can be categorized based on their effects on micro-organisms.



Antibiotics that target the bacterial cell wall include: cephalosporin and penicillin.

Antibiotics that target protein synthesis include: tetracycline and aminoglycoside.



58/63





Connect Drugs with Physiologic Targets

Based on an understanding of the **underlying physiology** of the process, how a drug treatment works will make more sense. By understanding, for example, the physiology in dilating and constricting blood vessels, potential drug targets such as smooth muscle or nitric oxide will be more obvious.



59/63



Question: Challenge

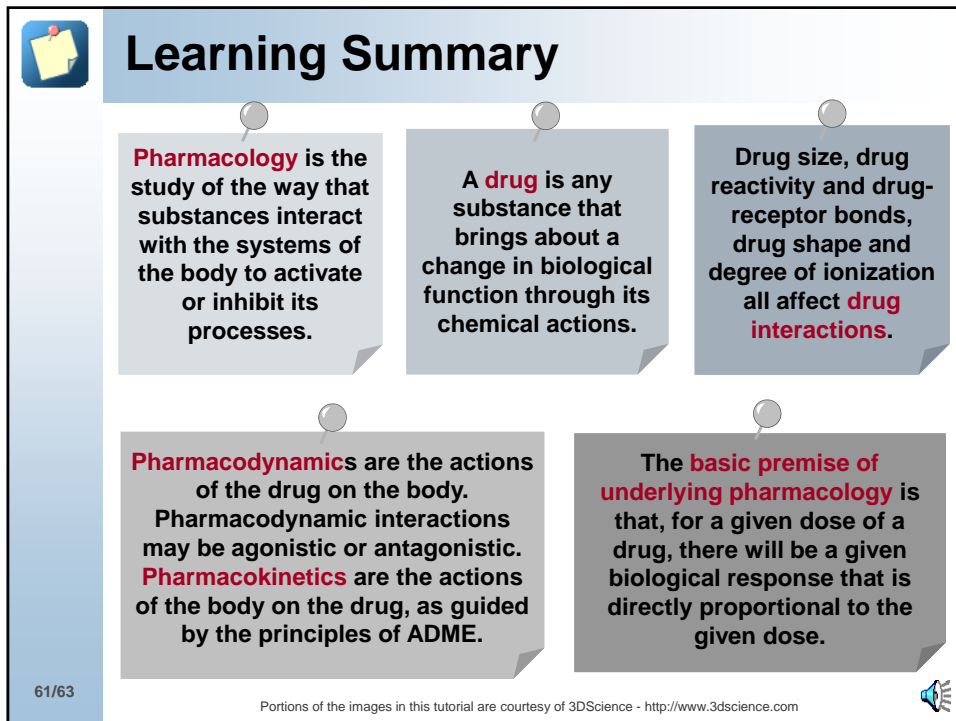
What are some of the study tips presented in this tutorial?

Some of the **study tips** in this tutorial include: Memorize basic information to save time later, and review basic biology where necessary. Ask for help when you need it! Don't be afraid to seek out help early. A useful way to study pharmacology is to learn drugs by type.



60/63





Learning Summary

Pharmacology is the study of the way that substances interact with the systems of the body to activate or inhibit its processes.

A **drug** is any substance that brings about a change in biological function through its chemical actions.

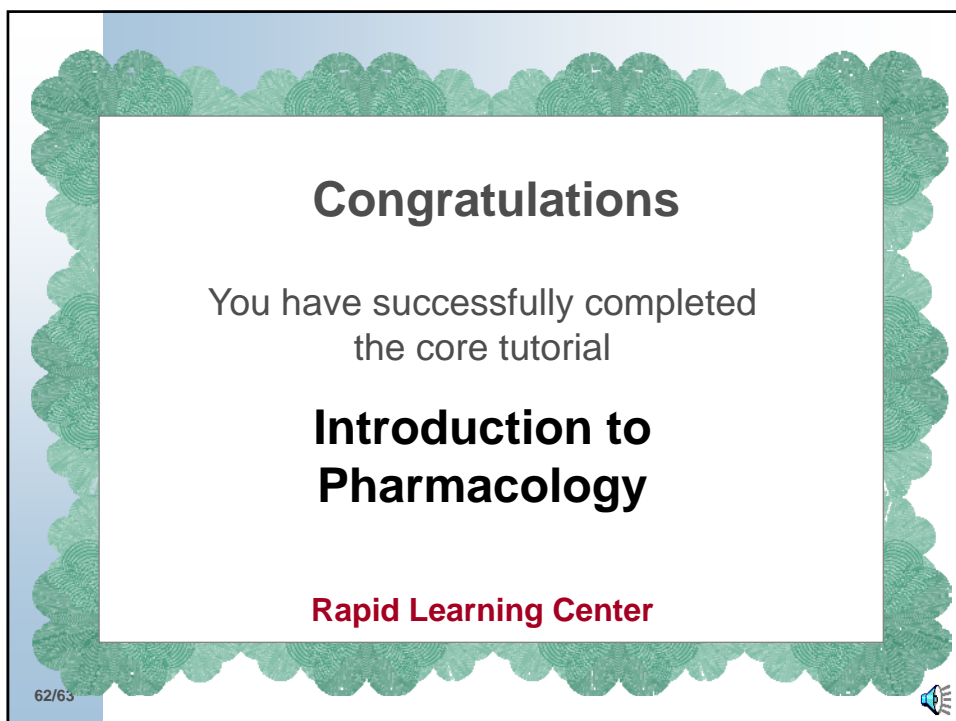
Drug size, drug reactivity and drug-receptor bonds, drug shape and degree of ionization all affect **drug interactions**.

Pharmacodynamics are the actions of the drug on the body. Pharmacodynamic interactions may be agonistic or antagonistic. **Pharmacokinetics** are the actions of the body on the drug, as guided by the principles of ADME.

The **basic premise of underlying pharmacology** is that, for a given dose of a drug, there will be a given biological response that is directly proportional to the given dose.

61/63

Portions of the images in this tutorial are courtesy of 3DScience - <http://www.3dscience.com>




Congratulations

You have successfully completed the core tutorial

Introduction to Pharmacology


Rapid Learning Center

62/63



Rapid Learning Center

Chemistry :: Biology :: Physics :: Math




What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)

→ Step 2: Practice – Interactive Problem Drill

Step 3: Recap – Super Review Cheat Sheet

Go for it!



63/63

<http://www.RapidLearningCenter.com>