Pharmacology is the study of drug effect on living systems.

How are drugs used to understand neural function and behavior?

C. Elegans

'Mind of the Worm' (White et al, 1986)
pharmacokinetics

drug effectiveness

effects of repeated administration

placebo effects

pharmacokinetics

absorbed
distributed
metabolized
excreted

“How will that stuff get from down there up to his sore throat?”
administration/absorption
how the drug enters the blood

- injections: iv, ip, im, sc, ic
- oral
- rectal
- inhaled
- topical
distribution

how the drug travels in the bloodstream

- molecular size
- ionization
- water/lipid solubility
- depot binding
metabolism
how the body chemically changes a drug

metabolism involves breaking a drug down or adding a chemical that makes it easier to eliminate

intestines and liver
elimination
this is how the body gets the drug out

kidneys

urine

liver

stool

drug effectiveness

effective dose: smallest dose required to produce a measurable effect
standard dose-response curve

- **maximum response**
- **slope**
- **baseline**

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Response
log[Dose]  EC50
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**Dose-response curve for the analgesic effect of morphine**

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Effect of drug
low  high
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**Dose-response curve for the depressive effect of morphine on respiration**

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low  Dose of drug  high
Margin of safety
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therapeutic ratio

\[
\text{Therapeutic ratio} = \frac{\text{LD}_{50}}{\text{ED}_{50}}
\]

lethal dose for 50% of the animals

effective dose for 50% of the animals
effect of repeated drug exposure

Initial dose-response curve

Dose-response curve after drug exposure

tolerance

relationship between tolerance and withdrawal

Drug effect

withdraw from drug
relationship between tolerance and withdrawal

Drug effect

withdrawal effect

psychopharmacology
the study of the effects of drugs on the nervous system and on behavior.

drug effect
the changes a drug produces in an animal’s physiological processes and behavior.

sites of action
the locations at which molecules of drugs interact with molecules located on or in cells of the body, thus affecting some biochemical processes of these cells.

pharmacokinetics
the process by which drugs are absorbed, distributed within the body, metabolized, and excreted.
intravenous (iv) injection
injection of a substance directly into a vein.

intraperitoneal (ip) injection
injection of a substance into the peritoneal cavity
the space that surrounds the stomach, intestines,
liver, and other abdominal organs.

intramuscular (im) injection
injection of a substance into a muscle.

subcutaneous (sc) injection
injection of a substance into the space beneath the skin.

oral administration
administration of a substance into the mouth, so that is
swallowed.

sublingual administration
administration of a substance by placing it beneath the tongue.

intrarectal administration
administration of a substance into the rectum.

inhalation
administration of a vaporous substance into the lungs.

topical administration
administration of a substance directly onto the skin or mucous membrane.
intracerebral administration
administration of a substance directly into the brain.

intracerebroventricular (icv) administration
administration of a substance into one of the cerebral ventricles.

depot binding
binding of a drug with various tissues of the body or with proteins in the blood.

albumin
a protein found in the blood; serves to transport free fatty acids and can bind with some lipid-soluble drugs.

dose-response curve
a graph of the magnitude of an effect of a drug as a function of the amount of drug administration.

therapeutic index
the ratio between the dose that produces the desired effect in 50 % of the animals and the dose that produces toxic effects in 50 % of the animals.
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ED$_{50}$
the dosage that produces a desired effect in half the test population - "effective dose, 50%".

LD$_{50}$
lethal (toxic) dose for 50% of the animals

EC$_{50}$
represents the concentration of a compound where 50% of its maximal effect is observed.

affinity
de the readiness with which two molecules join together.

tolerance
a decrease in the effectiveness of a drug that is administered repeatedly.

sensitization
an increase in the effectiveness of a drug that is administered repeatedly.

withdrawal symptom
the appearance of symptoms opposite to those produced by a drug when the drug is administered repeatedly and then suddenly no longer taken.

placebo
an inert substance that is given to an organism in lieu of a physiologically active drug; used experimentally to control for the effects of mere administration of a drug.