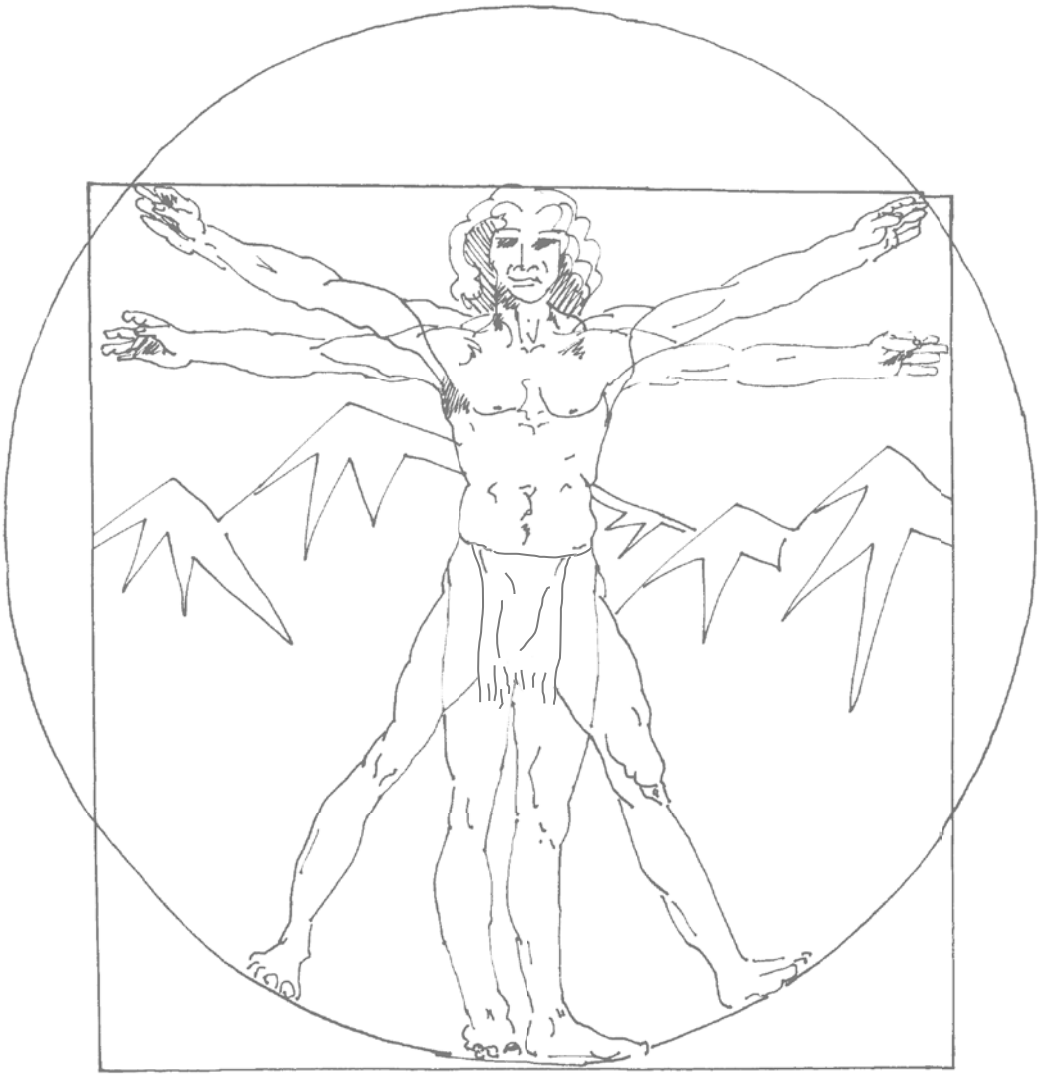
Basic Pharmacology



the Wilderness Medicine Training Center
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Basic Pharmacology

Introduction

Pharmacology is the study of drugs. Drugs are defined as chemical substances that have an effect on living organisms; medicines are drugs used to prevent or treat disease. The administration route, health and age of the patient, and the chemical structure of the drug all play a role in how fast it will act. A drug is considered effective if it elicits the desired therapeutic response with minimal side effects.

ALL drugs elicit more than one response and the use of multiple drugs at the same time may lead to desirable or dangerous drug interactions. Fortunately, due to effective drug control laws, the desired therapeutic response usually occurs and the side effects of most official drugs are predictable, minimal and can be reduced by adjusting the dose of the drug. That being said, a few patients experience side effects strong enough to warrant discontinuing the drug treatment regime. Unlike most side effects, systemic allergic reactions are unpredictable and while most result in hives some cause respiratory distress, vascular collapse, and death. Interactions between multiple drugs taken concurrently may result in either an increase or decrease of one or both drugs due to changes in each drug's absorption, distribution, metabolism, or excretion (ADME) characteristics. The majority of drug interactions are known and can be prevented by checking the appropriate data base. Patients taking any form of drug should be monitored for side effects, systemic allergic reactions, and drug interactions (if taking more than one drug).

Drug Classifications

Drugs fall into two distinct categories: those that require a physician's prescription to obtain (Rx) and those that can be purchased over-the-counter (OTC); both are regulated by the United States Food and Drug Administration (FDA).

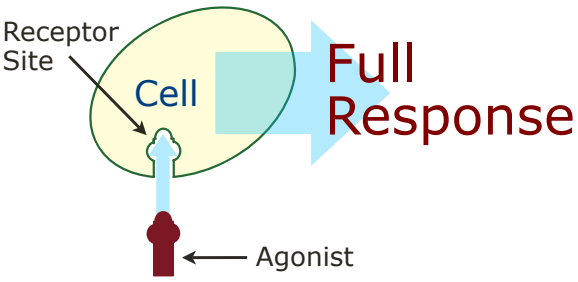
Within these categories they are further classified by the body system they effect, how they are used, or how they elicit their response. Drugs may be referred to by their chemical names, official names, brand names, or by their generic names. Because it describes the drug's exact molecular structure the chemical name is complex and really only useful to chemists. Upon approval the FDA gives each drug an official name. Trademark or brand names are proprietary and assigned and registered by the drug's manufacturer. In order to distinguish them from generic names, official drug names and brand names are capitalized when in print. The generic name is non-proprietary, simpler, and not capitalized when in print.

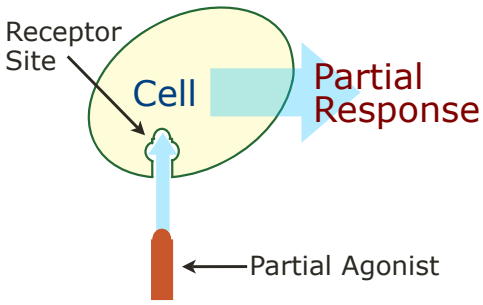
How Drugs Work—A Conceptual Overview

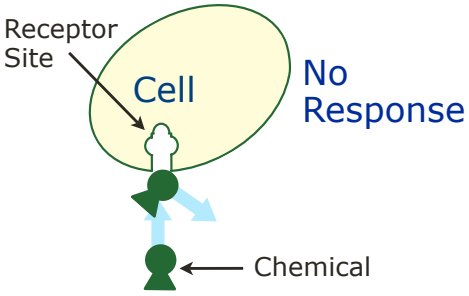
Most drugs act by forming chemical bonds with specific receptor sites within the body to stimulate or inhibit a response. While drugs alter the body's physiologic activity along existing chemical pathways, they DO NOT create new pathways or responses. The success of a drug's response depends on two factors: its molecular fit and the number of receptor sites it bonds to. The better the fit and the greater number of receptor sites occupied, the stronger the response. Chemical agonists fit and bond well into receptor sites and therefore elicit a strong response. Partial chemical agonists bond but only fit well enough to elicit a partial response. Chemical antagonists also bond to receptor sites but do NOT fit well enough to elicit a response; their main role is to occupy the site and prevent agonists from bonding. If a receptor site is occupied other drugs cannot bond to it.

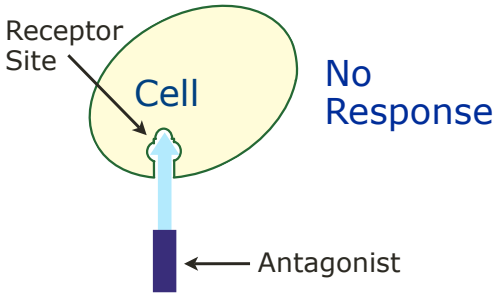
In order for drugs elicit a response they must first be dissolved in the patient's blood or plasma and then transported to their respective receptor sites. Once dissolved, they go thorough four distinct stages: absorption, distribution, metabolism, and excretion (ADME).

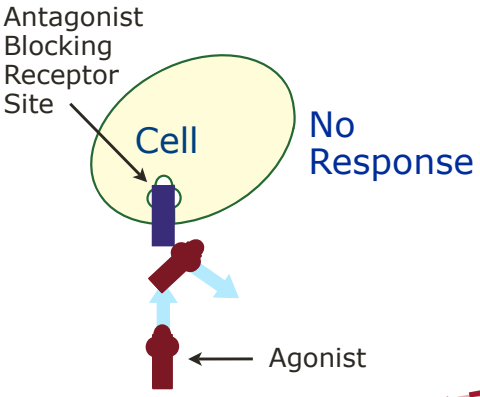
Absorption is the process by which a drug is transported from its administration site into general circulation. The rate of absorption depends on the patient's hydration status, the administration route, the blood flow through the tissue at the administration site, and the solubility of the drug. Once absorbed most drugs bind to—and are carried by—plasma proteins in the blood and lymph for distribution. When bound, the large size of the resulting drug/protein complex prevent the drug from crossing the vascular membranes into the tissue; and a drug MUST cross into tissue to bathe receptor sites,









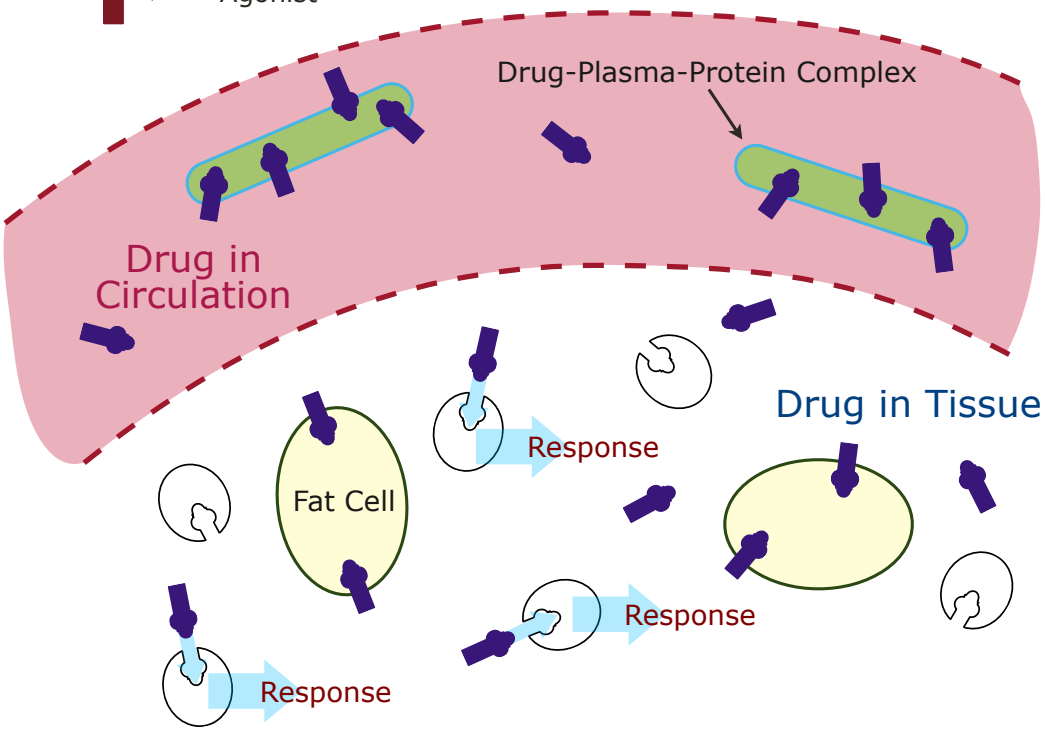


Basic Drug Actions

Agonists bond and elicit a full response.

Partial agonists bond and elicit a partial response.

Antagonists bond and prevent other drugs from occupying the site.



become metabolized by the liver, or be excreted by the kidneys. Furthermore, once in the extra cellular space, fat soluble drugs are likely to bind to fat cells rendering them temporarily inactive. As serum drug levels change due to a drug response, metabolism, or excretion, molecules of the bound drug are released from the drug/protein complex and/or fat cells to maintain the equilibrium between the free and bound drug. It is only the unbound drug in solution that is pharmacologically active. The amount of the drug that reaches the receptor sites determines the strength of its response. Serum levels of the drug MUST remain within a specific range in order to render the desired therapeutic effect.

Enzymes produced by the liver are the body's primary way of breaking down drugs and preparing them for removal (metabolism). Once inactivated, drug metabolites—and in some cases the active drug—are excreted from the body primarily through the urinary system and kidneys. Other less utilized removal methods are via the GI tract (bile), lungs (exhalation), and skin. Age, disease, smoking, and dehydration may decrease liver and renal function slowing both drug metabolism and excretion.

Drug Administration in a Wilderness Environment

Drugs are administered by one of three routes: through the digestive system via ingestion, directly into the body's fluid reservoir via injection, and through body membranes via the lungs, mucous membranes, or skin. Choosing and administering a drug in a wilderness context by non-physicians should be done only in specific circumstances and according to protocols established by the expedition's—or organization's—physician advisor. Hydration, even in healthy people, is always a concern in a wilderness environment and becomes even more so when administering drugs. Because dehydration equals poor absorption, distribution, metabolism, and excretion (ADME) and inhibits the desired therapeutic response, ***make sure that your patient is well-hydrated before administrating any drugs.***

Because oral drugs are effective, easy to carry, and simple to administer, they tend to make up the majority of the drugs carried in an expedition first aid kit. Before an oral medication can reach general circulation it must survive the acids and enzymes of the digestive system, be successfully transported across the stomach or intestinal lining, and survive the initial pass through the liver. Throughout the process hydration is extremely important; even in a well-hydrated patient oral medications should be given with water (8 ounce minimum).

The skin and mucous membranes are another common drug administration route used in a wilderness setting because, like oral drugs, they are effective, easy to carry, and simple to administer. Ear and eye drops are used to treat local infections. Rectal suppositories are used to treat constipation and nausea. Vaginal suppositories or creams are used to treat vaginitis. Topical skin ointments are used to treat local allergic reactions, promote healing in partial thickness wounds, and treat a variety of cutaneous fungal infections. Sub-lingual or buccal glucose tablets are used to treat hypoglycemia in the insulin dependant diabetic and sub-lingual tablets are used to treat angina.

Absorption via inhalation is influenced by the depth of the patient's respirations. Absorption in the lungs is more effective when a spacer is used to disperse the medication prior to inhalation and the patient can take a deep breath and hold the drug in their lungs for a few seconds before exhaling. In a wilderness setting the inhalation route tends to be reserved for participants suffering from asthma.

While all types of injections bypass the digestive system and frequently offer the fastest absorption and distribution route, they should NOT be the first choice for a expedition first aid kit because they are expensive, difficult to carry, and require advanced training to use. Subcutaneous (SC) and intramuscular (IM) injections of epinephrine are commonly given—primarily by auto-injectors—to treat systemic allergic reactions. Because there are more blood vessels in muscles than in subcutaneous tissue, absorption is faster via IM injection. Give IM injections in the belly of the muscle where blood flow is the greatest and there are no large arteries or veins; the most common site used in the field is the anterior thigh.

Infusions are similar to injections in that they are an invasive procedure requiring a needle; however, during infusions the needle—or a catheter—remains in place for hours and occasionally days.

Intravenous (IV) infusions provide the most direct route to the blood and are commonly used in the acute pre-hospital setting where large amounts of fluid are required. Subcutaneous (SC) infusions are easier to start, maintain, have significantly less problems and potential problems than other infusion methods, and may be of value in the marine environment when used to treat dehydration secondary to sea sickness (hypodermoclysis). Intraosseous (IO) or bone infusions are similar to IVs in that they require specialized equipment and training but are easier to use in hazardous environments. Infusion solutions and kits are rarely carried in the backcountry due their relatively high weight, low need, storage problems, difficulty of administration in challenging environments, and the high level of training needed to administer them correctly even under the best of circumstances. As a result, infusions tend to be reserved for inbound rescue teams, remote field clinics who are staffed with field paramedics, nurses, or physicians, and have the capacity to carry or store the necessary equipment.

When choosing a drug, make sure that you:

- have authorization.
- adhere to your protocols.
- review the patient's history for prior systemic allergic reactions to the drug.
- make sure there is no possibility of dangerous drug interactions if multiple drugs are to be given.
- review and advise the patient of the possible side effects.

Prior to administration, assess and document the patient's response to any prior medications and make sure they are hydrated. Make sure you have the:

- Right patient.
- Right drug.
- Right administration route.
- Right dose.
- Right time.

After administering the drug, document all of the above in the patient's SOAP note and/or a separate drug log.

Herbs

Medicinal herbs have been successfully used to treat ailments for thousands of years. Their gathering, preparation, and use have been documented in the writings and folklore of numerous cultures worldwide. Their use has been refined by generations and provides a built-in safety factor unavailable in modern drugs. Although herbs may be evaluated according to their pharmacological actions and chemical compounds, the constituents of the entire plant are greater than the sum of its parts. Some plant components are synergistic and enhance the herb's action far beyond the synthesized "active" compound, while other constituents buffer chemicals that would, without their presence, cause harmful side-effects. In addition to their direct therapeutic affect many medicinal herbs provide necessary trace elements and vitamins required for effective healing. Pharmaceutically both herbs and drugs are chemicals and work within the body in a similar manner; although, the line between therapeutic and toxic doses tends to be much broader with herbs thus increasing their safety factor when used by lay people. Herbs may be gathered and stored for use as the dried herb, dried powders, essential oils, tinctures, ointments, liniments, capsules, lozenges, and syrups. Teas may be made from fresh or dried herbs, tinctures, and tonics.

- ***Essential oils*** extracted from the plant are used as inhalants and when diluted, for massage; they should not be taken internally.
- ***Fresh herbs*** steeped in alcohol or cider vinegar produce concentrated tinctures. ***Tinctures*** are taken internally or used to make teas, compresses, or ointments. Be aware, some herbs, like comfrey, should not be taken internally. A single tincture made from multiple herbs is referred to as a ***tonic***. Unless you are a trained herbalist or have done your research, take care in mixing herbs. Different herbs taken together—like different drugs—can be either synergistic and amplify their effects, nullify one another, or produce an unexpected and potentially dangerous side effect.
- ***Infusions*** are teas made from the flowers and leaves of fresh or dried herbs. To make an infusion pour boiling water over the herb, cover, and allow it to steep for 10-15 minutes before straining. Infusions reserve the volatile oils present in the herb.
- ***Decoctions*** are teas made by boiling the hard, woody parts of an herb. The roots, woody stems, bark, or nuts are first chopped (or ground) and

then boiled for 10-15 minutes before straining.

- ***Compresses*** are made by soaking a clean cloth in an infusion or decoction. ***Poultices*** are similar to compresses but are made by wrapping the herb in gauze before applying to the skin. Both compresses and poultices are applied hot to the injured area and changed when they become cool. The active components are absorbed through the skin.
- ***Ointments*** are made by combining the fresh herb or tincture with a base of wax, fat, or oil that is then applied to the skin.
- ***Liniments*** are an oil based herbal extract and used externally.
- ***Capsules*** are gelatin containers filled with powdered herbs or oils.
- ***Lozenges*** are powdered herbs or oil combined with gum or dried sugar.
- ***Syrups*** are tinctures added to sugar.

Herbs may be carried and stored in chopped or powdered form for later use in infusions, decoctions, compresses, or poultices. Since they do not keep well, water-based infusions and decoctions should be used immediately. Essential oils, ointments, liniments, and tinctures are prepared prior to use and for specific purposes; they are easily carried and last for years.