Chemistry Study Sheet

 Drug: A chemical that affects how the body works. These changes can be better or worse.

 Medicine: A substance that improves health. The beneficial effect of medicine is called the therapeutic effect.

 Effects of drugs in general:

 - Alteration of the physiological state, consciousness, activity level, and coordination.

- Alteration of incoming sensory sensations.

-Alteration of mood or emotion.

Classes of drugs: Analgesics, Stimulants, Depressants, Antacids, Antibiotics, Antivirals

 Placebo Effect: The effect that a pharmacologically inert substance produces not due to physiology, but due to what the patient believes will happen.

 The effect that an inert substance produces due to what the patient or subject expects or believes will happen and not actual physiologically altering chemical changes.

So patients release opioids in the brain or natural pain relief when taking placebos. Generally 1/3 of the control group taking a placebo show some sort of improvement.

 Methods of Administering Drugs:

 Oral – Taken by mouth (example: pill; capsule; tablet; liquids). This is convenient but rate of absorption depends on stomach content and pH of stomach. Majority of drug is absorbed in the small intestine. (1/3 of alcohol is absorbed in stomach).

 Inhalation – Vapor breathed in. (Medications for respiratory conditions such as asthma.) The administration through inhalation is rapid because there is an extensive network of blood vessels around the lungs. Drugs administered this way will produce a systemic effect. (ex: Ventolin).

 Skin patches – absorbed directly from the skin to the blood.

 Suppositories (Rectal) – Inserted into rectum. This is affected when stomach needs to be bypassed due to pH, and the patient has nausea and can’t take the drug orally. This method of administration can produce a systemic effect and is most often used for the treatment of Hemorrhoids.

 Parenteral (By Injection):

 Subcutaneous – Drug is injected directly under the skin. (Drug absorption is slower than intravenous.) Dental injections are often subcutaneous.

 Intramuscular – Directly into the muscles. This method is used when the immediate response is not required rather large volumes of a drug need to be injected. Vaccination injections from overseas tend to be intramuscular.

 Intravenous – Directly into the veins (bloodstream). This is the most practical and fastest acting as the drug is distributed throughout the body in one minute and the effect is virtually instantaneous. **This is useful for injecting precise amounts of the drug.**

Therapeutic Window: Measure of the relative margin of safety for drug. It is a ratio of the Lethal does to the Effective Dose. LD50:ED50

 LD 50 and ED 50 are the effective and lethal doses in 50 percent of the population in mg per kg of body mass. The therapeutic window refers to the levels of the lethal dose and effect dose. If the lethal does is low and the effective does is high, the drug is said to have a narrow therapeutic window. If the effective dose is low, and the lethal dose is high the drug is said to have a wide therapeutic window.

Tolerance: This is the physiological condition that over time and with regular use causes a need for increasing amounts of drug to get the same desired effect. Tolerance is dangerous for two reasons:

 - The body doesn’t always develop tolerance to the harmful side effects of the drug.

 - If the drug user has not taken the drugs for a long period of time, the expected tolerance may have decreased, and the risk of accidental overdose is increased.

Dependence: Physical Dependence occurs when a drug users body can only function normally when the drug is present. When the drug is not present the user experiences withdrawal symptoms.

Psychological dependence: The dependence that occurs when the drug is so central to a persons thoughts, emotions, and acticities that it is extremely difficult to stop using it let alone stop thinking about it.

 Antacids:

The walls of the stomach contain cells that secrete gastric juices containing hydrochloric acid. Normal pH of the stomach is a 1-3 range.

 Purposes of the acidic solution in the stomach are:

 - to suppress growth of harmful bacteria in food among other stomach contents.

 -to help in digestion by hydrolising proteins to amino acids.

 - optimize activity of digestive enzymes.

Over eating, stress and other things stimulate HCL production. Any discomfort that occurs due to excess acid in the stomach is called indigestion.

 Antacid serve to remeby the excess stomach acidity. These antacids work by neutralizing HCl. They are usually **weak basic compounds.** They are often metal oxides or hydroxides, carbonates and hydrocarbonates that react with the acid to produce **salt and water**. By doing this they allow the stomach lining to repair itself and thus help prevent ulcers etc.

 Most popular antacids are

 -Mg(OH)2

 -Al(OH)3

 -NaHCO3

 -CaCO3

These antacids are often present with chemicals called alginates that produce a neutralizing layer that prevents acid reflux (acid backing up into the oesophagus; which is not protected by a mucous membrane.) Anti-foaming agents are added also to reduce the surgace tension of gas bubbles, causing them to coalesce and reduce the volume of the foam via defoaming action (dimethicone).

*Important Equations*

Magnesium Oxide

 MgO + 2HCl -> MgCl2 + H2O

Magnesium Hydroxide

 Mg(OH)2 + 2HCl -> MgCl2 + 2H2O

Aluminum Hydroxide

 Al(OH)3 + 3HCl -> AgCl3 + 3H2O
Calcium Carbonate

 CaCO3 + 2HCl -> CaCl2 + H2O + CO2

Sodium Hydrogen Carbonate

 NaHCO3 + HCL -> NaCl + H2O + CO2

Magnesium Trisilicate

 Mg2Si3O8 + 4HCl -> 3SiO2 + 2H2O + 2MgCl2

Side effect of antacids:

 - Aluminum Hydroxide causes constipation or irregularity.

 - The bind to certain drugs due to their high charge density, and low ionic radius.

 - Magnesium Hydroxide has laxative properties.

 -Calcium Carbonate may result in kidney stones.

 - Sodium ions may lead to hypertension.

 - Too strong antacids cause a basic stomach and can hinder the function of the gastrointestinal tract.

 -Sodium Hydrogen Carbonate can lead to alkalosis (high pH in the blood) as well as fluid retention.

 Note that calcium carbonate neutralizes more HCl than sodium bicarbonate for the same mass.

Analgesics:

 Pain is a sensory input associated with actual or potential tissue damage.

 Pain receptor in our bodies are nerves that transmit pain.

When tissues become injured, their cells release prostaglandins and leukotrines. Prostaglandins stimulate pain receptors, dilate blood vessels (make capillaries permeable thus causing water to flow to site of injury) thus casuing swelling, and also raises the temperature of the body causing fever.

Analgesics are drugs that relieve pain without causing loss of consciousness.

 -mild analgesics are used for relief of mild pain. (Aspirin, Paracetamol, and Ibuprofen, Tylenol, Advil etc). All these drugs except paracetamol are NSAID (non-steroidal anti inflammatory drugs). Paracetomal does not have an anti inflammatory effect because it does not inhibit prostaglandin production at the site of injury but rather in the brain.

 Strong Opiates including morphine, heroin, and codeine are used to relieve strong pains.

Local Anaesthetics include lidocain and procaine.

Mild Analgesics work by **indirectly blocking the enzyme controlled synthesis of prostaglandins**. The also constrict blood vessels, this increases body temperature because less heat can escape from the tissues into the blood.

 Prostaglandins also have a direct effect on the hypothalamus, and thus can produce fever. Mild analgesics also produce the permeability of capillaries which allows water to pass from them to the nearby damaged tissue causing swelling. By reducing the concentration of prostaglandins, mild analgesic prevent pain, inflammation and fever.

 Endophrins and Enkephalins are pain killers that are produced naturally in the body.

 Enkephalins are natural opiates which are able to bind to neuro receptors in the brain an inhibit pain sensory input.

Derivative of salicylic acid are used for:

 Relief of minor pains or headaches.

 Anti-pyretics; to reduce fever.

 Anti-inflammatory agent.

 Anti-platelet agents in prevention of abnormal blood clotting. Because of this property, mild analgesics such as aspirin can be used to prevent the recurrence of heart attacks.

Side Effects:

 Aspirin and other mild analgesics can cause internal bleeding and peptic ulcers.

 0.5 percent of people taking aspirin are allergic; this leads to skin rashes, respiratory illness and shock.

 Development of Reye Syndrome.

Acetaminophen is unique because it does not cause internal bleeding. The drug is hypothesized to be used to block pain receptors in the brain and therefore is only an anti-pyretic and anti inflammatory drug.

 It can cause kidney and blood disorders, and overdose can cause serious liver damage.

Opiates referes to any drug that administers similar effects on the body to morphine.

Morphine is the principle alkaloid (nitrogen containing compound). Morphine makes up 10 percent of natural opium in poppy seeds, Codeine makes up 0.5 percent. Heroin is semi-synthetic because it is produced by a diesterification reaction in which the two hydroxyl groups are replaced with Ch3COO- groups.

Codeine contains one hydroxyl (-OH) and one –( -OCH3) group. Heroin contains two acetyl groups (CH3OO-)

Heroin isa more potent than Codeine, but less potent than heroin. These opiates produce constipation, and can reduce the cough reflex.

Dependence and Tolerance is created due to the drug metabolizing enzyme in the liver, and the presence of the drugs in the brain.

Long Term Effects of Strong Analgesics (Opiates)

Loss of apetite

Risk of dangerous infections due to sharing needles.

Withdrawal illness.

Sterility.

Short Term Effects

Sedation

Relief of Pain

Reduced Tension

Reduced Cough Reflex

 Methadone is sometimes used to treat opiate addiction because it provides the same pain releasing effect without the euphoric high.

Depresssants: Depressants act on the CNS by altering the concentration of chemical transmitters known as neuro transmitaers.

Effects are that they decrease heart rate, breathing rate, relieve tension, cause sleep, and relieve pain. The reduce the activity of the CNS.

Tranquilizers: Alcohol, Valium, and Librium. These do not induce sleep in normal doses.

Sedative: These include the soothing of distress and in high doses can induce sleep.

Hypnotics: produce sleep and may lead to coma or death.

Ethanol is an active ingredient in many depressants. The polarization of the hydrogen molecule (C2H5OH) allows for it to form hydrogen bonds in with water. Ethanol is fat soluble and is relatively small therefore it can easily penetrate any area in the body.

30-50 mg / 100 cc of blood leads to mild intoxication.

100 mg per 100 cc of blood leads to slurred speech and staggering gait.

200 mg per 100 cc of blood impairs vision and movement

400 mg per 100 cc leads to coma and death.

Alcoholism is psychological addiction characterized by an inability to control intake.

Short term effects: reduces tension, anxiety, and inhibition. Euphoria, and small blood vessels are dilated.

Long term- Cirrhosis, cancer, heart disease, high blood pressure, peptic ulcers, gastritis (stomach bloating). Drinking during pregnancy can lead to miscarriage.

Synergistic Effects

When used with cocaine cocaethylyne is formed. This compound extend the high of cocaine. Similarly alcohol can

BAC is grams of ethanol per 100cm cubed of blood. Ethanol passes from the stomach to the blood stream. And into the lungs. The ethanol concentration in the lungs reaches an equilibrium and depends on the ethanol concentration in the blood stream.

Breathalyzer test – acidified Potassium Dichromate is used as an oxidizing agent that oxidizes alchohol in the breath to ethanoic acid. The orange Cr(VI) is reduced to green Cr(III) Cr3+ as it oxidizes the ethanol into ethanoic acid CH3COOH.

 Formula for the breathalyzer test:

2 Cr2O72- + 3 C2H5OH + 16 H+ 🡪 4Cr3+ + 3CH3COOH + 11 H2O

Cr6+ -> Cr3+ (Chromium gains three electron) The below is the reduction reaction:

Cr2O7 + 6e- 🡪 2Cr3+ 7H2O

C2H5OH + H2O 🡪 3 CH3COOH + 4H+ + 4e-

Gas Liquid Chromatography – The blood or urine is injected into a stream of inert gas (called mobile phase) over the surface of the non volatile liquid (stationary phase). The components of the vapor move at different speeds depeding on boiling points and relative solubility. The results of the gas liquid chromatogram is retention time which is the interval of time at which the substance leaves the liquid phase.

The ethanol peak confirms its presence in the vapor while the area under the peak determines the concentration.

IR Spectroscopy depends on the vibrational motions of certain molecules that depend on the length of the bonds present in the functional groups of molecules. IR uses wavenumber which is = to 1/wavelength. Bonds such as C-H absorb IR at different wavenumbers and can therefore be identified. IR is passed through the sample and frequencies are absorbed by the sample depending on the bands present. The rest of the radiation is transmitted. The recorder produces the IR spectrum as the percent transmittance against the wave number. The C-H bonds are detected at wave number 2950cm. However the Intoximeter does not distinguish between ethanol and propanone which is present in the breath of a diabetic.

Benzodiazepines are a major group of depresents that depress activitity in part of the brain that controls emotion and so are used in treatment of anxiety disorders and related insomnia.

Stimulants:

Increase CNS activity.

Help facilitate breathing through relaxation of air passages (bronchiodilation).

Reduce Apetite

Cause Palpitations and tremors to Occur.

Alter the levels of neurotransmitters.

 Amphetamines are stimulants that mimic adrenaline. Effects of adrenaline are:

Increase heart rate and blood pressure.

Increase blood flow to the brain and muscles.
Increase air flow to the lungs

Increase mental awareness.

Adrenaline is similar is structure and effect to norepinephrine and effect.

Amphetamines are sympathomimetic drugs.

Ecstasy is a designer drug that is made by modification of many popular amphetamines. It is more potent than amphetamine and can be fatal at even a normal dose.

Nicotine: Increase heart rate and blood pressure as it constricts the blood vessels. Nicotine reduces urine output.

Long term: The long term use of nicotine increases the risk of coronary thrombosis (formation of blood clots) because it also increases the level of fatty acids in the blood. Smoking also introduces carbon monoxide which makes it difficult for blood cells to carry oxygen. Smoking can cause lung cancer.

Caffeine is an alkaloid that stimulates thje rates of cellular metabolism in the nerve cells. This means that the rate at which energy is made available to the cells is increased through respiration. Because it stimulate the kidneys it has a weak diuretic effect meaning it increases urine output.

Caffeine is a vasoconstrictor and can therefore be used as a remedy for migraines, which are caused by dilated blood vessels.

Similarities between Nicotine and Caffeine are that they both have BENZENE RINGS and TERTIERY AMINES.

 Antibacterials

Antibiotics –chemicals, usually produced by microorganisms, which act against other microorganisms

Core structure of penicillin G:

 Four Membered ring consisting of a nitrogen atom and three carbon atoms. It antibacterial action lies in the fact that it inhibits the development of crosslinking between bacterials cell walls (that is made possible by the enzyme peptidoglycan transpeptidase), water thus flows in by osmosis and bursts the cytoplasm of the cell.

 A disadvantage of penicillin G is that it is broken down by the stomach acid.

Bacterial resistance to penicillin is created by penicillinase. Bacteria are single celled organisms that can produce damage to body tissue.

Bacteria are cellular, viruses are not, bacteria multiply via cell division, viruses multiple via infection of host cells, viruses have no nucleus, cytoplasm, or cell membrane.

Antiviral drugs work by either altering the ribosomes of the host cell so that the virus cannot multiple, or by inhibiting all chemical activating in the cell so that the cell cannot produce viral nucleic acid.

Responses to resistant bacteria include: developing different forms of penicillin with modified side chains.

Controlling and restricting the use of antibiotics by legislation to make them prescription drugs only.

HIV is difficult to fight because it constantly mutates, and its metabolism is similar to that of a human cell, which makes them difficult to target with antivirals. Benig the fact that they lack the structure of bacteria they are not attacked with antibiotics

Amantadine – prevents entry of virus into the cell, and therefore serves as a prophylactic.

HIV incfects the CD4+ T cells by binding to specific receptor proteins on their surface and penetrating the cell. HIV is a retro virus meaning that it has RNA instead of DNA. The virus releases RNA into the cell and the enzyme reverse transcriptase controls the synthesis of DNA to RNA. HIV DNA replicates on the basis of the Host dna and when the cell dies it replicates in large numbers.

One way to prevent HIV is to prevent the enzyme reverse transcriptase as this is specific to the HIV virus and not the Host cell. Other anti-retroviral’s act by blocking the binding of HIV to cell membranes to inhibit the assembly of new particles.