1 D.1 Pharmaceutical products and drug action

1.1 Type 1: LD_{50}, TD_{50}, ED_{50}, Therapeutic Index, and Therapeutic Window

Could be asked asDistinguish LD and TD; Calculate TI; Define LD, TD, and ED

1.1.1 Type1.1: Define or Distinguish LD and TD

Lethal Dose 50: amount/dose that kills 50 percent of the population
Toxic Dose 50: amount/dose that negatively affects/produces toxic effects in 50 percent of the population

1.1.2 Type1.2: Distinguish TI for animals and humans

Therapeutic Index for Animal: $\frac{LD_{50}}{ED_{50}}$
Therapeutic Index for Humans: $\frac{TD_{50}}{ED_{50}}$

1.1.3 Type1.3: Define or Outline the significance of Therapeutic Window

Use definition of Therapeutic Window: range of doses that produce a therapeutic effect without causing toxic effects

Wide TW: Small ED and Large LD/TD
Narrow TW requireds small doses because **small LD/TD** and easily reach toxic level

1.2 Type 2: Drug Administration

1.2.1 Type 2.1: General Types of Drug Administration

- Oral
- Inhalation
- Tropical
- Rectal
- Injection (Parenteral)

1.2.2 Type 2.2: Types of Injection

- Intraveneous
- Intramuscular
- Subcutaneous

1.2.3 Type 2.3: Discuss Oral-taken Drug Administration

Advantage: Convenient to take
Disadvantage: Stomach acid reacts with drugs; Slow Effects...

1.3 Type 3: Bioavailibility

1.3.1 Type 3.1: Define Bioavailibity

fraction of administrated dosage that reaches **target part** of the body

1.3.2 Type 3.2: The method to increase/maximize bioavailibility

Intraveneous Injection: 100 percent

1.4 Type 4: Side Effects, Tolerance, and Ethical Issues

1.4.1 Type 4.1: Define Side Effects

an effect produced in addition to the one intended effect (unintended effect)

1.4.2 Type 4.2: Define Tolerance

person needs to take ever larger quantities of a drug to gain the original effect

1.4.3 Type 4.3: Ethical Consideration

Usually choose **2 of them** to recite

- side-effects of medication on patient
- effects on environment
- potential for abuse
- drugs may be developed that are contrary to some religious doctrines
- animal testing

1.5 Type 5: Development of Drugs and Effects of Medcine

1.5.1 Type 5.1: Stages of Development of Drugs

1. drug is isolated from existing species
2. tested on animals to establish LD50
3. tested on humans and half is given a **placebo**

1.5.2 Type 5.2: General Effects of Medcine on Body

- alter physiological state
- alter emotions or mood
- alter incoming sensory sensations

2 D.2 Aspirin and Penicillin

2.1 Type 1: Characteristics of Aspirin and Mild Analgesics

2.1.1 Type 1.1: Characteristics of Aspirin

Why Could not be Stored in **hot, humid** location?

- Humid → Water, Aspirin **react with water** (hydrolysis)
- Hot → Heat, Increase **rate of reaction** with water

How to identify aspirin? (memorize 2 ways)

- melting point
- mass spectrometry
- NMR

2.1.2 Type 1.2: Mild Analgesics

How mild analgesics function?

- Prevent the production of **prostaglandins**
- at the site of injury

How prostaglandins function?
Prostaglandins are involved in the **transmission of pain impulses**

2.2 Type 2: Structure, synthesis, and conversion of Aspirin

2.2.1 Type 2.1: Synthesis of Aspirin

Aspirin could be synthesized from **salicylic acid** and **acetic anhydride**
Type of reaction: esterification

D/sythesisofaspirin.jpg

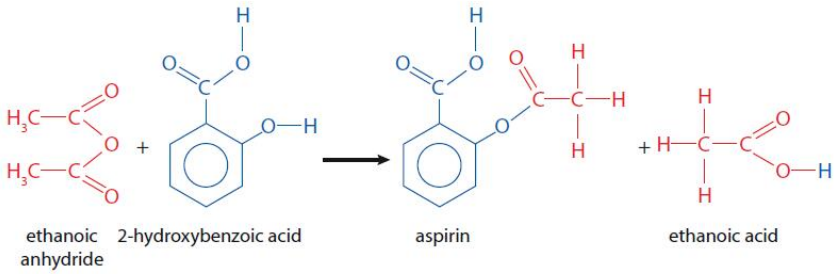

Figure 1: Synthesis of aspirin

2.2.2 Type 2.2: Structure of Aspirin

Partially Soluble because:

- Carboxyl: OH bond makes it soluble
- Ester: Non-polar makes it unsoluble

2.2.3 Type 2.3: Make Aspirin more Soluble

Could be asked with: ion salt; more soluble in water; **How to increase bioavailibility** etc.
Key point: react with **NaOH**

Equation:
$C_6H_4(OCOCH_3)COOH + NaOH \rightarrow c_6H_4(OCOCH_3)COONa + H_2O$

2.3 Type 3: Appropriate Use of Aspirin

2.3.1 Type 3.1: Use of Aspirin

Could be asked with: state the **other use** of aspirin (memorize 2 points)

- lower risk of heart attack
- prevent recurrence of heart attack
- prevent cancer of stomach/colon

2.3.2 Type 3.2: Misuse of Aspirin with Alcohol

Key point: It will lead to **stomach bleeding**

2.4 Type 4: Functions and Structures of Penicillin

2.4.1 Type 4.1: Penicillin work in general and as Anti-bacterial

Could be asked with: How penicillin work; how penicillin combat infection etc.
How Penicillin combat infection?

- Inhibits **enzyme** that produces cell walls
- Cells cannot reproduce

How Penicillin work as anti-bacterial?

- prevent the formation of bacterial cell walls
- causes water to enter bacterial cell and cell bursts

2.4.2 Type 4.2: The Beta-Lactam Ring on Penicillin

New concept: "ring strain", means bond angle smaller

Why Beta-lactam ring important

1. ring is **strained**
2. ring breaks up easily
3. binds to enzyme responsible for **cell wall formation**

Functional Group present in Beta-lactam ring: **amide**

2.4.3 Type 4.3 How to modify Penicillin

Could be asked with: Why necessary; How to;

How to modify?
Modify the **side chain**

Why necessary?
Modifying overcomes the resistance of bacteria

2.5 Type 5: Development and limitations of Penicillin

2.5.1 Type 5.1: Development of Penicillin

Could be asked with: Why develop?

- to overcome the resistance that bacteria develop to existing antibiotics
- prevents penicillinase enzyme from destroying penicillin

2.5.2 Type 5.2: Limitations of Penicillin

Could be asked with: Overpriscription of penicillin

- Might cause allergic reactions
- Might wipe out beneficial bacteria
- increase the proportion of resistant bacteria

3 D.3 Opiates

3.1 Type 1: Morphine and strong analgesics

3.1.1 Type 1.1 Strong Analgesics

Temeporarily bind to the **receptor sites** in brain

3.1.2 Type 1.2: Opiates as painkillers in general

1. work directly on pain recptors
2. surpress pain impulses
3. resemble endorphins

3.2 Type 2: Diamorphine from Morphine

3.2.1 Type 2.1: Reaction from Morphine to Diamorphine

Reactant: CH_3COOH
By-product: H_2O

3.2.2 Type 2.2: Comparison on the Structure between Morphine, Diamorphine, and Codeine

Similarities:

- Benzene Ring
- Amino
- Ether

Difference:

- TWo OH in morphine, one in codeine, and none in diamorphine
- Ester only in diamorphine

3.2.3 Type 2.3: Comparison on the effects between Morphine and Diamorphine

Could be asked with: Potent/potency; Advantage/disadvantage etc.
Why Diamorphine is more potent than morphine?

1. Diamorphine is **non-polar**
2. Can cross the **blood-brain** barrier more easily

Advantage and Disadvantage of Diamorphine
Advantage: Strong pain killer
Disadvantage: More addictive

3.3 Type 3: Codeine from Morphine

3.3.1 Type 3.1: Reaction from Morphine to Codeine

React with **methyl iodide** (CH_3I) in **alkaline solution**
Type of reaction: Nucleophilic Substitution

3.3.2 Type 3.2: Comparison on the effects between Morphine and Codeine

Could be asked with: Why widely used; why without prescription etc. Codeine has a wider **therapeutic window**

3.4 Type 4: Addiction, Use of Morphine

3.4.1 Type 4.1: Addiction of Morphine

Why opiates addictive?

- interact with opioid receptors in the brain
- withdrawal symptoms
- cause euphoria

3.4.2 Type 4.2: Advantage and Disadvantage of Using Morphine

Advantage:

- Strong pain relief
- Relieve coughing

Disadvantage:

- addiction
- tolerance
- dependence

4 D.4 pH Regulation of the Stomach

4.1 Type 1: Action of Omeprazole

General Function: **Increase** the stomach pH

4.1.1 Type 1.1: How does omeprazole regulates stomach pH

1. Bind to receptors of **proton pump**
2. Inhibits the secretion of stomach acid

Site of Action: Proton Pump

4.2 Type 2: Action of Ranitidine

General function: Increase the stomach pH

4.2.1 Type 2.1: How does ranitidine reduces stomach acid production?

1. Binds to H2 receptor in cells of stomach lining
2. Prevent **parental cells** from release acid

Notice that: Originally **histamine** binds to the H2 receptor

4.3 Type 3: Buffer Solution and pKa Calculation

4.3.1 Type 3.1: Calculation of Buffer Solution

pH = pKa + $log\frac{[base]}{[acid]}$

4.4 Type 4: Antacids, neutralization, and Change in pH of Stomach

4.4.1 Type 4.1: Acids present in gastric juice

Hydrochloric Acid (HCl)

4.4.2 Type 4.2: Common Antacids

In form of **tablets** (solid)

- 1 mole: $NaHCO_3$
- 2 mole: $CaCO_3$ and $MgCO_3$
- 3 mole: $Al(OH)_3$

4.4.3 Type 4.3: Neutralization

All about the equations.
Equation with base
$Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$

Equation with alkali salts
$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$
The CO_2 produced could lead to **belching**

4.4.4 Type 4.4: Change in pH of Blood

Could be asked with: effect of a large amount of aspirin

1. H^+ from Aspirin reacts with HCO_3^- to form CO_2 and H_2O
2. Causing the pH to decrease

5 D.5 Anti-viral Medicine

5.1 Type 1: Difference between Bacteria and Virus

Could be phrased as: State the difference; distinguish; Outline the difference, etc.
Answer:

- Bacteria performs living functions while Viruses is non-living.
- Bacteria have cell walls while viruses don't.
- Bacteria have capsid while viruses don't
- Bacteria are larger than viruses
- Bacteria are single cells while viruses are not cellular

5.2 Type 2: How Antiviral Drugs Work

Could be phrased as: x ways in which antiviral drugs work
Answer:

- alter cell's genetic material
- block enzyme activity within host cell
- inhibits virus entry/bonding to cell
- prevents virus from leaving cell
- becomes part of DNA of virus
- prevents virus from using cell to replicate

5.2.1 Type 2.1 How oseltamivir/zanamivir works

Answer:

- inhivits viral enzyme
- prevent virus from leaving host cells

5.2.2 Type 2.2: Reason for Zanamivir taken by inhalation

Answer:
Oral bioavailibility is low for zanamivir

5.3 Type 3: Structures of Oseltimivir and Zanamivir

5.3.1 The functional groups they both have

- ether
- carbonyl
- amido

5.3.2 Functional groups: Zanamivir Only

- Carboxyl
- Hydroxyl

5.4 Type 4: Why difficult to treat AIDS/HIV

- HIV retrovirus attacks immune system
- virus has ability to mutate
- virus makes people vulnerable to other infections
- Metabolism of virus is linked closely to metabolism of the (host) cell
- antiretroviral agents are expensive
- Stigma of diagnosis leads to not getting treatment

6 D.6: Environmental impact of some medications

6.1 Type 1: Environmental Impact of Nuclear Waste

Explain the low environmental impact of most medical nuclear waste.

- Low radioactivity
- Short Lives

Examples and Treatment of Nuclear Wastes

- Low Level Waste: Storage until the isotope has decayed
- Medium Level Waste: Storage underground

Ethical Implications of Nuclear Waste

- Security concerns if nuclear radioactive material ended up with terrorists
- Proper disposal of nuclear wastes
- Exposure of workers to radioactivity

6.2 Type 2: Organic Solvents and Green Chemistry

6.2.1 Type 2.1: Hazardous Solvents

- Benzene
- Methanol
- dichloromethane (chlorinated solvent)

6.2.2 Type 2.2: Green Solvent

- Water
- Carbon dioxide
- Ethanol (when replacing a hazardous solvent)
- propanone (acetone) when replacing a hazardous solvent

6.2.3 Type 2.3: Problem of Chlorinated Solvent and Green chemistry

Problem of Chlorinated Solvent

- incomplete combustion can produce toxic products
- ozone depletion
- contribute to formation of smog
- costs of disposal

Green Chemistry

- use organic solvent-free synthetic methods
- use a water as a solvent
- based on atom economy

6.3 Type 3: Antibiotics

6.3.1 Type 3.1: Consequences of Prescribing Antibiotics Unnecessarily

- Bacterial Resistance
- Destroy beneficial bacteria
- Damage to ecosystems

6.3.2 Type 3.2: Overuse of Antibiotics

Same as 3.1.