Alcohol forensic point of view

Maryam Akhgari
Pharm D, PhD
Professor of pharmacology & Toxicology

Outline

- Pharmacology and toxicology of alcohols
  - Alcohol definition
  - Ethanol pharmacodynamics
  - Ethanol pharmacokinetics

    Absorption, distribution and elimination in the body

Variations in ethanol pharmacokinetics

Methanol Pharmacology

Interpretation of alcohol analysis

Ethanol

- Ethanol (Ethyl Alcohol, C_2H_5OH) is derived from fermentation of sugars in fruits, cereals, and vegetables.
- Commercial beer, wine and liquors contain various amounts of ethanol.
- Ethanol is also found in variety of perfumes, after-shaves, mouthwashes, some rubbing alcohols, pharmaceutical preparations (elixirs) and may other products.
- Ethanol used as a solvent and antiseptic in industry and medicine.


CAITOS
PRIME


PASHA
CHIVAS REGAL

Alcohol Use/Abuse from Forensic Medicine Viewpoint

- High blood alcohol concentration (BAC) are a common finding in many crimes and accidents such as:
- *Car Accidents (DUI and Legal limits of BAC in Driving)*
- *Suicide*
- *Drowning*
- *Homicidal crime*
- *Falling, Workplace Accidents, Poisoning and drug overdose, Faked Alcohol Drinks(Methanol) Poisoning*

Alcohol prohibition in Iran

- **Alcohol in Iran** is prohibited for the majority of its citizens, due to laws against consumption of alcohol by Iranian Muslims who make up the great majority of the country.
- Despite complete prohibition for Muslim citizens, there is still widespread alcohol use across Iran.
- Alcohol is the second most popular drug in Iran, after opiates.
- From this view, alcohol analysis in body fluids is the most frequent requested service from forensic science and toxicology labs worldwide and in Iran.

What is called Alcoholic Beverage?

- An **alcoholic beverage** is a drink which contains a substantial amount of the ethanol (0.5-95% V/V).
- Also, they classified as fermented (beers and wines) and distilled (liqours) alcoholic beverages.
- Alcoholic beverages typically contain between 3% and 40% alcohol by volume.

Alcoholic beverages classification

- *1- Fermented beverages*

  Wine, champagne, sherry

  Beer

  Cider

  Mead

- 2- *Distilled beverages*

  Whisky (40-55%)

  Vodka (60p-90%)

  Rum (90-95%)

  Brandy (40-50%)

What is wine?

- Wine is a fermented beverage produced from grapes.
- Wine involves a longer fermentation process than beer and also a long aging process (months or years), resulting in an alcohol content of 9%–16% ABV.
- Fruit wines are made from fruits such as plums, cherries, or apples.
- "Rice wines" like sake are made from rice.

Red wine and white wine

Wine fermentation tanks

Sake

What is beer?

- Beer is a beverage fermented from grain mash.
- It is made from barley or a blend of several grains.
- If the fermented mash is distilled, then the beverage is a spirit.
- Beer is the most consumed alcoholic beverage in the world.

Barley fields in California and Germany

Beer

What is cider?

- Cider or cyder is a fermented alcoholic beverage made from any fruit juice; apple juice (traditional and most common), peaches, pears or other fruit.
- Cider alcohol content varies from 1.2% ABV to 8.5% or more in traditional English ciders.
- In some regions, cider may be called "apple wine".

Cider

What is mead?

- Mead or **honey wine** is an alcoholic beverage created by fermenting honey with water, sometimes with various fruits, spices, grains.
- The alcoholic content of mead may range from about 8% ABV to more than 20%.
- The defining characteristic of mead is that the majority of the beverage's fermentable sugar is derived from honey.

Mead

Distilled beverages

- A distilled beverage or liquor is an alcoholic beverage produced by distilling (i.e., concentrating by distillation) ethanol produced by means of fermenting grain, fruit, or vegetables.
- For the most common distilled beverages, such as whiskey, gin, brandy and vodka, the alcohol content is around 40%.

Distilled alcoholic beverages

What is champagne?

- **Champagne** is a sparkling wine produced from grapes.
- Champagne would seem to be a light, bubbly drink.
- Champagne has higher alcohol than many other wines, and the bubbles cause the alcohol to get into your bloodstream more quickly.
- Champagnes and sparkling wines in my house, they seem to range between 11.5% and 12.5%.

Champagne

Vodka

Whiskey

Gin

What is spirit

- A distilled **drink** or **liquor** is an alcoholic **drink** produced by distilling (i.e., concentrating by distillation) ethanol produced by means of fermenting grain, fruit, or vegetables.
- Unsweetened, distilled, alcoholic **drinks** that have an alcohol content of at least 20% ABV are called **spirits**.

What is Liqueur?

- **Liqueurs** are made by adding flavorings and sugar to neutral spirit base.

What is rum?

- **Rum** is a distilled alcoholic beverage made from sugarcane byproducts, such as molasses, or directly from sugarcane juice, by a process of fermentation and distillation.
- The distillate, a clear liquid, is then usually aged in oak barrels.


RUM

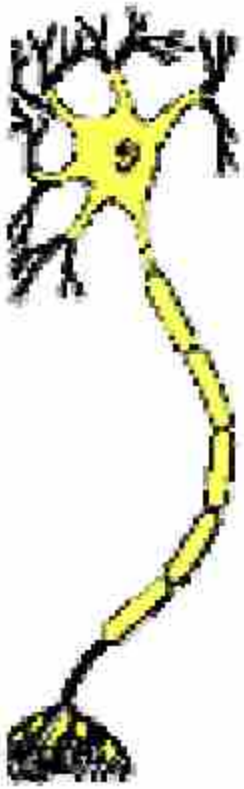

THE REAL McCOY
RUM
aged 3 years
THE REAL McCOY
RUM
aged 5 years
THE REAL McCOY
RUM
aged 12 years

Ethanolic Products

Beer 3-6%	Antiseptic 10-70%
Wine 16%	Perfume 40-80%
Whisky 40%	Aftershave 40-80%
Vodka 60-90%	Mouthwash 15-25%

Ethanol Pharmacodynamics

Pharmacodynamics

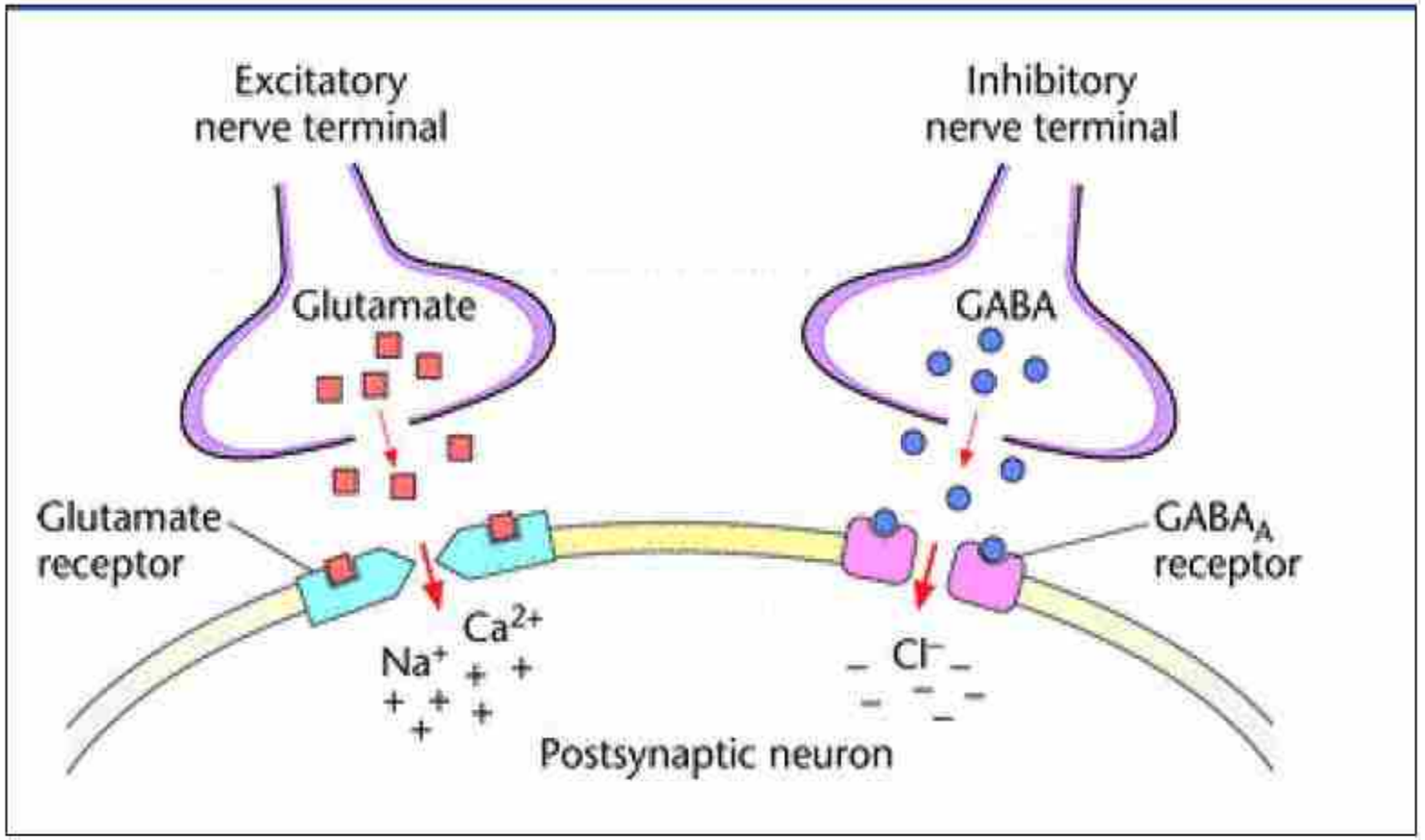


Studies of biochemical and physiological effects of drugs on living organisms including mechanisms of action, dose response relationships, and drug-effects on behavior in relation to chemical structure and dosage form.

Pharmacodynamics of ethanol

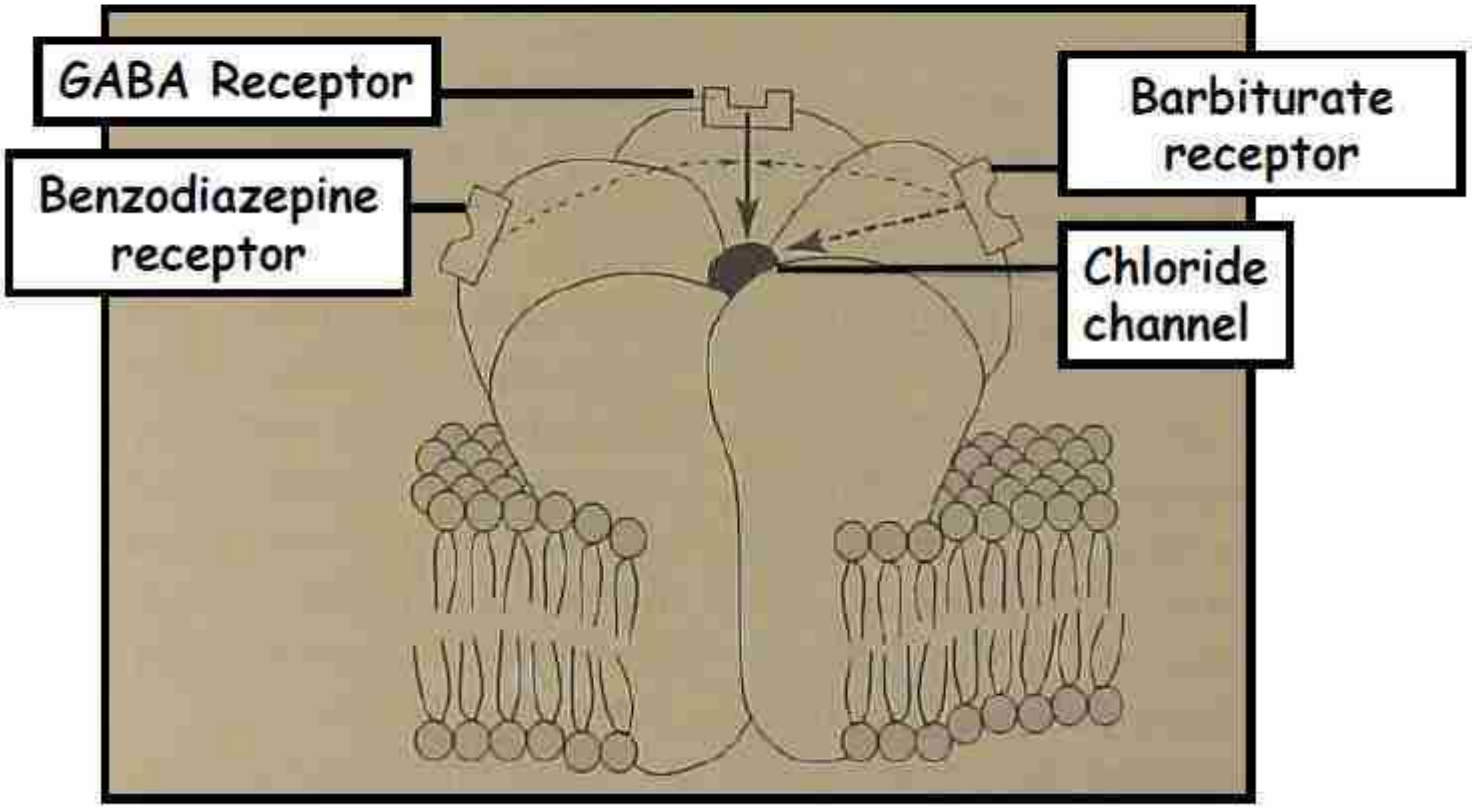
- How EtOH drinking influences the behavior and the actions of an individual
  - Metabolic effects
    - Metabolism of ethanol produces energy 7.1 kcal per g
  - Central Nervous System (CNS) effects
    - Ethanol as a psychotropic drug
    - Impairment of performance and behavior
- Mechanisms of action
  - Intermediary metabolism
  - Cell membranes
  - Receptor sites and ion channels

Receptors involved in some of the actions of ethanol

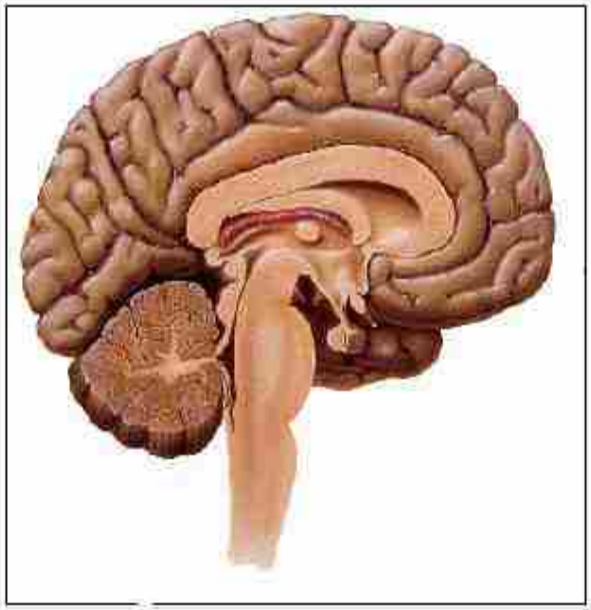


Effects on ligand-gated ion channels

$GABA_A$ inhibitory receptor EtOH potentiates the effect of GABA



Effects of Ethanol on the Brain



- Impairment of cognitive and psychomotor functions
- First emotion and decision making e.g. reasoning, thinking, learning and judgement
- Next muscular control e.g.marked impairment of movement, balance, speech, reaction time etc.
- Last affected is respiration and circulation (v. high BAC).
- Degree of impairment depends on dose, rate of drinking and prior experience with alcohol

Tolerance

Signs & symptoms of intoxication and BAC

<25 mg%	*sense of warmth, wellbeing, talkativeness, self confidence*
25-50 mg%	*Euphoria, decreased judgment and control*
50-100 mg%	*Ataxia, decreased reflexes/increased reaction time*
100-250 mg%	*Ataxia, diplopia, slurred speech, nystagmus*
250-400 mg%	*Stupor, coma, nausea, vomiting*
>400 mg%	*Respiratory paralysis, hypothermia, death*

Diplopia

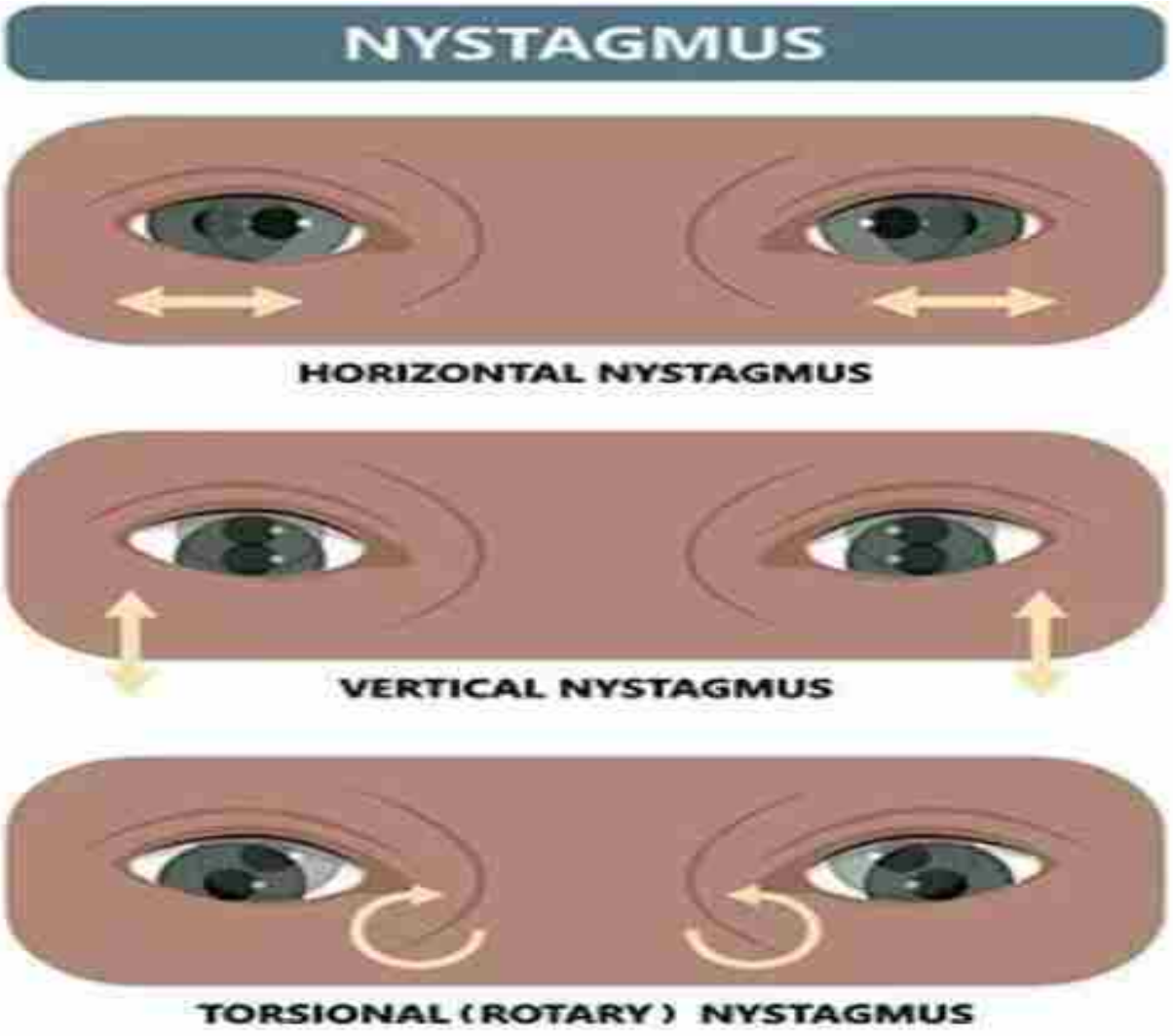
بررسی رانندگان مشکوک به مستی در صحنه

- **One-Leg Stand**
- **Horizontal Nystagmus**
- **Walking a Straight Line**

حفظ تعادل هنگام ایستادن روی یک پا

بررسی رانندگان مشکوک به مستی در صحنه

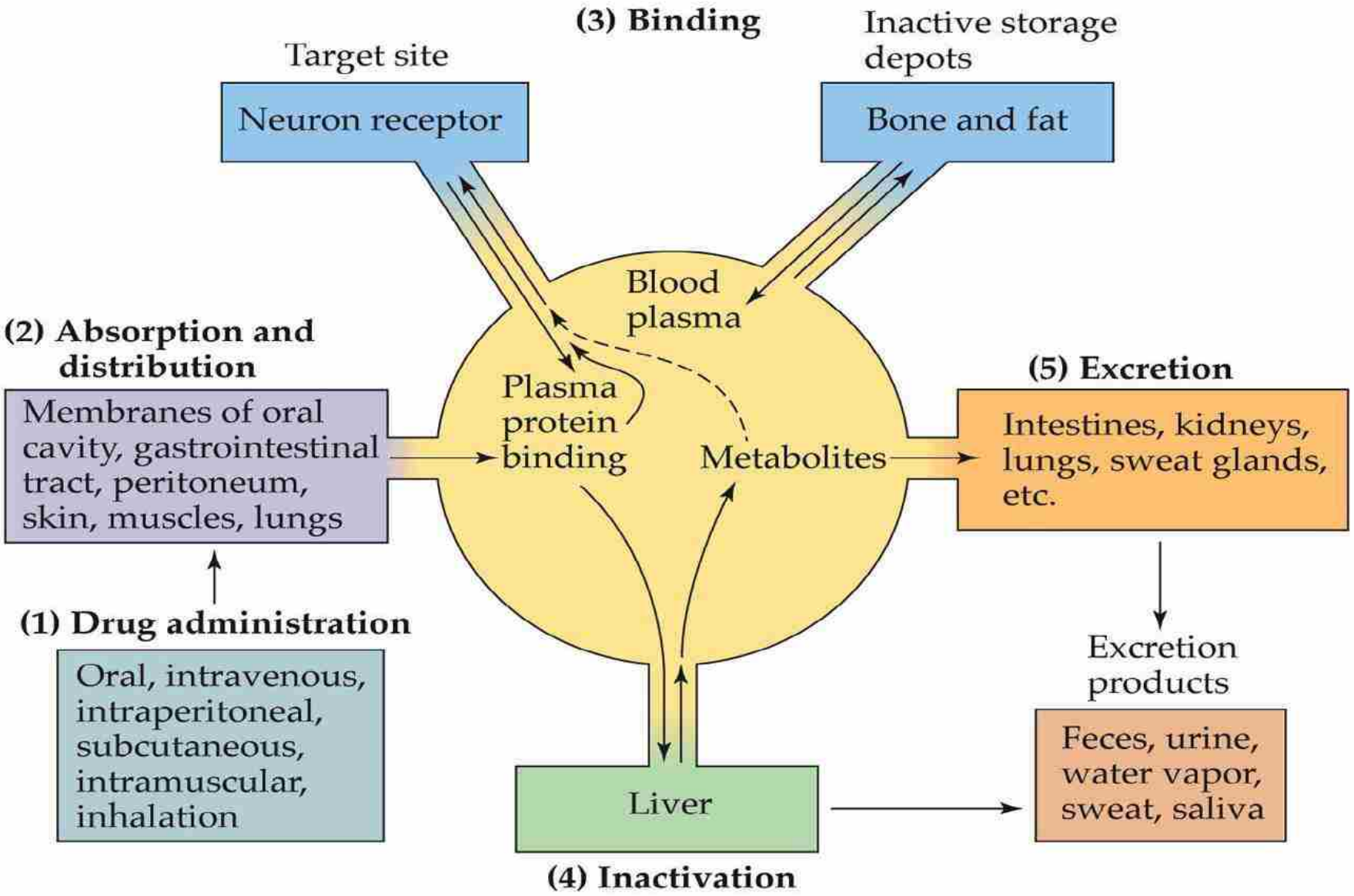
نیستاگموس افقی



توانایی حرکت روی خط مستقیم

Ethanol Pharmacokinetics

Pharmacokinetics theory



Ethanol absorption

- The alcohol molecule is a small polar molecule with both lipophilic and hydrophilic characteristics.
- The amphipathic qualities of alcohol help to explain its pharmacokinetics within the body.

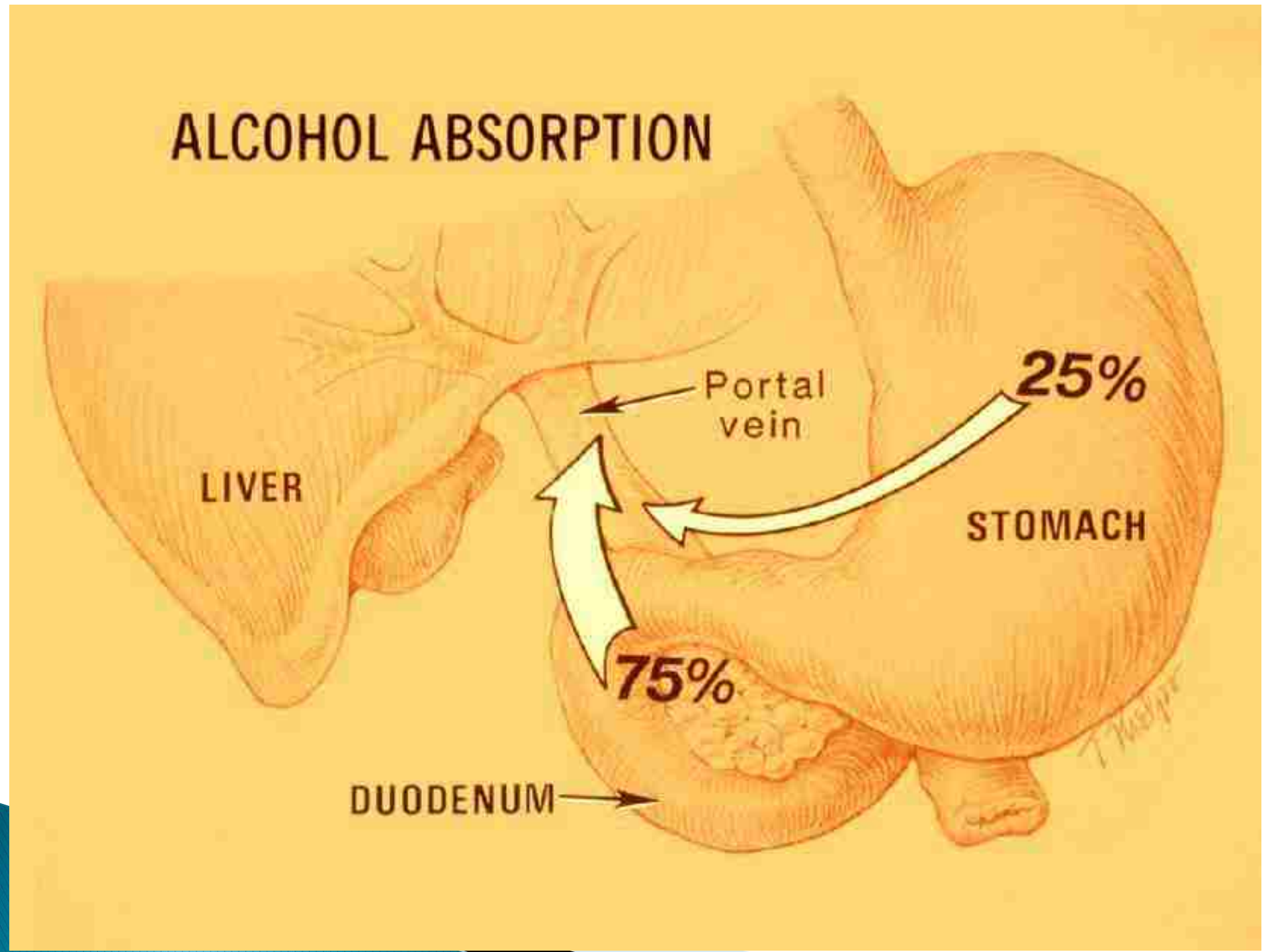
- The hydrophilic combined with the polar properties of the alcohol molecule explain how alcohol is completely soluble in water and thus has a similar volume of distribution (Vd) to total body water (TBW).

As alcohol is a small water soluble molecule that can cross cell membranes, it is absorbed from both the stomach (25 %) and the upper small intestine (75 %).

The time from the last drink to maximal concentration in blood usually ranges from 30 to 90 minutes.

Factors affecting:

Concentration of ethanol, Fasting, Delaying the stomach emptying, Co ingestion of some drugs.


ALCOHOL ABSORPTION
Portal vein
25%
LIVER
STOMACH
75%
DUODENUM

BAC is dependent to many factors

- Blood alcohol concentration (BAC) is determined by the various factors that affect the rate at which alcohol is absorbed, distributed, metabolised and excreted from the body.
- Following oral administration absorption and distribution determines the proportion and rate at which orally ingested alcohol reaches the blood and body tissues (bioavailability).

Factors affecting Blood Alcohol Concentration

Variable	Primary reason
Gender	Differences in TBW and gastric ADH
Ethnicity Different	Sensitivities to alcohol
Type of alcohol	Amount & strength can affect absorption
Mixer	Can affect absorption
Stomach content	Timing & meal type (e.g. fat content) affect absorption

Intraindividual and Interindividual variations

- The rate of absorption varies significantly in both intraindividual and interindividual comparisons even after standardised conditions.
- Intraindividual variability is due to variation in gastrointestinal function (gastric emptying, intestinal transit time, and portal blood flow).

Effect of gastric emptying

- The rate of **gastric emptying** has a significant impact on the speed at which alcohol is absorbed, because alcohol is absorbed much faster from the small intestine, than it is from the stomach.

Effect of gastric emptying

- Factors which affect alcohol availability and gastric emptying will greatly influence the rate of absorption.
- For example, the consumption of alcohol with food inhibits absorption because approximately 20% of the ingested alcohol is oxidised before it can be absorbed.