Chapter 10
FORENSIC TOXICOLOGY

Introduction

- Toxicologists are charged with the responsibility for detecting and identifying the presence of drugs and poisons in body fluids, tissues, and organs.
- Toxicologists not only work in crime laboratories and medical examiners' offices, but may also reach into hospital laboratories and health facilities to identify a drug overdose or monitor the intake of drugs.
- A major branch of forensic toxicology deals with the measurement of alcohol in the body for matters that pertain to violations of criminal law.

Toxicology of Alcohol

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- The analysis of alcohol exemplifies the primary objective of forensic toxicology—the detection and isolation of drugs in the body for the purpose of determining their influence on human behavior.
- Alcohol, or ethyl alcohol, is a colorless liquid normally diluted with water and consumed as a beverage.
- Like any depressant, alcohol principally effects the central nervous system, particularly the brain.

Alcohol Levels

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- Alcohol appears in the blood within minutes after it has been taken by mouth and slowly increases in concentration while it is being absorbed from the stomach and the small intestine into the bloodstream.
- When all the alcohol has been absorbed, a maximum alcohol level is reached in the blood; and the postabsorption period begins.
- Then the alcohol concentration slowly decreases until a zero level is again reached.
- Factors such as time taken to consume the drink, the alcohol content, the amount consumed, and food present in the stomach determine the rate at which alcohol is absorbed.

Alcohol Levels

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- Elimination of alcohol throughout the body is accomplished through oxidation and excretion.
- Oxidation takes place almost entirely in the liver, while alcohol is excreted unchanged in the breath, urine, and perspiration.
- The extent to which an individual may be under the influence of alcohol is usually determined by either measuring the quantity of alcohol present in the blood system or by measuring the alcohol content in the breath.
- Experimental evidence has verified that the amount of alcohol exhaled in the breath is in direct proportion to the blood concentration.

Alcohol and Circulatory System

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- Humans have a closed circulatory system consisting of a heart, arteries, veins, and capillaries.
- Alcohol is absorbed from the stomach and small intestines into the blood stream.
- Alcohol is carried to the liver where the process of its destruction starts.
- Blood, carrying alcohol, moves to the heart and is pumped to the lungs.
- In the lungs, carbon dioxide and alcohol leave the blood and oxygen enters the blood in the air sacs known as alveoli.
- Then the carbon dioxide and alcohol are exhaled during breathing.

Breath Testers

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- Breath testers that operate on the principle of infrared light absorption are becoming increasingly popular within the law enforcement community.
- Many types of breath testers are designed to capture a set volume of breath.
- The captured breath is exposed to infrared light.
- It's the degree of the interaction of the light with alcohol in the captured breath sample that allows the instrument to measure a blood alcohol concentration in breath.

Field Testing

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- Law enforcement officers typically use field sobriety tests to estimate a motorist's degree of physical impairment by alcohol and whether or not an evidential test for alcohol is justified.
- The horizontal gaze nystagmus test, walk and turn, and the one-leg stand are all considered reliable and effective psychophysical tests.
- A portable, handheld, roadside breath tester may be used to determine a preliminary breath-alcohol content.

Gas Chromatography Testing

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- Gas chromatography offers the toxicologist the most widely used approach for determining alcohol levels in blood.
- Blood must always be drawn under medically accepted conditions by a qualified individual.
- It is important that a nonalcoholic disinfectant be applied before the suspect's skin is penetrated with a sterile needle or lancet.
- Once blood is removed from an individual, its preservation is best ensured when it is sealed in an airtight container after an anticoagulant and a preservative have been added and stored in a refrigerator.

Alcohol and Law

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- The American Medical Association and the National Safety Council have been able to exert considerable influence in convincing the states to establish uniform and reasonable blood-alcohol standards.
- Between 1939 and 1964 a person having a blood-alcohol level in excess of 0.15 percent w/v was to be considered under the influence, which was lowered to 0.10 percent by 1965.
- In 1972 the impairment level was recommended to be lowered again to 0.08 percent w/v.

Alcohol and Law

- Starting in 2003, states that have not adopted the 0.08 percent per se level will lose part of their federal funds for highway construction.
- To prevent a person's refusal to take a test for alcohol consumption, the National Highway Traffic Safety Administration recommended an "implied consent" law.
- Adopted by all states by 1973, this law states that the operation of a motor vehicle on a public highway automatically carries with it the stipulation that a driver will submit for a test for alcohol intoxication if requested or be subject to loss of the license.

Role of the Toxicologist

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- Beyond the analysis of alcohol, the toxicologist is confronted with a maze of drugs and poisons.
- The toxicologist is originally presented with body fluids and/or organs and is normally requested to examine them for the presence of drugs and poisons.
- Without supportive evidence, such as the victim's symptoms, a postmortem pathological examination, or an examination of the victim's personal effects, the toxicologist is forced to use general screening procedures with the hope of narrowing thousands of possibilities to one.

Role of the Toxicologist

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- In addition, the toxicologist is not dealing with drugs at the concentration levels found in powders and pills, having been dissipated and distributed throughout the body.
- Furthermore, the body is an active chemistry laboratory as few substances enter and completely leave the body in the same chemical state.
- Last, when and if the toxicologist has surmounted all of these obstacles, he or she must be prepared to assess the toxicity of the drug or poison.

The Analytical Scheme

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- The forensic toxicologist must devise an analytical scheme that will successfully detect, isolate, and specifically identify toxic drug substances.
- Once the drug has been extracted from appropriate biological fluids, tissues, and organs, the forensic toxicologist can proceed to identify the drug substance present.
- Drug extraction is generally based on a large number of drugs being either acidic or basic.
- The strategy used for identifying abused drugs entails a two-step approach: screening and confirmation.

The Screening Step

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- A screening test is normally employed to provide the analyst with quick insight into the likelihood that a specimen contains a drug substance.
- Positive results arising from a screening test are considered to be tentative at best and must be verified with a confirmation test.
- The most widely used screening tests are thin-layer chromatography, gas chromatography, and immunoassay.

The Confirmation Step

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- Gas chromatography/mass spectrometry is generally accepted as the confirmation test of choice.
- The GC separates the sample into its components, while the MS represents a unique "fingerprint" pattern that can be used for identification.
- Once the drug is extracted and identified, the toxicologist may be required to provide an opinion on the drug's effect on an individual's natural performance or physical state.

The DRE

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- The Drug Recognition Expert program incorporates standardized methods for examining automobile drivers who are suspected of being under the influence of drugs.
- To ensure that each subject has been tested in a routine fashion, each DRE must complete a standard Drug Influence Evaluation form.
- The DRE program usually cannot determine which specific drug was ingested.
- Hence, it is the production of reliable data from both the DRE and the forensic toxicologist that is required to prove drug intoxication.

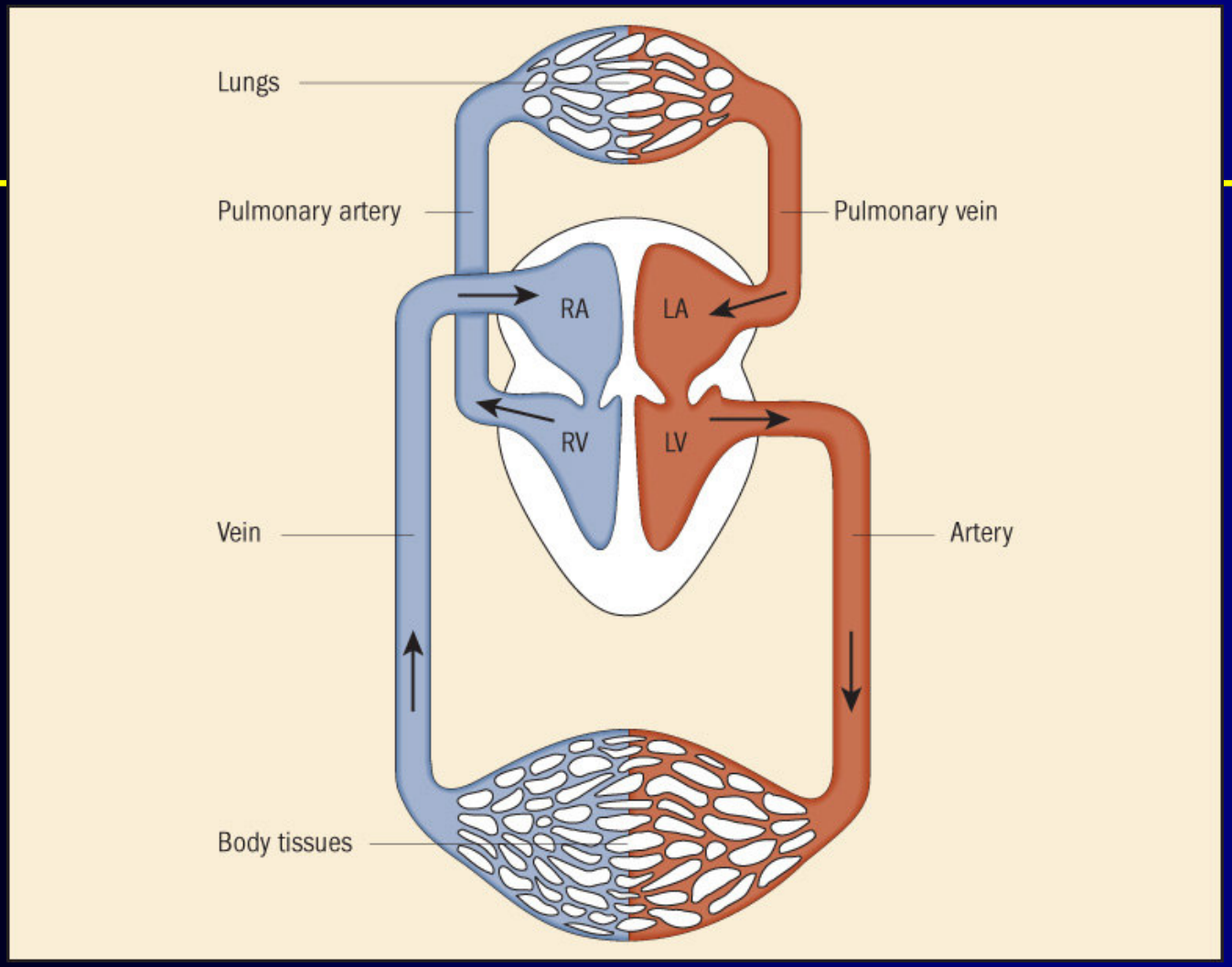


Figure 10–2 Simplified diagram of the human circulatory system. Dark vessels contain oxygenated blood; light vessels contain deoxygenated blood.

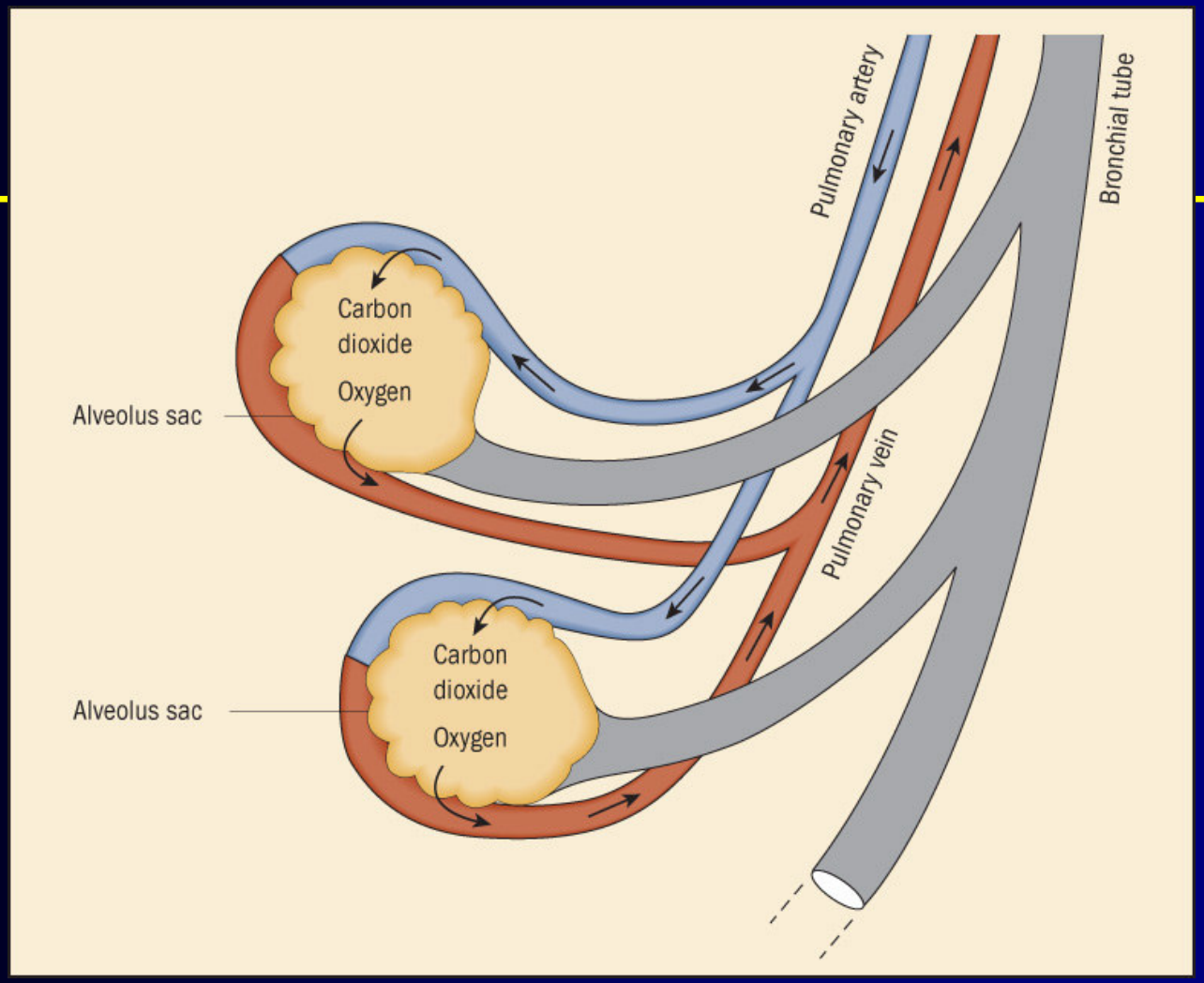


Figure 10–3a Gas exchange in the lungs. Blood flows from the pulmonary artery into vessels that lie close to the walls of the alveoli sacs. Here the blood gives up its carbon dioxide and absorbs oxygen. The oxygenated blood leaves the lungs via the pulmonary vein and returns to the heart.

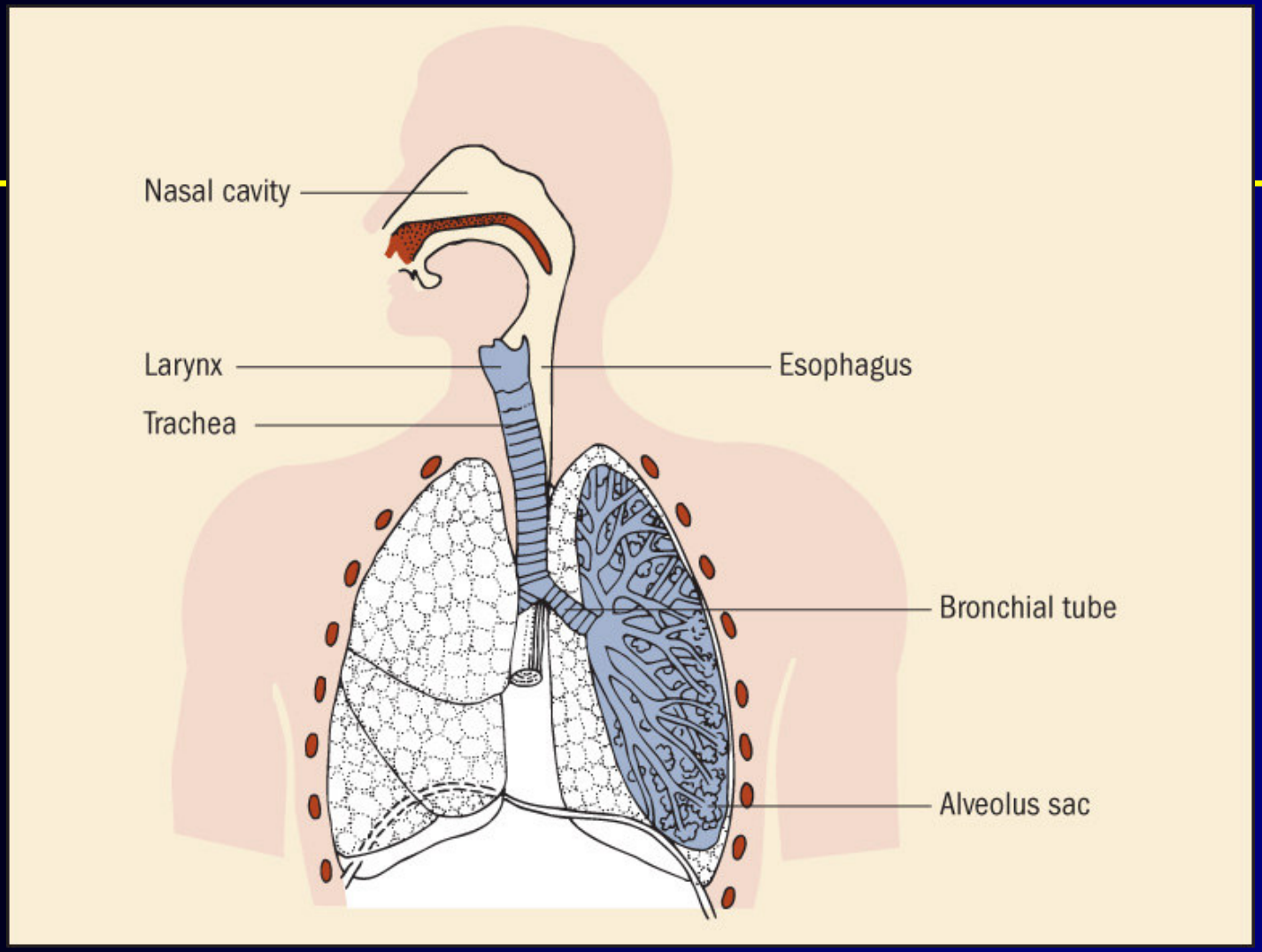
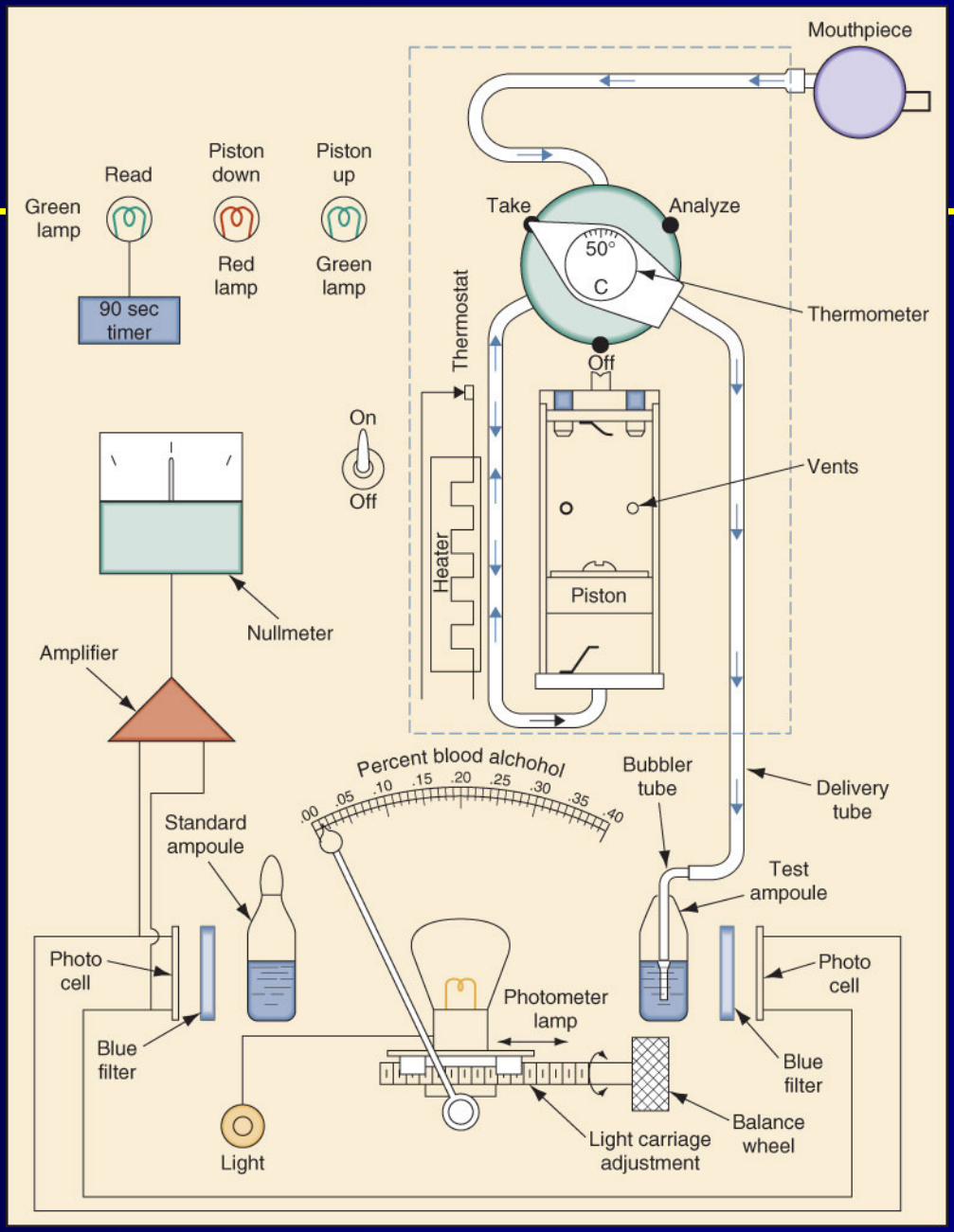


Figure 10–3b The respiratory system. The trachea connects the nose and mouth to the bronchial tubes. The bronchial tubes divide into numerous branches that terminate in the alveoli sacs in the lungs.

Figure 10–4 Schematic diagram of a Breathalyzer. Courtesy Draeger Safety, Inc., Breathalyzer Division, Durango, Colo.



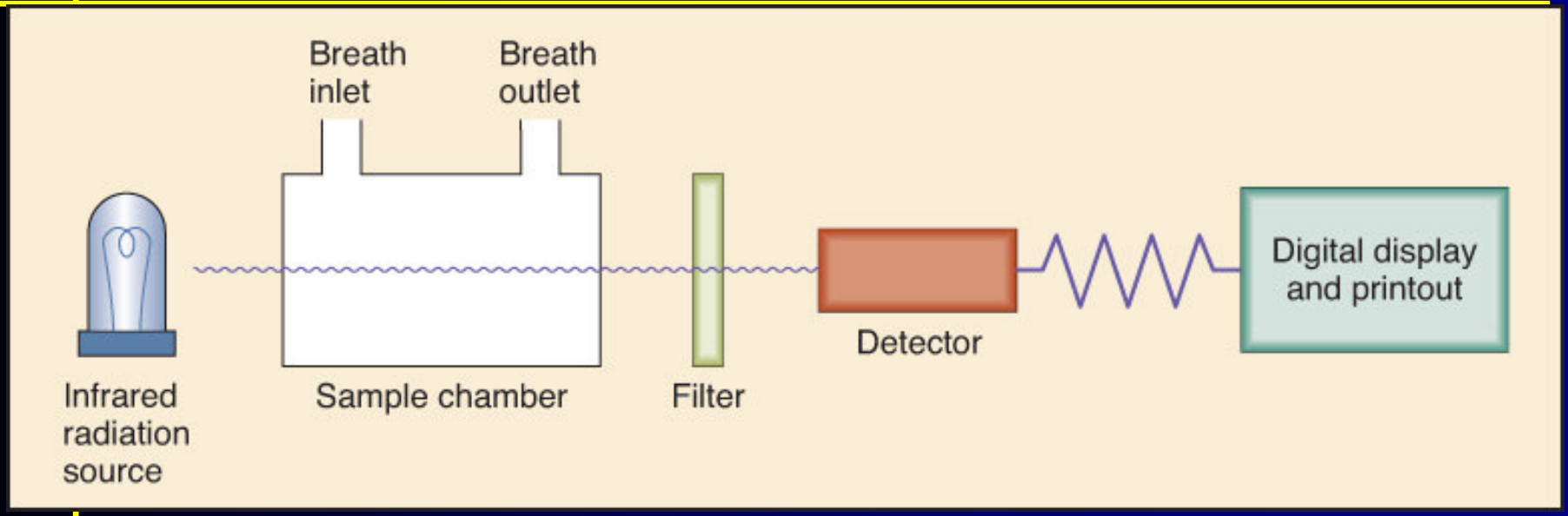


Figure 10–6 Schematic diagram of an infrared breath-testing instrument.

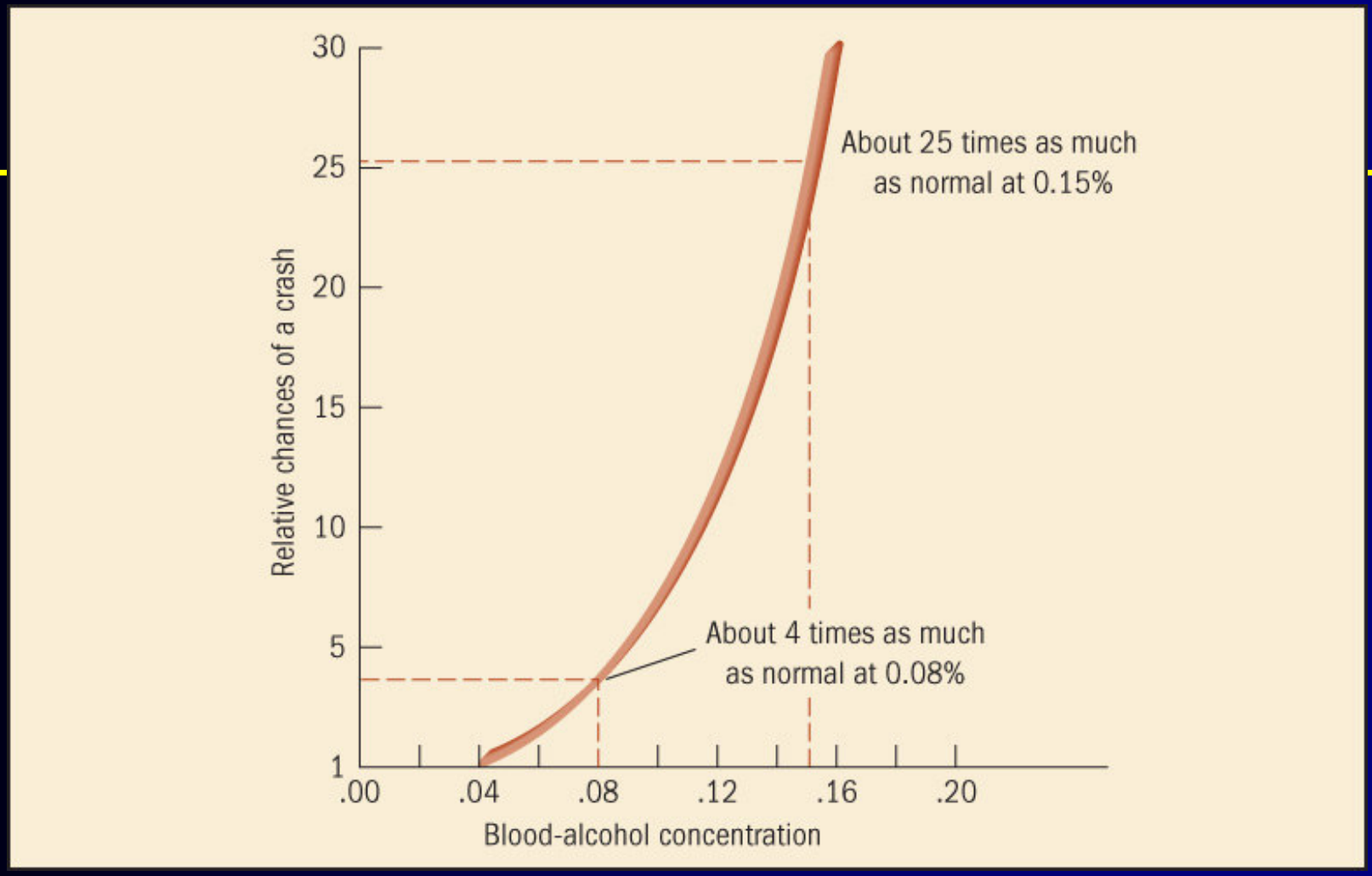


Figure 10–10 Diagram of increased driving risk in relation to blood-alcohol concentration. Courtesy U.S. Department of Transportation, Washington, D.C.

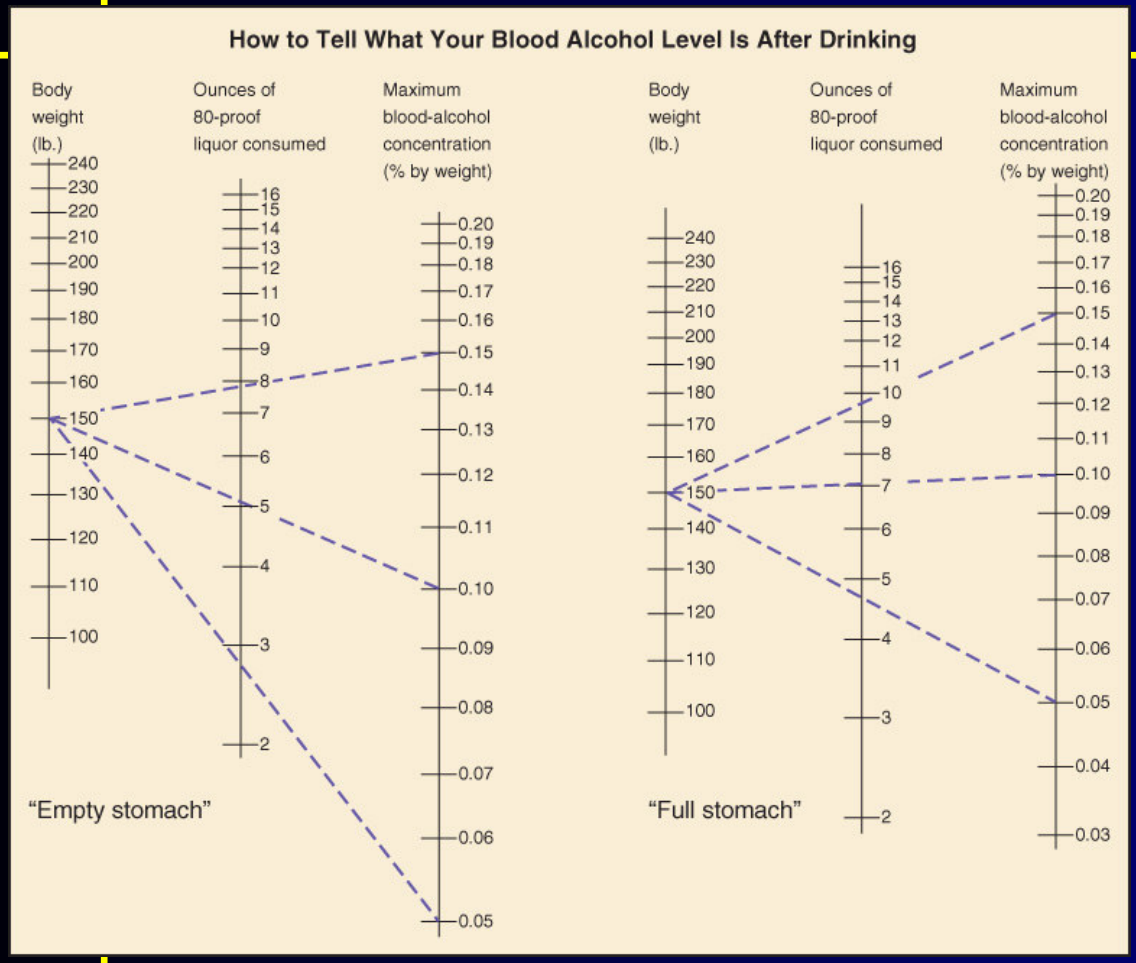


Figure 10–11 To use this diagram, lay a straightedge across your weight and the number of ounces of liquor you've consumed on an empty or full stomach. The point where the edge hits the right-hand column is your maximum blood-alcohol level. The rate of elimination of alcohol from the bloodstream is approximately 0.015 percent per hour. Therefore, to calculate your actual blood-alcohol level, subtract 0.015 from the number in the right-hand column for each hour from the start of drinking.

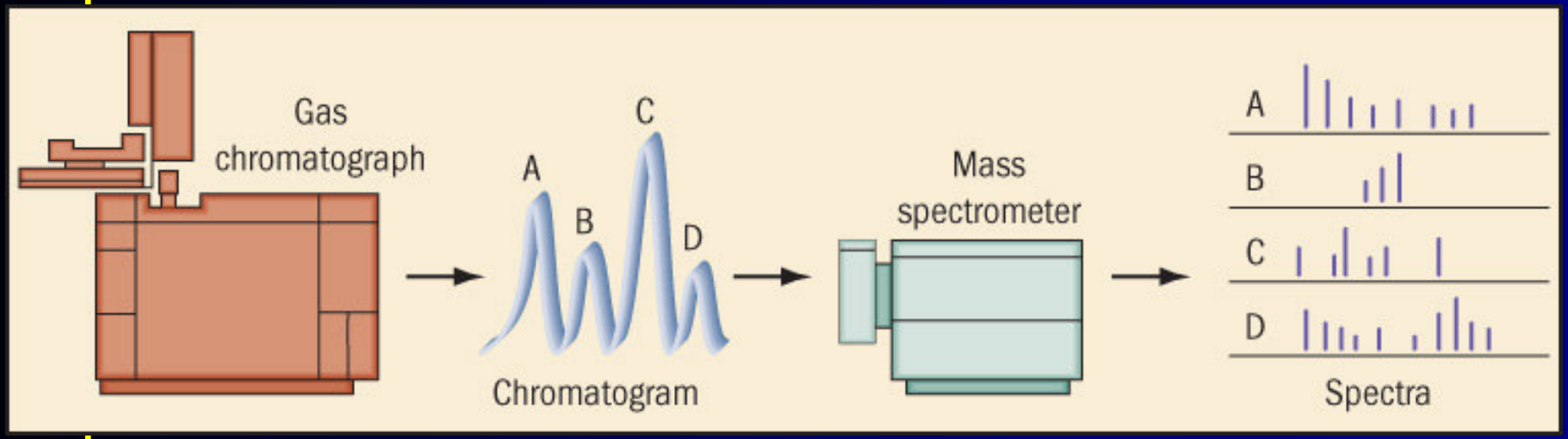


Figure 10–13 The combination of the gas chromatograph and the mass spectrometer enables forensic toxicologists to separate the components of a drug mixture and provides specific identification of a drug substance.