

## EVE 491/591 Toxicology

### Lecture #2

1. Chemicals and their properties
2. Case study - Introduction

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## 2<sup>nd</sup> Anniversary of Haiti Earthquake

- 7.0 on Richter scale ("major" category)
- More than 200,000 dead
- Approximately 1.5 million homeless
  - "Chronic" homelessness in US: < 200,000
- What are some of the toxicological implications of the disaster?
- 2011-2012 Cholera epidemic:
  - The world's largest
  - 7000 dead
  - 500,000 infected

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## Elements, Atoms, & Compounds

- Our bodies are made up of elements that form inorganic and organic compounds
- approximately 99% of our body weight is made up of compounds containing
  - carbon
  - hydrogen
  - nitrogen
  - oxygen
  - calcium
  - phosphorus
  - sulfur

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## Elements, Atoms, & Compounds

- There are also millions of chemical compounds that have no physiological role in the body.
- More than 6 million different chemical compounds are known.
- 80,000 chemical compounds in household and industrial use.
- Thousands of chemicals are synthesized yearly.
- Numerous compounds can be formed with just carbon, nitrogen, hydrogen, oxygen, and sulfur, including some with toxicological importance

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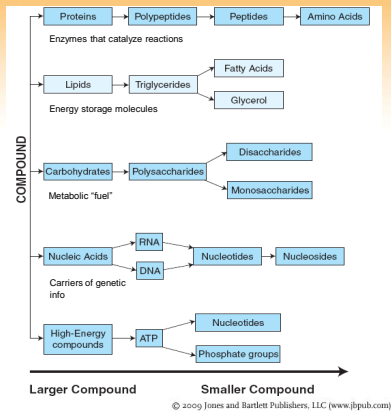
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## Important Compounds of the Body




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## Mixtures, Suspensions, & Aerosols

- A *mixture* is any substance that contains more than one chemical compound or element that has retained its individual properties.
  - Phases? Routes of entry?
- A *suspension* is a mixture of liquid and small solid substances.
  - Phases? Routes of entry?
- An *aerosol (mist)* is a mixture of tiny droplets of a liquid or tiny particles of a solid in a gas.
  - Phases? Routes of entry?

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## Identifying Chemicals

- The chemical structure shows the arrangement of atoms within a compound.
  - Example: "Ethene"
- Chemicals have common names, trade names, technical names, and chemical formulas associated with them.
  - Technical name: Ethene
  - Common name:
  - Chemical formula:

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## Identifying Chemicals

- Manufacturers frequently choose commercial names for their products.
  - What's polytetrafluoroethylene?
- Chemical formula tells us how many atoms of each element are contained within a compound but does not reveal the arrangement.
  - Example: Propanol (C<sub>3</sub>H<sub>8</sub>O) has 3 isomers
    - Can you show them?
  - Different arrangements = different compounds.

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## Physical Properties of Chemicals

- Water Solubility - weight (generally in grams or milligrams) of a substance that can be completely dissolved in 1 liter of water to form a solution
  - Relationship between the solubility of a gas and its health effect upon inhalation?
- pH - refers to how acidic or basic (caustic) a substance is
  - pH of 7 is neutral (e.g. "pure" water)
  - What's the difference between skin contact exposure to a chemical with pH = 1.2 versus one with pH = 13.2?

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## Physical Properties of Chemicals, continued

- *Relative Molecular Mass* - relative weight of a molecule of a chemical compared with the relative weight of an atom of hydrogen

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## Physical Properties of Chemicals, continued

- *Octanol-to-Water Partition Coefficient* -ratio indicates how readily any chemical dissolves in a fatty or oily medium compared with water.
  - A highly water-soluble chemical has a greater affinity for water than for octanol so it has a low partition coefficient
  - a substance with the partition coefficient of 7 is much more lipophilic (fat loving)
  - What's the toxicological implication of exposure to a substance with a high octanol-to-water partition coefficient?

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## Physical Properties of Chemicals, continued

- *Boiling Point* - temperature at which the chemical changes from a liquid state to the gaseous state
  - Toxicological importance?
- *Melting Point* - temperature at which there is a change from a solid to a liquid
  - Toxicological importance?
- *Vapor Pressure* - pressure at which the chemical in the liquid or solid state turns into the gaseous state even at temperatures below the boiling point
  - Toxicological importance?

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## Physical Properties of Chemicals, continued

- Flash Point - temperature at which a substance gives off enough vapor in the air to form an ignitable mixture
- Autoignition Temperature - temperature at which a substance spontaneously burns
  - Difference with respect to gasoline and diesel fuel?
- Flammability - a flammable material can be a solid, liquid, or gas

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## Physical Properties of Chemicals, continued

- Flammability (Explosive) Limits - a range of concentrations for a flammable vapor or gas in air at which an explosion may occur in the presence of a flame or spark
  - lower explosive limit (LEL) is a level below which there is not enough chemical present to burn (i.e., the mixture is too lean)
  - The upper explosive limit (UEL) is a level above which there is too much chemical to burn (i.e., the mixture is too rich)

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## Physical Properties of Chemicals, continued

- Relative Density or Specific Gravity - the ratio of the density of a material to the density of water
  - Substances with a specific gravity of less than 1 are lighter than water so they float
  - Substances with a specific gravity of greater than 1 are heavier than water so they sink
  - Knowing the specific gravity is important for planning spill cleanup and fire-fighting procedures

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### Physical Properties of Chemicals, continued

- *Relative Vapor Density* - the weight of a specific volume of a chemical substance in the gaseous state compared with the weight of the same volume of air
  - Toxicological importance?

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### Physical Properties of Chemicals, continued

- *Odor Threshold* - the smallest concentration of the chemical in the air that can be smelled
  - Usually measured in parts per billion
  - Some chemicals/compounds have odor thresholds that are low enough to provide adequate warning properties
    - Examples?
  - many chemicals have no smell associated with them
    - Examples?

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### Additional Resources

- APPENDIX 2.1 Some Web-Based Resources
- APPENDIX 2.2 Regulatory Agencies That Maintain Lists for Hazardous Chemicals
- APPENDIX 2.3 Regional Poison Control Centers

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## Case Study #1 “Mary Beth”

Refer to the handout provided.

Questions:

- List as many concerns or questions that you would have if you were a resident of Mary Beth's hometown.
- To whom would you look to address your concerns? How would you find answers to your questions?
- Suggest possible explanations for the color in the water.

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