Human Body Systems

Clint Guymon

Brigham Young University

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Learning Outcomes

- Identify major human body systems (e.g., integumentary, respiratory, nervous) and their critical functions.
- Understand the role of specific cell types, such as pneumocytes and erythrocytes, in maintaining life and how they interact with chemical agents.
- Recognize the physiological impact of damage to specific systems, such as the collapse of alveoli or interruption of oxygen transport.

Reading

- Foundations of Spiritual and Physical Safety: with Chemical Processes; Chapter 3, Sections 1-2 (Chemical Lethality).

This section provides an overview of human body systems and toxicology, which are essential for understanding how injuries occur. It covers the anatomy and physiology of major body systems, as well as the principles of toxicology, including dose-response relationships and exposure routes.

Figure 1: AI generated image of parts of the circulatory, respiratory, and digestive systems.

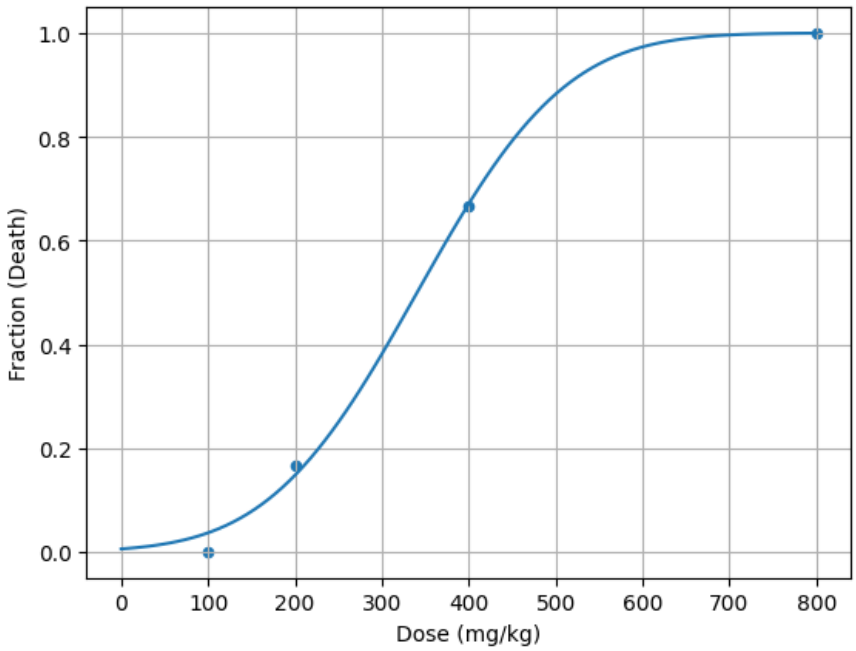
Human Body System	Common Injury Modes
Muscular, skeletal	Slips, trips, falls, heavy or awkward lifting of objects, falling objects, machine crushing or cutting, high-speed or high-energy debris, blast or pressure waves, or blast fragment
Integumentary (skin, ears, eyes)	Cuts, thermal burns, chemical burns, noise, damage to eyes
Nervous, circulatory, digestive, respiratory, excretory, endocrine, reproductive, lymphatic, microbiome	Chemical interactions upon absorption through the skin, inhalation, ingestion, or injection

Figure 2: Un adapted image of an alveolus: a 200 micron diameter air sac found in the bronchi of the lungs. Credit to Katherinebutler1331, used per the Creative Commons Attribution-Share Alike 4.0 International license.

1 Chemical Lethality

```
import numpy as np; import pandas as pd
import matplotlib.pyplot as plt
from scipy.optimize import curve_fit
from scipy.stats import norm
#create a dataframe with the data
df = pd.DataFrame([100,200,400,800], columns=['Dose (mg/kg)'])
df['Fraction (Death)'] = [0/6,1/6,4/6,6/6]
#set function for fitting with curve_fit
def cumulative_gaussian(x, mu, sigma):
    return norm.cdf(x, mu, sigma)
# fit a cumulative gaussian to the data
popt, pcov = curve_fit(cumulative_gaussian, df['Dose (mg/kg)'], df['Fraction (Death)'],p0=[350, 100])

x = np.linspace(0, 800, 100)
y = cumulative_gaussian(x, *popt)
#plot the data and the fit
df.plot(x='Dose (mg/kg)', y='Fraction (Death)', kind='scatter')
plt.plot(x, y, label='fit'); plt.grid()
plt.show()
```



$Y = \text{scipy.stats.norm.ppf}(f) + 5$

where Y is the probit value and f is the mortality fraction of probability.

Action Items

1. Pick a human cell type mentioned in the sources (e.g., pneumocytes or erythrocytes) and research its function; write three paragraphs discussing its specific role in the body and the potential consequences if these cells were damaged by chemical exposure.
2. Explain the pathway through which a chemical entering the respiratory system eventually interacts with cells throughout the body.
3. Plot the linearized version of the plot given in the Figure above.