SFS2. Students will use various scientific techniques to analyze physical and trace evidence.

c. Evaluate how post mortem changes are used to determine probable time of death: rigor mortis, livor mortis, algor mortis, & gastric contents

SFS5. Students will evaluate the role of Forensics as it pertains to Medicolegal Death Investigation.

a. Identify various causes of death (blunt force trauma, heart attack, bleeding, etc.).
b. Analyze evidence that pertains to the manner of death (natural, homicide, suicide, accidental, or undetermined).
What postmortem changes allow the determination of time of death?

How do preliminary investigations and medico-legal autopsies allow for determination of TOD and cause of death?

How are cause, manner and mechanism of death identified and distinguished?
Various sciences study the decomposition of bodies to determine the time and cause of death for legal purposes:

- Forensic taphonomy
- Forensic entomology
- Forensic anthropology
- Forensic pathology
Forensic taphonomy is the study of the postmortem changes to human remains, focusing largely on environmental effects—including decomposition in soil and water and interaction with plants, insects, and other animals.

Relationship to Forensic Science
Forensic entomology is the study of insects/arthropods in criminal investigation. It is of particular interest when:
- Establishing the geographical location of death
- Associating a victim and suspect
- Identifying the sites of trauma
- Determining time of death
- Providing alternative toxicology and DNA samples
Forensic anthropology is a sub-field of physical anthropology that involves applying skeletal analysis and techniques in archaeology to solving criminal cases. It is of particular interest when identifying remains or cause of death when other physical characteristics no longer exist.

- War crimes, mass fatalities, historical gravesites
Forensic pathology is a subspecialty of pathology dealing with the examination of persons who die suddenly, unexpectedly or violently.

A forensic pathologist, coroner, or medical examiner is responsible for the following tasks:

- Identification of the decedent
- Determining time of death (TOD) or post-mortem interval (PMI)
- Conducting an autopsy
- Determining cause of death
Life is dependent on the interrelation of three systems:
- Circulatory
- Respiratory
- Central Nervous System

Failure of anyone one of these systems leads to death.
What is death?

- Death occurs when there is a permanent loss of capacity from consciousness and loss of all brainstem functions.
- This may result from permanent cessation of circulation and/or after catastrophic brain injury.
Identification of the Decedent

To facilitate identification of a corpse, the following information is gathered:

- Physical Description
- Scars and Marks
- Fingerprints
- Photographs
- Dental Features
- Radiological (x-ray) Evidence
- Blood factors
- Medical Indications
Determining Time of Death

- Generally, time of death (TOD) is estimated from certain physical and chemical changes that occur with regularity in the body following death.
- Post-mortem interval (PMI) is the time that has elapsed since death.
  - Subtracting PMI from current time will give you TOD.
Physical Changes
1. Pallor Mortis – loss of color from skin
2. Livor Mortis – pooling of blood in tissues
3. Rigor Mortis – stiffening of the muscles
4. Algor Mortis – cooling of the body
5. Ocular Changes – changes in the eyes
6. Gastric Contents – emptying of stomach

Chemical Changes
1. Autolysis – enzymatic self-destruction
2. Putrefaction – bacterial decomposition
Defined as ‘Paleness of Death’

- Describes changes in skin tone
- Happens 15-20 minutes after death
- Is due to lack of capillary circulation in the body.
- Cannot be used to determine time of death except if body is found still with color (within 30 minutes of death)
TOD – Livor Mortis

- Defined as ‘Color of Death’
  - Describes changes in skin coloration

At death, the heart stops working. **Because the blood stops circulating,** the blood accumulates in the tissues closest to the floor, producing a purplish-blue discoloration called **lividity**.
Lividity appears in 1-2 hrs after death; clotting (fixed) in 6-10 hrs

A line forms after 8 hrs if the body hasn’t been moved. If moved, a new line starts to form.

Lividity does **not** develop in tissues contacting another surface, as the capillaries are compressed.
TOD – Livor Mortis
TOD – Rigor Mortis

- Defined as ‘Stiffness of Death’.
  - Describes changes in the flexibility of the body
  - Immediately after death the body is limp due to relaxation of the muscles
  - Develops 5-7 hrs after death, peaks 8-12 hrs after death, and dissipates 24-36 hrs after death
  - Moves from head to toe (eyelids first, then the jaw, face, trunk, arms, legs)
Defined as ‘Coolness of Death’.

- Describes the changes in body temperature
- This happens because at death, the body’s ability to maintain temperature ceases
- Typically these measurements are taken rectally or by inserting a probe into the liver (at least twice with an hour between)
Rate of cooling depends on ambient air temperature, the type and amount of clothing, and the mass of the body.

In a controlled environment, starting at 98.6°F (37°C), the body temperature will drop faster (2°C) in the first hour and slower (1°C) each subsequent hour until ambient temperature is reached.
TOD – Ocular Changes

- **Corneal changes**
  - Dependent on whether eyes are open or closed
  - Thin film may form in a few minutes, cloudiness in two to three hours

- **Pupillary changes**
  - Dilation at death, constriction as rigor sets in

- **Potassium levels**
  - Increase steadily after death
TOD – Ocular Changes

Post-mortem changes in the eye: "tache noire".
B. Knight. Forensic Pathology, 1996.
Gastric Contents

Time of death can be approximated by appearance and amount of stomach contents; HOWEVER, it has a great degree of imprecision and should not be relied upon for accuracy
TOD – Gastric Contents

- **General Rules**
  - Under ordinary circumstances, the stomach empties 4-6 hrs after a meal
  - Small intestine empties ~12 hrs after a meal
TOD – Decomposition

Fresh (autolysis)

Bloat (putrefaction)

Active Decay (purge)

Advanced Decay (post-decay)

Remains (skeletonization)
Fresh (Autolysis) 1-2 days

- Once blood no longer circulates, the cells begin to lose structural integrity, causing them to rupture.
- This releases cellular enzymes which begin to break down the surrounding cells and tissues – autolysis.
- Although this degradation is not typically externally visible, blisters may appear at the surface of the skin.
TOD – Decomposition

- **Bloat (Putrefaction) 2-6 days**
  - Occurs as a result of bacteria and other microorganisms
  - Abdomen inflates from gases produced during bacterial decomposition
  - Fluids and liquified tissues froth and escape through orifices
  - Skin marbles as hemoglobin is converted to other pigments
  - Maggot activity is evident
  - Noticeably distinct odor of death
TOD – Decomposition

- **Adipocere**
  - Results from the anaerobic bacterial hydrolysis of body fat; replaces putrefaction
  - Occurs best in moist, anaerobic environments, such as in wet ground, mud on a lake bottom, or sealed casket

- **Mummification**
  - Typically occurs in warm, arid conditions, resulting in desiccation, rather than putrefaction
TOD – Decomposition

- **Active Decay (Purge) 5-11 days**
  - Deflation or rupture of body
  - Period of greatest mass loss from maggot activity and purging of fluids
  - Tissues appear wet and odors become more pronounced
  - Once maggots are fed, they migrate to begin pupation
Advanced Decay (dry) \textit{10-24 days}

- Decomposition slows, as most flesh is stripped from the skeleton
- Strong odors begin to subside
- Cheese-like smell may persist (butyric acid)
- Vegetation death in surrounding soil
- Beetles arrive to breakdown tougher tissues
Remains (skeletonization) **24+ days**

- Bones, some dried skin, and cartilage is left
- No odor of decay
- Bones may be sun-bleached if exposed
Factors Affecting Decomposition

- **Temperature/humidity**
  - Lower temps slow down microbes & insects
  - Low humidity dries corpse, mummifies

- **Access**
  - Submerged vs. on land
  - In open vs. interred vs. in shade

- **Reduction & Cause of Death**
  - Large wounds lead to faster decomposition
  - Scavengers/vertebrate predators important too
Factors Affecting Decomposition

- **Coverings**
  - Tightly wrapped bodies decompose slower
  - Heavy clothing slows decomposition more than thinner clothing

- **Percent of body fat in corpse**
  - More fat (higher water content, better heat retention) means faster decomposition

- **Drugs & chemicals**
  - Insects on coke or meth burn through a body faster, bodies with arsenic decompose slower.
TOD – Decomposition

Images of Various Human Postmortem Changes

Images of the Stages of Porcine Decomposition
Conducting an Autopsy

- A medico-legal autopsy seeks to find the cause and manner of death and to identify the decedent.
- Consists of an external exam, an internal exam, and the reconstitution of the body.
- A formal report is issued concluding cause of death.
Conducting an Autopsy

- External exam includes:
  - photography of body
  - external evidence collection
  - detailed description of any trauma
  - cleaning, weighing and measuring of body
  - general description of body
Conducting an Autopsy

- Internal exam includes:
  - dissection and detailed description and measurement of internal state of body
  - testing of organs and body fluids for drugs and poisons
Conducting an Autopsy

- **Dissection**
  - Chest cavity is opened with a Y-shaped incision
  - Front portion of ribs is removed, as a unit
  - Organs are removed in a systematic fashion
  - Organs are examined, weighed, and sliced for tissue sampling
  - Stomach and intestinal contents are examined and weighed
  - Brain is examined, removed, and preserved
Determining Cause of Death

- **Cause** of Death: the injury or illness that is incompatible with life
  - Immediate cause – the *final* step in the chain
  - Proximate (underlying) cause(s) – the *prior* step(s) in the chain
- **Mechanism** of Death: how the body has malfunctioned, resulting in death
  - Typically not reported on death certificates
- **Manner** of Death: the category of death
Causes of Death

Top 10 Global Causes of Death
- Heart disease
- Stroke
- Chronic obstructive pulmonary disease
- Pneumonia and influenza
- Alzheimer disease and other dementias
- Lung cancer
- Diabetes
- Road injury
- Diarrheal disease
- Tuberculosis

Top 10 US Causes of Death
- Heart disease
- Cancer
- Accidents
- Chronic lower respiratory diseases
- Stroke
- Alzheimer’s disease
- Diabetes
- Pneumonia and influenza
- Kidney disease
- Suicide
Manners of Death

The five manners of death are

- **Natural** – 90% of all deaths in US
- **Accidental** – 4%
- **Homicidal** – <1%
- **Suicidal** – 2%
- **Undetermined** – 3%
Death by natural causes is due solely or nearly totally to disease and/or the aging process.

The majority of natural death is caused by old age.

Includes heart disease, stroke, genetic disorders, etc.
Accidental death is often caused by mistake or in a freak occurrence.
There is little or no evidence that the injury occurred with intent to harm or cause death.
Includes falls, auto accidents, electrocution, etc.
The term ‘homicide’ refers to the act of killing another person.
Homicide is often the most investigated death, therefore making it the most autopsied.
Homicidal Death

- Non-criminal (self-defense, war, capital punishment)
- Criminal
  - Murder – unlawfully and with ‘malice aforethought,’ either express or implied, causing the death of another human being
    - Georgia Law does not distinguish between degrees of murder
    - Punished by death or by imprisonment for life
Homicidal Death

- Manslaughter – killing without premeditation
  - Voluntary – involves provocation
    - Punishable by imprisonment for 1 to 20 years
  - Involuntary – involves negligence
    - Punished by imprisonment for 1 to 10 years (or less)
Suicidal Death

- **Suicide** is the act of ending one’s own life.
- Autopsies often easily identify source, cause, and other factors of the death.
- Includes self-inflicted gunshot wounds, drug overdoses, self-hangings, etc.
Undetermined is intended for cases in which it is impossible to establish, with reasonable medical certainty, the circumstances of death after thorough investigation.

- Includes deaths *in absentia*, SIDS, etc.
On January 2, 2003, a 21-year-old female was critically injured in an automobile accident and died from a fractured skull causing cerebral contusion soon after being brought to the hospital. Police records indicated she was the driver in a two-car collision that occurred at 2:15 a.m. at the corner of 21st Street and Ash Street. The decedent crossed the center line and struck an oncoming car head on. Autopsy showed injuries and blood ethanol of 0.240 grams percent.
Possible Scenario #1

- **Cause**—cerebral contusion due to fractured skull due to blunt impact to head due to car collision
- **Mechanism**—intracranial hemorrhage
- **Manner**—accident
**CAUSE OF DEATH (See instructions and examples)**

32. **PART I.** Enter the chain of events—diseases, injuries, or complications—that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.

**IMMEDIATE CAUSE (Final disease or condition resulting in death)**

- Cerebral contusion
- Fractured skull
- Blunt impact to head
- Collision of two motor vehicles

**UNDERLYING CAUSE (disease or injury that initiated the events resulting in death) LAST**

- Due to (or as a consequence of):
- 30 minutes

**PART II.** Enter other significant conditions contributing to death but not resulting in the underlying cause given in PART I.

Acute ethanol intoxication

33. **WAS AN AUTOPSY PERFORMED?**  
   - Yes  □ No

34. **WERE AUTOPSY FINDINGS AVAILABLE TO COMPLETE THE CAUSE OF DEATH?**  
   - Yes  □ No

35. **DID TOBACCO USE CONTRIBUTE TO DEATH?**  
   - Yes  □ Probably  □ No  □ Unknown

36. **IF FEMALE:**
   - □ Not pregnant within past year
   - □ Pregnant at time of death
   - □ Not pregnant, but pregnant within 42 days of death
   - □ Not pregnant, but pregnant 43 days to 1 year before death
   - □ Unknown if pregnant within the past year

37. **MANNER OF DEATH**
   - □ Natural  □ Homicide
   - □ Accident  □ Pending Investigation
   - □ Suicide  □ Could not be determined

38. **DATE OF INJURY (Mo/Day/Year) (Spell Month)**
   - January 2, 2003

39. **TIME OF INJURY**
   - 0215

40. **PLACE OF INJURY** (e.g., Decedent's home; construction site; restaurant; wooded area)
   - City street

41. **INJURY AT WORK?**  
   - □ Yes  □ No

42. **LOCATION OF INJURY:**  
   - State: Nevada  
   - City or Town: Xylene
   - Street & Number: 21st and Ash Street

43. **DESCRIBE HOW INJURY OCCURRED:**
   - Decedent unrestrained driver in an auto-auto collision. Decedent crossed line and hit oncoming vehicle head on.

44. **IF TRANSPORTATION INJURY, SPECIFY:**
   - □ Driver/Operator  □ Passenger  □ Pedestrian  □ Other (Specify)
On October 1, 2003, at 2:30 p.m., a 22-year-old male was found hanging by the neck in the garage at the rear of his residence. He had a history of despondency and drug abuse and was last seen by his mother 30 minutes earlier.
Possible Scenario #2

- **Cause**—Asphyxnia due to hanging by the neck
- **Mechanism**—cerebral hypoxia/anoxia
- **Manner**—suicide
**CAUSE OF DEATH (See instructions and examples)**

32. **PART I.** Enter the chain of events—diseases, injuries, or complications—that directly caused the death. DO NOT enter terminal events such as cardiac arrest, respiratory arrest, or ventricular fibrillation without showing the etiology. DO NOT ABBREVIATE. Enter only one cause on a line. Add additional lines if necessary.

- **IMMEDIATE CAUSE** (Final disease or condition resulting in death)
  - a. **Asphyxia**
    - Due to (or as a consequence of):
  - b. **Hanging by the neck**
    - Due to (or as a consequence of):
  - c. ________________
    - Due to (or as a consequence of):
  - d. ________________
    - Due to (or as a consequence of):

- **Sequentially list conditions, if any, leading to the cause listed on line a. Enter the UNDERLYING CAUSE (disease or injury that initiated the events resulting in death) LAST**
  - ________________

**PART II.** Enter other significant conditions contributing to death but not resulting in the underlying cause given in PART I.

- Substance abuse, depression

**33. WAS AN AUTOPSY PERFORMED?**
  - □ Yes  □ No

**34. WERE AUTOPSY FINDINGS AVAILABLE TO COMPLETE THE CAUSE OF DEATH?**
  - □ Yes  □ No

**35. DID TOBACCO USE CONTRIBUTE TO DEATH?**
  - □ Yes  □ Probably  □ No  □ Unknown

**36. IF FEMALE:**
  - □ Not pregnant within past year
  - □ Pregnant at time of death
  - □ Not pregnant, but pregnant within 42 days of death
  - □ Not pregnant, but pregnant 43 days to 1 year before death
  - □ Unknown if pregnant within the past year

**37. MANNER OF DEATH**
  - □ Natural  □ Homicide
  - □ Accident  □ Pending Investigation
  - □ Suicide  □ Could not be determined

**38. DATE OF INJURY** (Month/Day/Year) (Spell Month)
  - October 1, 2003

**39. TIME OF INJURY**
  - 1430

**40. PLACE OF INJURY** (e.g., Decedent’s home; construction site; restaurant; wooded area)
  - Garage at decedent’s home

**41. INJURY AT WORK?**
  - □ Yes  □ No

**42. LOCATION OF INJURY:**
  - State: Kansas
    - City or Town: Wichita
  - Street & Number: 217 Kirk Avenue
  - Zip Code: 67204-6666

**43. DESCRIBE HOW INJURY OCCURRED:**
  - Hanging by rope from rafters

**44. IF TRANSPORTATION INJURY, SPECIFY:**
  - □ Driver/Operator
  - □ Passenger
  - □ Pedestrian
  - □ Other (Specify)
Terms to Know

- **Trauma** – a physical wound or injury
  - **Blunt** – closed contusion
    - Most are caused by motor vehicle accidents
  - **Penetrating** – open wound
    - Most are caused by firearms
Asphyxia – forms of external hypoxia (deficit of oxygen to the brain)

- Suffocation
- Smothering/Gagging
- Choking
- Throttling
- Strangulation
Terms to Know

- **Petechial hemorrhage** – a tiny pinpoint red mark often indicating death by strangulation, hanging, or smothering.
Septicemia (sepsis) – the result of a massive immune response to blood poisoning by bacteria (staph, E. coli, strep)

- If it progresses to *septic shock*, the death rate is as high as 50%
- 1 in 3 hospital deaths result from sepsis