CHATTANOOGA STATE COMMUNITY COLLEGE
CHATTANOOGA, TENNESSEE
ALLIED HEALTH DIVISION
SEMESTER SYLLABUS

RADIOBIOLOGY AND RADIATION PROTECTION (RT 2543)

CLASS HOURS: 4 CREDITS: 4
LABORATORY HOURS: 3

CATALOG COURSE DESCRIPTION:
A study of the effects of ionizing radiation in biological systems; radiation units; radiation protection standards for patients, occupationally exposed, general public and special groups; design of medical diagnostic laboratories; and radiation monitoring devices.

ENTRY LEVEL SKILLS:
A basic understanding of cell structure and function; the interaction of radiation with matter; mathematical skills; and basic physics and chemistry concepts are necessary for successful completion of this course.

PREREQUISITES:
MATH 1710, and CHEM 1010 or high school chemistry. Must be a radiologic technology student.

TEXTBOOK AND OTHER REFERENCE MATERIAL BASIC TO THE COURSE:
Travis, E.L., Primer of medical radiobiology, 2nd ed., Yearbook Medical Publishers, 1989.
Sherer, M.A.S., P.J. Visconti and E.R. Ritenour, Radiation Protection in Medical Radiography, 4th ed., Mosby Inc., St. Louis, MO 63146, 2002.

Required Student Learning Outcomes (Program Student Learning Outcomes and Course Student Learning Outcomes):
(PSLO 1-9 are covered in different courses. If a PSLO is not identified here it is not addressed in this course.)

PSLO#2. Apply the principles of x-ray production, x-ray interactions with the body, and the biological effect of exposure to ionizing radiations in the performance of medical imaging procedures to protect the patient, self and others.

- CSLO #1 Understand and explain the fundamental concepts of radiation biology.
- CSLO #2 Understand and correctly employ the appropriate units utilized in radiation protection.
- CSLO #3 Know and follow the appropriate regulations related to radiation protection.
- CSLO #4 Understand and carry out operational radiation protection programs.
- CSLO #5 Understand and utilize appropriate documentation requirements for radiation protection and radiation survey results.
- CSLO #6 Well acquainted with somatic cell mitosis in *Allium* (onion) root tips.
- CSLO #7 Familiar with radiation-induced chromosome aberrations in *Allium* (onion) root tips.
- CSLO #8 Introduced to radiation-induced somatic changes in dormant seeds.
- CSLO #9 Able to determine the somatic mutation frequency in irradiated *Tradescantia*.
- CSLO #10 Keenly aware of the effects that changes in kV and mAs produce in patient dose.
- CSLO #11 Introduced to the lethal effects of ultraviolet radiation on bacteria plus the capability of certain bacteria to enzymatically repair sublethal damage.

Other Learning Indicators or Objectives (optional): The student will be able to:

Sherer, Chapter 1

1. Define and explain:
   - radiation protection
   - biologic effects of radiation
   - diagnostic efficacy
   - occupational & non-occupational dose limits
   - As Low As Reasonably Achievable (ALARA)
   - optimization for radiation protection (ORP)
   - background equivalent radiation time (BERT)

radiation
electromagnetic wave
ionization
radiation dose
equivalent dose (H_T)
International System of Units (SI)
sievert (Sv)
traditional system of units
rem
effective Dose (E)
biologic damage
cellular damage
organic damage
lymphocyte
natural background radiation
radon
isotope
cosmic rays
radionuclides
manmade (artificial) radiation
TMI-2 nuclear power plant accident
ETHOS Project
Entrance Skin Exposure (ESE)

2. Explain the justification and responsibility for radiologic procedures.
3. Explain how diagnostic efficacy of a radiographic procedure can be maximized.
4. Explain how imaging professionals can help ensure that both occupational and nonoccupational dose limits remain well below maximal allowable levels.
5. List employer requirements for implementing and maintaining an effective radiation safety program in a facility that provides imaging services.
6. List radiation worker requirements that must be met to maintain an effective radiation safety program.
7. Explain how radiographers should answer patient questions about the potential risk of radiation exposure from an imaging procedure.
8. List the different forms of electromagnetic radiation.
9. Explain the concept of equivalent dose and effective dose.
10. Discuss the significance of the sievert as a unit of measure for equivalent dose.
11. Describe the potential for ionizing radiation to cause biologic damage.
12. List and describe three sources of natural background ionizing radiation, as well as six sources of manmade (artificial) ionizing radiation.
13. Discuss local and/or global consequences of radiation exposure resulting from accidents in nuclear power plants.
14. Discuss the responsibility and need for radiation protection in medical imaging.
15. State the way electromagnetic radiation frequency and energy change as the wavelength becomes shorter.
16. Know the value of Plank's Constant; be able to calculate the energy (in eV) of an electromagnetic wave when you are given the wavelength (ν).
17. State the average overall annual radiation equivalent dose for the U.S.A.
18. State the percentage of the total average effective dose to the U.S. population that is collectively contributed by diagnostic medical x-rays and nuclear medicine procedures.
19. Know what percent that radon contributes to natural background radiation in the U.S.A.
20. Name the terrestrial radiation considered by the Environmental Protection Agency (EPA) to be the second leading cause of lung cancer in the U.S.A.
21. Give four examples of radionuclides that exist in small quantities within the human body.
22. Know what type of link exists between radiation released during the TMI-2 nuclear power plant accident and cancer deaths among persons living in the area of the accident.
23. State the relative quantities of radioactive material released in the accidents at TMI-2 and Chernobyl nuclear power plants.
24. Name the main adverse health effect of the 1986 Chernobyl nuclear power plant accident.
25. List three reasons that patient dose for each radiographic examination varies.
26. Name the x-ray exam(s) that give(s) the highest typical bone marrow dose.
27. List the x-ray exam(s) giving the highest typical gonad dose to the male and to the female.

28. Name the x-ray exam(s) giving the highest typical fetal dose factors as a function of entrance skin exposure.

Sherer, Chapter 2

1. Define and describe the following terms:
   - absorbed dose (d)
   - absorption
   - attenuation
   - characteristic photon
   - coherent scattering
   - Compton scattering
   - contrast media (positive, negative)
   - effective atomic number
   - exit (image formation) photons
   - fluorescent yield
   - mass density
   - milliampere-seconds (mAs)
   - pair production
   - peak kilovoltage (kVp)
   - photodisintegration
   - photoelectric absorption
   - photoelectron
   - primary radiation
   - radiographic contrast
   - radiographic density
   - radiographic fog
   - radiographic image receptor
   - small-angle scatter
2. Differentiate between peak kilovoltage (kVp) and milliampere-seconds (mAs) as technical exposure factors.
3. Describe the process of absorption and explain the reason why absorbed dose in atoms of biologic matter should be kept as small as possible.
4. Differentiate between primary radiation, exit (image formation) radiation, and scattered radiation.
5. List two types of x-ray photon transmission and explain the difference between them.
6. Discuss the way x-rays are produced and explain the range of energies present in the x-ray beam.
7. List the events that occur when x-radiation passes through matter.
8. Discuss the probability of photon interaction with matter.
9. Describe and illustrate by diagram the x-ray photon interactions with matter that are important in diagnostic radiology.
10. List the x-ray photon interactions with matter that occur above the energy range used in diagnostic radiology.
11. Describe the impact of positive contrast media on photoelectric absorption and identify its effects regarding absorbed dose in the body structure that contains it.
12. Describe the effect of increasing kVp on radiographic image quality and absorbed dose.
13. Describe the nature of the negative effects that may result to the patient due to the absorption of x-ray energy.
14. Describe the property of various body structures that make the radiographic imaging of human anatomy possible.
15. State the effect of scattered radiation to the
    - a) patient
    - b) radiographer
    - c)radiograph
16. Name the type of interaction of x-radiation with matter that forms the basis of radiographic imaging.
17. State which interaction of x-radiation with matter is the bane of radiographic imaging.
18. Name three variables that radiographers must balance to arrive at technical exposure factors that will provide an acceptable image yet stay within the standards of radiation protection.
19. State the probability of photoelectric interaction as:
    - a) photon energy, E, changes
    - b) atomic number, Z, changes
20. State the probability of Compton Scattering as:
    - a) E changes
    - b) Z changes
21. Name the x-ray interaction with matter in which the energy of the incident photon is
    - a) reduced

b) absorbed
c) unchanged

22. Identify the fate of a Compton scattered electron.
23. State the process that results in the majority of scattered radiation produced during radiographic processes.
24. Name three things that influence attenuation.
25. Know the characteristic that primarily differentiates the probability of occurrence of the various interactions of x-radiation with human tissue.
26. State the type of interaction between x-radiation and matter that leads to radiographic fog.
27. Describe the way patient dose varies when kVp is decreased within the energy range of diagnostic radiology that includes mammography (23-150 kVp).
28. Describe the effect on Photoelectric interaction and on absorbed dose of ingesting or injecting into human tissue a high atomic number solution to visualize it during an imaging procedure

Sherer, Chapter 3

1. Define and describe the following:
   - absorbed dose (D)
   - collective effective dose (S_E)
   - coulomb per kilogram (C/kg)
   - dose equivalent (DE)
   - effective dose (E)
   - effective dose equivalent (H_E)
   - equivalent dose (H_T)
   - exposure (X)
   - genetic (heritable) effects
   - Gray (Gy)
   - International System of Units (SI)
   - linear energy transfer (LET)
   - long-term or late somatic effects
   - occupational exposure
   - quality factor
   - rad
   - radiation weighting factor (W_R)
   - rem
   - roentgen (R)
   - sievert (Sv)
   - short-term somatic effects (acute or early effects)
   - somatic damage
   - tissue weighting factor (W_T)
   - traditional units
2. Explain the concept of skin erythema dose, tolerance dose, and threshold dose.
3. Differentiate between the following radiation quantities: exposure, absorbed dose, dose equivalent, equivalent dose, and effective dose, identifying the appropriate symbol for each.
4. List and explain the International System (SI) and traditional units for radiation exposure, absorbed dose, dose equivalent, equivalent dose, and effective dose.
5. Describe the function of a tissue weighting factor.
6. Determine the effective dose when given the numeric value for an absorbed dose in gray (rad), the radiation weighting factor for the type and energy of radiation in question, and the tissue weighting factor.
7. State the purpose of the radiation quantity, collective effective dose, and list its International System and traditional unit.
8. Explain the importance of linear energy transfer as it applies to biologic damage resulting from irradiation of human tissue.
9. Explain the function of a quality factor and identify this factor for each of the ionizing radiations.
10. State the formula for determining dose equivalent and equivalent dose.
11. Determine the dose equivalent in terms of SI and traditional units when given the quality factor and absorbed dose for different ionizing radiations.
12. Determine the equivalent dose in terms of SI and traditional units when given the radiation weighting factor and the absorbed dose for different ionizing radiations.
13. Explain the concept of effective dose when used for radiation protection purposes.

14. Give the unit by which LET is expressed.
15. Name the SI and traditional unit used for radiation exposure in air.
16. Specify the method used to calculate effective absorbed dose for all types of ionizing radiation.
17. Name the radiation quantity used to specify how biological damage from different types and doses of radiation will be equivalent if correct weighting factors are included.
18. State the quantity of choice for describing the way the same effective amount of damage can be attained by giving different equivalent doses to different organs.
19. Specify the radiation quantity used when calculating group/population radiation exposure from low doses of different sources of ionizing radiation. Give the unit used to express this quantity.
20. Give the formula for calculating effective dose.
21. Give the formula for calculating dose equivalent.
22. Give the formula for calculating equivalent dose.
23. Explain the concept of tissue weighting factor (W_T) is designed to do.
24. Specify the radiation quantity that accounts for some biological tissues being more sensitive to radiation damage than other tissues.

Sherer, Chapter 4

1. Name and describe the function of the 4 major organizations that share the responsibility for evaluating the relationship between radiation equivalent dose and induced biologic effects.
2. List and describe the function of the 5 U.S.regulatory agencies responsible for enforcing established radiation effective dose limiting standards.
3. State the function of the radiation safety committee (RSC) in a medical facility and describe the role of the radiation safety officer (RSO) by listing the responsibilities he/she must fulfill.
4. Differentiate between effective dose limit and the effective dose limiting system.
5. State the purpose of the Radiation Control for Health and Safety Act of 1968.
6. Explain the purpose of the Consumer Patient Health and Safety Act of 1981.
7. List the important provisions of the code of standards for diagnostic x-ray equipment that began on August 1, 1974.
8. Explain the ALARA concept.
9. State the current radiation protection philosophy and give the goal and the 3 objectives of radiation protection.
10. Define nonstochastic (deterministic) effects of radiation.
11. Define stochastic (probabilistic) effects of radiation.
12. Name 4 early nonstochastic (deterministic) radiation-induced responses that are of serious concern for radiation protection.
13. List 6 late deterministic (nonstochastic) radiation-induced responses that are of serious concern for radiation protection.
14. Name the 3 stochastic (probabilistic) radiation-induced responses that are of erious concern for radiation protection.
15. Explain the concept of risk as it relates to the medical imaging industry.
16. Explain the concept of radiation hormesis.
17. Describe the risk from exposure to ionizing radiation at low absorbed doses.
18. Know and correctly state the current NCRP Recommendations for occupational and nonoccupational dose limits.
19. Using supplied appropriate data, calculate the cumulative effective dose for the whole body for a radiation worker.
20. Describe the function of collective effective dose and list both the SI and traditional units used to express this quantity.
21. Using both SI units and traditional units, state the annual occupational effective dose limit and cumulative effective dose (CED) limit for whole-body exposure excluding medical and natural background exposure, which are based on stochastic effects.
22. Using both SI units and traditional units, state the annual effective dose limit for continuous/frequent exposure and for infrequent exposure of the general public from man-made sources other than medical and natural background, which are based on stochastic effects.
23. Using both SI units and traditional units, state the annual equivalent dose limit for tissues and organs such as lens of the eye, skin, hands, and feet of members of the general public, which are based on deterministic effects.
24. State the NCRP recommended equivalent dose limit for monthly embryo-fetus exposures using both SI and Traditional units.
25. State the annual negligible individual dose in both SI and traditional units.
26. Explain the concept behind the establishment of the effective dose limiting system.
27. Explain why scientists have established occupational and nonoccupational effective dose limits.
28. Specify the radiation protection term that is used concerning the upper boundary dose of ionizing radiation that results in negligible risk of bodily injury or genetic damage.

29. Recent information obtained from long-term follow-up of the Japanese atomic bomb survivors has led to revised estimates of risk to those victims. State whether the risk estimate has been raised or lowered, and by how much.
30. State what type of biological response has been noted among the survivors as a result of the longer follow-up time.
31. Name the term that refers to birth defects from irradiation of the unborn child in utero.
32. State the unit used to express the collective effective dose.
33. Name the legislation passed by the U.S. Congress to protect the public from the hazards of unnecessary radiation exposure resulting from electronic products including diagnostic x-ray equipment.
34. Name the effect in which ionizing radiation produces somatic responses exhibiting a threshold dose below which the effects do not normally occur and above which the severity of the biologic damage increases as the radiation dose increases.
35. Specify the population group that has provided sufficient evidence of the induction of stochastic effects in humans resulting from high radiation absorbed doses.

Travis, Chapter 1

1. Identify the most abundant atoms and molecules in the body.
2. Define macromolecules.
3. Name the most abundant molecule in the body.
4. Describe protein in terms of its basic subunits, type of bonding between the subunits, and relative overall size.
5. Specify the function of proteins.
6. State the number of amino acids present in human cells.
7. Identify the macromolecules that serve as the primary source of energy for cellular metabolism.
8. Name the macromolecules composed of 3 fatty acids + 1 glycerol molecule which form the structural component of the cell membrane.
9. State the major subdivisions of the cell.
10. Distinguish between protoplasm, cytoplasm, and nucleoplasm.
11. Define cytoplasmic organelles.
12. Given a diagram, identify the following parts of a cell: cell wall, cell membrane, cytoplasm, endoplasmic reticulum, golgi complex, lysosome, mitochondria, nucleus, nucleolus, nuclear membrane.
13. State the function of the following parts of the cell: nucleus, cytoplasm, mitochondria, golgi complex, lysosome, ribosome, endoplasmic reticulum.
14. Specify the site of cellular protein synthesis.
15. Describe the function of centrioles in mitosis.
16. Define the term chromosome.
17. State how the following genetic constituents are related to one another: DNA, nitrogenous bases, genes, chromosomes, human genome.
18. Describe the importance of DNA in the cell.
19. State the reason the diploid number of chromosomes (2n) are a life necessity.
20. State the function of genes.
21. Describe the landmark information that was established in 2001 when two rival groups of researchers succeeded in mapping the human genome. Specify the number and the arrangement of these entities from smallest to greatest in size.
22. Identify two types of nucleic acids found in the cell and state where they are located.
23. Name the subunits of DNA.
24. Describe the structure of molecule of DNA in 3-dimensional as well as 2-dimensional terms.
25. Name the bases included in the DNA molecule.
26. Name the permitted pairing among the bases of the DNA molecule.
27. Describe mutation in terms of the DNA molecule.
28. Distinguish between somatic and germ cells.
29. Identify the type of cell division that is known as reduction division.
30. Identify the type of cell division that preserves the genetic continuity of the cell.
31. Name the portion of mitosis that is the period of cell growth between divisions.
32. State the 4 phases of the somatic cell cycle.
33. State the 4 subphases of the somatic cell cycle.
34. Define G_1, S, and G_2 .
35. Distinguish between the terms chromosome and chromatid.
36. Describe prophase, metaphase, anaphase and cytokinesis.
37. Describe crossing over and explain whether it occurs during mitosis or meiosis.
38. State the number of progeny cells that result from mitotic cell division. State whether these progeny cells are

diploid or haploid.

39. State the number of progeny cells that result from meiotic cell division. State whether these progeny cells are diploid or haploid.

Travis, Chapter 2

1. State the two forms of interactions that occur between matter and ionizing radiation.
2. Compare the time required for the initial interaction of radiation with matter to the time required for biologic changes to occur from such interactions.
3. Know that:
    a) The probability of radiation interacting with a cell is a matter of chance.
    b) If radiation does interact with a cell, cellular damage may or may not occur.
    c) Visible changes in cells, tissues and organs resulting from interactions with ionizing radiation ARE NOT UNIQUE!
    d) Much radiation induced biologic damage is reversible.
4. Compare the relative effects of irradiating a solution of macromolecules under *in vivo* and *in vitro* conditions.
5. Describe direct and indirect action of ionizing radiation on the cell, comparing the importance of these two actions on the cell.
6. Give the equation for the initial reaction in the ionization of a water molecule.
7. Define free radical; give the equations which describe the way in which free radicals are formed from:
    a) the radiolysis of water (4 equations)
    b) the direct action of radiation on organic molecules.
8. Describe the way in which free radicals produce damage in molecules.
9. Describe the way in which the presence of oxygen increases the fomation of free radicals (2 equations).
10. Name the two compounds considered to be the most damaging products formed following the radiolysis of water.
11. State what amount of the total radiation-induced damage is ultimately believed to be caused by the hydroxyl free radical.
12. State the immediate cause of the biologic damage that occurs through the indirect action of radiation
13. Explain why no radiation dose is too small to be without biological hazards in terms of direct and indirect action of radiation on critical molecules within the cell.
14. Define linear energy transfer (LET).
15. Define relative biologic effectiveness (RBE).
16. Explain the relationship of RBE to LET.
17. State whether repair enzymes are more effective in reversing cellular damage in cells irradiated with low LET or with high LET.
18. State the values of LET and RBE for 250 kVp x-rays.
19. Compare the LET values for neutrons and beta particles.
20. Specify whether point mutations commonly occur with high LET or with low LET radiation.
21. State whether the concept of RBE is more practical for specifying radiation protection dose levels in humans or for use with specific cells or animal tissues.
22. Explain how the concepts of RBE, quality factor (Q), and dose equivalent (DE) are related.
23. Define target.
24. Define hit in relationship to the Target Theory.
25. Name the 4 types of DNA damage which can be brought about by ionizing radiation.
26. Name and explain 2 mechanisms by which UV-induced damage to DNA is repaired in certain bacteria.
27. Define genetic mutation.
28. Define aberration.
29. Describe the 3 principle effects of radiation-induced DNA damage to the cell/organism.
30. Compare point mutations and chromosomal aberrations in terms of amount of damage involved and the effect of each on the cell/organism.
31. Compare the effects of chromatid aberrations to the effects of chromosome aberrations on resulting daughter cells.
32. State the 3 consequences of structural changes that result from chromosome aberrations.
33. Compare single chromosome breaks with double chromosome breaks in terms of:
    a) resulting numbers of chromosome aberrations produced and
    b) the efficiency of restitution of those breaks.
34. Recall that:
    a) chromosome breaks are independent of each other,

b) Single-hit chromosome aberrations are produced by linear, non-threshold dose responses, and
c) Multi-hit chromosome aberrations are produced by non-linear, non-threshold dose responses.

Travis, Chapter 3

1. Specify examples of *in vivo* and *in vitro* systems used in the study of cellular radiation responses.
2. Compare the advantage of using asynchronus cell populations to that of using synchronus cell populations in the study of radiation response.
3. Define interphase death (apoptosis); state which types of cells generally undergo interphase death at low radiation doses.
4. State the relationship that exists between interphase death (apoptosis) and attempts by the cell to undergo mitosis.
5. Define the following terms: mitotic index, mitotic overshoot, mitotic delay.
6. Differentiate between interphase death (apoptosis) and reproductive death.
7. Recognize, label and explain the components of a cell survival curve. This will require significant understanding of dealing with semilog graphs. Be certain you are clear about interpreting the graph.
8. Be able to calculate D_q, n, and D_o from an appropriately labeled survival curve. (Make certain to use the correct decade of the vertical axis when calculating D_o.
9. For mammalian cells, state the range of values for
    a) the extrapolation number
    b) D_o
10. Specify whether low LET irradiation generally causes single stranded or double stranded breaks in the DNS.
11. State whether repair enzymes are more effective in reversing cellular damage in cells irradiated with low LET or with high LET radiation.
12. State whether the concept of RBE is more practical for specifying radiation protection dose levels in humans or for use with specific cells or animal tissues.
13. Explain how the shoulder of a survival curve is associated with the LET of radiation given to a population of cells.
14. State the manner in which intracellular repair is related to recovery from radiation exposure.
15. Explain why fractionated doses are biologically less damaging than a single dose.
16. Distinguish the similarity/difference between SLD and PLD in the following:
    a) number of radiation exposures required
    b) category of LET radiation associated
    c) nutritional requirements
    d) oxygen requirement

Travis, Chapter 4

1. State the Law of Bergonie and Tribondeau.
2. State whether Bergonie and Tribondeau based their defintion of radiation sensitivity on the characteristics of the radiation or on cellular characteristics.
3. For cell renewal systems, state the 3 types of cell populations present in the specific compartments making up the system.
4. Compare the radiosensitivity of DIM cells to that of FPM cells.
5. Compare the radiosensitivity of testis and bone marow to that of liver, muscle and nerve tissue.
6. State the most radiosensitive cells in the mammalian body.
7. State the most radioresistant cells in the mammalian body.
8. Given a list of cells, classify them by decreasing radiosensitivity (most sensitive to least sensitive).
9. Name the RPM cell that is HIGHLY RADIOSENSITIVE, and is therefore an exception to the Law of Bergonie and Tribondeau.
10. Compare and contrast the stromal and parenchymal compartments of tissues and organs.
11. State the direction of flow for the various cell populations in the parenchymal compartment.
12. For radioresistant organs, state the relative sensitivity of critical cells in the parenchymal compartment to that of the cells in the stromal compartment.
13. Compare the mechanism of radiation damage produced in radiosensitive tissues to that produced in radioresistant tissues.
14. Be familiar with the Law of Ancel and Vitemberger.
15. Recall that the visible and detectable changes induced by radiation (radiation damage at the tissue and/or whole body level) is brought about by damage to critical parenchymal cells of the tissue or organ.
16. State that: the time radiation damage is expressed is a function of turnover rate of the critical parenchymal cell.
17. Define acutely responding tissues as expressing radiation injury within 3 months of irradiation due to fast turnover rates in these cells.

18. Define late responding tissues as expressing radiation injury 3 or more months after irradiation due to longer turnover rates in these cells.
19. State the 2 criteria necessary for an assay of radiation-induced tissue effect to be of value.
20. Name the 3 categories of assays used to measure radiation damage in tissues.
21. Name the assay technique that is based on the physiology of the organ or is scored on the basis of visible changes in the organ following irradiation exposure.
22. Name the assay technique that quantifies the number of dead animals following localized irradiation of a specific organ as a function of dose.

Travis, Chapter 5

1. Assuming that mammalian cells have more than 2 target in their nuclei, state whether high LET radiation or low LET radiation would be more efficient at killing the cells on a dose basis.
2. Describe the shoulder of survival curves of cells irradiated with high LET radiation.
3. Low LET radiation (x- or gamma rays) always has a (smaller ?/larger?) value of D_o than high LET does.
4. With reference to survival curves of mammalian cells, state how high LET radiation affects
    a) slope of the curve
    b) shoulder of the curve
5. Compare the shape of the survival curve shoulders following irradiation for intestine and bone marrow.
6. State whether high or low dose-rates are more efficient for producing biological damage.
7. Recall that low dose-rates allow time for repair to occur before sufficient damage accumulates to produce cell death.
8. State the role of oxygen in the magnitude of the radiation response.
9. State the time when oxygen must be present in biological systems in order to most greatly affect the radiation response.
10. Define oxygen tension.
11. Describe the radiation response as oxygen concentration increases.
12. Describe the basic premise of the application of the oxygen effect to radiotherapy.
13. Explain how the oxygen effect and protection by radioprotective compounds are both related to the LET of the ionizing radiation.
14. When supplied correct data, be able to calculate the Oxygen Enhancement Ratio (OER).
15. State the value of OER for mammalian cells.
16. Name the first compound widely used to sensitize cells to radiation. State how well this compound protects
    a) cells in tissue culture
    b) animal tumors
    c) humans
17. Name the 2 specific conditions that must be met in order for halogenated pyrimidines to be effective as radiosensitizers.
18. When a radiosensitizer sensitizes cells by a factor of 3, how much radiation will it take to observe the same response that is observed in the absence of the sensitizer?
19. Be able to calculate the Dose Reduction Factor when supplied the appropriate data.
20. State the reason radioprotectors are not generally used.
21. Explain the relationship between dose of radiation and time necessary to administer the dose for:
    a) acute doses
    b) protracted doses
    c) fractionated doses
22. Explain why low dose-rates are biologically less damaging than high dose-rates of ionizing radiation.
23. Compare the radiosensitivities of cells during the 4 stages of the cell cycle:
    a) G1
    b)S
    c) G2
    d) Mitosis
24. State how intracellular repair is related to recovery from radiation exposure.

Travis, Chapter 6

1. Distinguish between "acute effect" and "acutely responding" normal tissues.
2. State the way in which the Primary chronic effect occurs.
3. State the way in which the Secondary chronic effect occurs.
4. State the time at which the acute effect can be visualized.

5. State the time in which the chronic effect can be visualized.
6. State the outcome of acute effects.
7. State the outcome of chronic effects.
8. Define "response" of a system/organ to radiation.
9. Name 3 factors which determine healing.
10. Compare and contrast the 2 forms of healing.
11. Name 2 important factors which influence radioresponse.
12. State the primary effect of radiation on the bone marrow.
13. List the types of mature blood cells in order of depression of blood counts as a function of radiation dose.
14. State both the function and the typical lifespan in the circulating blood of the mature formed elements of the blood.
15. State the 2 factors that determine which blood cells will decrease first in the circulating blood post-irradiation.
16. State the portion of the epidermis that is most radiosensitive (therefore is responsible for the radiation response known as erythema).
17. Compare and contrast clinical tolerance and SED_{50}
18. Compare the relative radiosensitivity of sebaceous glands, sweat glands, and hair follicles.
19. Define epilation and be able to state that 300 rads to a small field is the minimum dose necessary to produce this effect.
20. Compare the radiosensitivities of the different portions of the digestive tract.
21. Identify the most radiosensitive portion of the small intestine.
22. State the most radiosensitive phase of gametogenesis for:
    a) male
    b) female
23. State the radiation dose/dose-range necessary to produce temporary as well as permanent sterility in
    a) males
    b) females
24. State whether radiation-induced cataracts are properly classified as an early/late radiation effect and whether they are produced by threshold/non-threshold response.
25. Compare the radiosensitivities of small and large blood vessels.
26. State the 2 forms of radiation damage observed in the vasculature.
27. State the 3 portions of growing bone and cartilage that contribute to the radiosensitivity of the tissues.
28. Relate the following terms to the appropriate system damaged by radiation and give the radiation dose necessary to bring about this damage.
29. State whether organs exhibit functional radiation responses at higher/lower doses than are required to bring about morphological radiation responses.

<u>Travis, Chapter 7</u>

1. Describe the importance of uniformity of dose when studying the response of whole organisms to total body irradiation.
2. State what determines the total body response to radiation.
3. State the 4 parameters that must be included in the definition of Acute Radiation Syndrome (ARS).
4. State the primary effect of ARS.
5. Define mean survival time (MST)
6. State how ARS lethality is measured quantitatively.
7. Define $LD_{50/30}$
8. List and describe the 4 stages of ARS.
9. Identify the basis for establishing the 3 radiation syndromes that comprise ARS.
10. Discriminate between the 3 main radiation syndromes in terms of MST and their defined dose range.
11. State the threshold dose for the bone marrow (hematopoietic) syndrome.
12. Recall that the MST in the bone marrow syndrome is dependent on radiation dose.
13. State the cause of the bone marrow syndrome.
14. List the symptoms of the bone marrow syndrome.
15. State the cause of death in the bone marrow syndrome
16. Give the total body radiation dose which no human has been reported to survive.
17. State the threshold dose for the Gastrointestinal (GI) Syndrome.
18. State the defined dose range for the full GI Syndrome.
19. Recall that MST does not vary with dose in the GI Syndrome.
20. From the Chernobyl nuclear plant disaster data, it appears that bone marrow transplants have little effect in saving the life of individuals who receive total body doses greater than a specific amount. State that dose.

21. Name the 2 organ systems which fail leading to death from the GI Syndrome.
22. Describe the changes in the villi of the small intestine resulting from the GI Syndrome.
23. Name the 3 specific effects on the Intestinal villi that combine to cause death from the GI Syndrome.
24. Recall the threshold dose for cerebrovascular (CNS) damage.
25. State the defined dose range for the full CNS Syndrome.
26. Note that the MST is dependent on dose within the CNS Syndrome.
27. Describe the terminal period of the CNS Syndrome, stating that damage in this syndrome is likely result in e_____, m_____, and v_____.
28. State the probable cause of death in the CNS Syndrome.
29. Name the 3 general stages of fetal development
30. State the reasons that the embryonic period of life is so radiosensitive.
31. Explain why the loss of a few embryonic cells is important.
32. State what factor determines which organ system of the totally irradiated embryo will be most seriously damaged by radiation.
33. State the specific days, weeks, and trimester of gestation during which the embryo is most radiosensitive in terms of producing congenital anomalies.
34. Describe the stage of human gestation during which neonatal death occurs rather than prenatal death.
35. Name the 1 specific abnormality that has been reported as a result of irradiation during pre-implantation.
36. State the 2 general manifestations of congenital abnormalities that occur following embryonic irradiation during the period of major organogenesis.
37. State the general stage of development where higher doses of irradiation are necessary to produce lethality and gross abnormalities; but irradiation at this stage may result in effects that occur later in life (cancer) or in functional disorders after birth.
38. Give the incidence of spontaneous congenital abnormalities in the USA.
39. Name 4 situations in which radiation effects on developing human embryos have been observed.
40. Name the CNS abnormalities observed in children who had been irradiated during the 1st trimester of development.
41. State the 2 major abnormalities observed in the children irradiated *in utero* at Hiroshima and Nagasaki.
42. State the time period during gestation known as the "window of maximal sensitivity" for Japanese atomic bomb survivors who were irradiated *in utero*.
43. Name the one consequence believed to be the most common result of *in utero* radiation exposure after the first trimester.

Travis, Chapter 8

1. Describe late effects of radiation and classify them appropriately as somatic or genetic effects.
2. State the factors that may modify the occurrence of late somatic effects.
3. Give examples of populations in which radiation-induced leukemia have been observed.
4. Recall the increased incidence of cancer in populations surviving the detonation of the atomic bombs and the \ response by males and youth.
5. Give 2 examples each of populations in which radiation-induced cancer of the following organs was observed:
    a) skin
    b) thyroid
    c) lung
    d) bone
    e) breast
6. Recall the dose response relationships for the following types of radiation-induced late effects:
    a) general late effects
    b) leukemia
    c) skin cancer
    d) lung cancer
    e) thyroid cancer
7. Differentiate between the different types of epidemiological risk estimates.
8. Recall the absolute risk estimate value for:
    a) overall absolute risk for radiation-induced malignancy
    b) lung cancer
    c) breast cancer
9. State the length of the latent period and the at-risk period for radiation-induced leukemia.
10. Recall the Oncogene hypothesis concerning the method of radiation-induced carcinogenesis.
11. List 5 general conclusions drawn from animal experiments concerning genetic effects of radiation.

12. State the time during gestation when it is considered safe to administer I-131 to the pregnant female, thereby reducing the chances of the embryo developing thyroid cancer later in its life.
13. Define Doubling Dose and state its value
14. Note: Human data show no statistically significant increase in genetic mutations among the irradiated population surviving Hiroshima and Nagasaki.

Travis, Chapter 9

1. State the name for the new NCRP term used to designate the limit for the combined external + internal radiation dose.
2. State the dose above which immediately expressed radiation damage occurs in diagnostic radiology.
3. State the doses yielded by diagnostic procedures and tell whether they are responsible for immediately expressed radiation damage.
4. State whether the risks of diagnostic radiology & nuclear medicine are stochastic or non-stochastic.
5. Name 3 diagnostic procedures that have been shown to produce persistent chromosome aberrations in lymphocytes of patients.
6. State the current evidence for diagnostic x-rays inducing leukemia.
7. Define "Genetically Significant Dose (GSD).
8. Define "Doubling Dose"
9. State the value of the doubling dose and the GSD for diagnostic radiology.
10. State the risk of nuclear medicine inducing leukemia, other cancers, and/or genetic effects.
11. Define target organ.
12. Define critical organ.
13. Name 3 biologic variables that influence patient response to nuclear medicine.
14. Name the biological variable that is the main determinant of radiopharmaceutical radiation exposure in an organ.
15. State the GSD for nuclear medicine procedures.
16. State how much greater or lower the GSD is for diagnostic radiology than it is for nuclear medicine.
17. State whether nuclear medicine procedures are more harmful to the fetus or to adults.
18. State what treatment of hyperthyroidism with 131-I does with regard to inducing thyroid cancer.
19. State what treatment of hyperthyroidism with 131-I does with regard to inducing leukemia.
20. State the current association of increased cancer in occupationally exposed radiation workers.

Travis, Chapter 10

1. State the goals of radiotherapy.
2. Compare the probability of radiation interacting with tumor cells to the probability of radiation interacting with normal cells.
3. Name the 3 factors that must be balanced to control the rate of tumor growth.
4. State the main factor controlling the oxygen and nutrient supply to the tumor.
5. State the way in which oxygen supply controls the growth of a tumor.
6. Name the thing that determines the radioocurability of curing a tumor using radiation.
7. State whether biologically speaking, fractionated doses are more efficient or are less efficient in causing cell death than are single doses of radiation.
8. Name the "4 R's" that combine to determine the effect of fractionated doses on both tumor and normal cell growth.
9. State the clinical results of irradiating tumors under hypoxic conditions to attempt to eradicate tumors in humans.
10. Normal cells (acutely-responding and late-responding) are impacted by fractionation radiation treatment to destroy tumors. State how fraction size AND overall treatment time affect
    a) tumors
    b) acutely responding normal tissues
    c) late responding normal tissues.

Sherer, Chapter 7

1. Define and describe the following terms:
    air gap technique
    bone marrow dose
    cumulative timer
    entrance skin exposure rates
    filtration
    gonadal dose
    half-value layer (HVL)

off-focus (stem) radiation
positive beam limitation (PBL)
primary protective barrier
quantum mottle
radiographic grid
rare-earth screens
scattered radiation
skin dose
source-to-image receptor distance (SID)
source-to-tabletop distance
thermoluminescent dosimeters (TLDs)
useful beam
x-ray beam limitation devices.

2. State the first step in holistic patient care during radiologic procedures.
3. Discuss the manner in which the technologist should explain the upcoming procedure to the patient.
4. Explain what type of input the patient must have with the technologist before the radiologic procedure is begun.
5. State the reason for immobilizing a patient during a radiologic exposure.
6. List 3 means of reducing or eliminating voluntary motion of the patient during a radiologic exposure.
7. State the purpose of an x-ray beam limitation device.
8. List 4 types of x-ray beam limiting devices.
9. Name the most versatile device for defining the size and shape of the radiographic beam.
10. State the distance the patient's skin surface should always be below the collimator to minimize exposure to the epidermis.
11. State the requirement for the luminance of the collimator light source.
12. Both alignment and length and width dimensions of the radiographic and light beams must correspond to within what percentage of the SID?
13. PBL devices are required to be within what percentage of the SID?
14. State the function of the filter in diagnostic radiology.
15. State what determines the total amount of filtration is required for a given x-ray unit.
16. State the required amount of inherent filtration of the radiographic beam.
17. State what comprises the total filtration of the radiographic beam.
18. State the way that it is determined that an x-ray beam is adequately filtered.
19. State the regulatory standard for the total filtration of a fixed x-ray unit operating above 70 kVp.
20. State the required total filtration for x-ray units operating from 50 to 70 kVp.
21. State the filter material that is most suitable for larger and/or dense breasts having a compression thickness of 6 cm and greater.
22. State what the HVL of beam is measured to verify.
23. State the units in which the HVL for diagnostic x-ray beams is expressed.
24. Name the 4 basic types of gonadal shielding devices.
25. Explain at what distance from a properly collimated beam it is necessary to shield the reproductive organs (unless this would compromise the diagnostic value of the study).
26. Name the gonadal shielding device that is not suitable for use during fluoroscopy and state the reason for its unsuitability.
27. State the gonadal shielding device this not recommended for PA projections.
28. State the percentage by which appropriate gonadal shielding can reduce the exposure received by:
    a) females
    b) males
29. Name the device and the projection that can significantly reduce the dose to the breast of young patients under going a scoliosis examination.
30. State the purpose of compensating filters used in radiography; name 3 types of these compensating filters and describe their use.
31. List 7 technical exposure factor <u>considerations</u> used to determine appropriate technical factors.
32. State whether the use of higher kVp and lower mAs increases or decreases patient dose.
33. Name the chart that should be available for each x-ray unit to help provide a uniform selection of technical exposure factors.
34. State whether the use of a radiographic grid increases or decreases patient dose.
35. State the advantage in using a radiographic grid.
36. State the technique that can be used as an alternative to the use of a grid.

37. State the reason repeat radiographs must be minimized.
38. State the minimum Source-skin distance (SSD) required when using mobile radiographic units.
39. Name the diagnostic radiology procedure that produces the greatest patient radiation exposure rate.
40. List 5 ways to limit patient exposure during fluoroscopy.
41. State the minimum source-to-tabletop distance for fixed fluroscopes and for mobile fluroscopes.
42. Name 3 significant benefits of image intensification fluoroscopy.
43. State the type of vision the radiologist uses during image intensification fluoroscopy.
44. Compare the exposure rate to the patient resulting from fluoroscopic procedures with that resulting from image intensification fluoroscopy.
45. State the patient-image intensifier distance needed for C-arm fluoroscopic procedures.
46. Recall that cinefluorography patient doses can result in the highest patient doses of all diagnostic procedures. List 3 means of reducing cine dose to the patient.
47. State the exposure rates that may be used in HLC fluoroscopy.
48. State the skin dose received during HLC fluoroscopy that requires a notation be placed in the patient's record
49. Name 5 ways radiation received by a patient during diagnostic radiologic procedures may be specified; specify which is the easiest to obtain and the most widely used.
50. State the mean dose that should not be exceeded to the glandular tissue of a 4.5-cm compressed breast using a screen-film mammography system.
51. List 2 concerns related to CT scanning.
52. State how conventional CT patient dose compares to scanning CT patient dose when:
    a) pitch ratio is = 1
    b) pitch ratio = < 1
    c) pitch ratio =>1
53. State whether children are more or less vulnerable than adults to the late somatic and genetic effects of ionizing radiation.
54. State the projection that should be used to protect breasts of female patients.
55. State what type of shielding is required in small girls to protect the ovaries.
56. List 3 means of reducing the exposure of a developing embryo-fetus to radiation during diagnostic radiologic procedures.

<u>Sherer, Chapter 8</u>

1. Define or describe:
    Bucky slot shielding device
    control-booth barrier
    controlled area
    cumulative-effective dose (CED) limit
    diagnostic-type protective tube housing
    fluoroscopic exposure monitor
    inverse square law (ISL)
    leakage radiation
    occupancy factor (T)
    occupational risk
    primary protective barrier
    primary radiation
    scatter radiation
    secondary protective barrier
    uncontrolled area
    use factor (U)
    workload (W)
2. State the annual occupational effective dose for whole body exposure during routine operations.
3. State the annual effective dose for individuals of the general population
4. State the CED limit for a radiation worker's whole body lifetime effective dose.
5. State what happens to the GSD when radiation workers are permitted to receive a larger equivalent dose than The general public.
6. List 6 means of reducing scatter radiation, thereby reducing the occupational hazard for the radiographer.
7. State the means by which pregnant radiographers can ensure that her monthly equivalent dose does not exceed 0.5mSv (0.05 rem).
8. State the direction at which the primary protective barriers are located to the line of travel of the primary x-ray

beam.

9. Describe the composition and arrangement of the primary protective barrier if the peak beam energy of the beam is 130 kVp.
10. Describe secondary protective barrier composition and arrangement including the amount of overlap with the primary protective barrier.
11. State the number of times the radiation should scatter before reaching any area behind the control booth barrier.
12. The control booth barrier consists of what thickness of lead equivalent?
13. State the maximum allowance of exposure allowed per week behind the control-booth barrier having the appropriate lead-equivalent in the barrier.
14. State the amount of lead-equivalency required for clear lead-plastic overhead x-ray barriers.
15. Name the type of diagnostic-type protective tube housing that must be used to protect the radiographer and patient from leakage radiation.
16. List 4 requirements that must be met to protect the radiographer during routing fluoroscopy.
17. List 3 requirements that must be met to protect the radiographer during mobile radiographic exams.
18. Name 2 things that are required to protect the radiographer during high-level control (HLC) fluoroscopy.
19. State the most effective means of protection for ionizing radiation for the radiographer.
20. State the thickness of lead-equivalence required in the apron worn if a radiographer cannot remain behind a protective barrier.
21. List 3 devices that are sometimes required to be worn by the radiographer if he/she cannot remain behind a protective barrier.
22. State the condition(s) under which the radiographer should stand in the primary beam to hold a patient during diagnostic radiology.
23. State 8 considerations that must be taken into account when designing and x-ray suite that will meet radiation protection standards.
24. State the 3 categories of radiation sources that can be generated in an x-ray room. State which 2 are collectively known as secondary radiation.
25. State the conditions in which leakage radiation is not present during operation of the x-ray unit.
26. Name the quantity that best describes the weekly radiation usage of a diagnostic x-ray unit. Specify the units used to express this quantity.
27. State and correctly use the Inverse Square Law.
28. Name the quantity that was introduced to select the fraction of the weekly beam-on time when structures in the x-ray room are struck by radiation.
29. State numeric value of the use factor for floors, doors, walls, ceilings of radiation rooms exposed routinely to the primary beam.
30. Name the factor used to modify the shielding requirement for a particular barrier by taking into account the fraction of the workweek that the space beyond the barrier is occupied.
31. Distinguish between controlled area and uncontrolled area.
32. State the maximum equivalent dose per week when protective shielding is used for an uncontrolled area such as a hall or corridor that is frequented by the general public.
33. Specify the thickness of aluminum equivalent that a Bucky slot shielding device must have to automatically cover the Bucky slot opening in the side of the x-ray table during a fluoroscopic examination when the Bucky tray is positioned at the foot end of the table.

<u>Sherer, Chapter 9</u>

16-11. Define and describe the following:

characteristic curve
control badge
densitomiter
extremity dosimeter
film badges
Geiger-Mueller (G-M) detector
ionization chamber-type survey meter
optical density
optically stimulated luminescence dosimeter
personnel dosimeter
personnel monitoring report
pocket ionization chamber (pocket dosimeter)
proportional counters

radiation-dosimetry film
radiation survey instruments
thermoluminescent dosimeter (TLD)
TDL analyzer

2. State the reason that a radiation worker should wear a personnel dosimeter and explain the function and characteristics of such devices.
3. Identify the appropriate location on the body where the personnel dosimeter(s) should be worn during the following conditions:
    a) routine radiographic procedures
    b) fluoroscopic procedures
    c) special radiographic procedures
    d) pregnancy
4. Describe the various components of the following and explain the use of each of these devices as personnel monitors:
    a) film badge
    b) optically stimulated luminescence dosimeter (OSL)
    c) pocket ionization chamber
    d) thermoluminescent dosimeter (TDL)
5. State the type dosimeter that provides a new degree of sensitivity by giving an accurate reading as low as 1 mrem for x-ray and gamma ray photons with energies ranging from 5kVp to >40 MeV.
6. State the type dosimeter that is the most sensitive personnel dosimeter, yet it is not commonly used in diagnostic imaging.
7. State the conditions that require personnel monitoring for radiation workers.
8. State the determining factor that most health care facilities use when deciding to provide dosimeter devices for their occupationally expose personnel.
9. Describe 2 types of information that can be obtained over a designated period of time through the use of the personnel dosimeter.
10. State the type of personnel dosimeter allows a radiation worker to determine exposure received immediately on completion of a specific radiologic procedure.
11. State the place where a personnel monitoring device should be worn during routine radiographic procedures to approximate the maximum radiation dose to the thyroid and the head and neck.
12. State the position where the dosimeter should be worn by the radiographer during high-level radiation procedures to provide a reading of the approximate dose equivalent to the thyroid and eyes.
13. Designate 2 separate positions at which a radiographer should wear a personnel dosimeter during special radiographic procedures to monitor the approximate dose equivalent to the lower body trunk.
14. Designate the position where the pregnant radiographer should wear a second personnel dosimeter during diagnostic procedures.
15. State the type of personnel dosimeter worn under certain conditions to monitor and determine dose equivalent to the hands when they are near the primary beam.
16. State the reason health care facilities must maintain a record of exposure recorded by personnel dosimeters as part of each radiation workers employment record.
17. Name 3 general requirements of personnel dosimeters.
18. State what procedure must be performed before using a pocket dosimeter to record radiation exposure.
19. List 3 disadvantages of using a TDL dosimeter as a personnel monitoring device.
20. State which instrument should be used in an x-ray installation to assess fluoroscopic scatter radiation exposure rate.
21. State the title of the person in the health care facility responsible for receiving and reviewing personnel monitoring reports to assess compliance with ALARA guidelines.
22. State 3 types of occupational exposures the monitoring report lists for each person wearing the device in the facility as measured by the exposed monitor.
23. State the function of radiation survey instruments.
24. State the difference between a detection system and a dosimetry system.
25. List 3 requirements that radiation survey instruments must fulfill.
26. State the instrument combination used to calibrate radiographic and fluoroscopic units.
27. State the 2 ways the ionization chamber-type survey meter or "cutie pie" Is able to function.
28. State what property that ionization chamber-type survey meters, proportional counters, and Geiger-Muller detectors have in common.
29. Name the instrument that should be used to locate a lost radioactive source or to detect low-level radioactive

contamination.

Required Assessments:
Assessment Names and Descriptions:

1. Test 1 (PSLO 1, CSLO 1-2)
2. Test 2 (PSLO1, CSLO 3-4)
3. Test 3 (PSLO 1, CSLO 5-6)
4. Test 4 (PSLO 1, CSLO 7-11)

CSLO/Assessment Alignment:

Course	CSLO 1	CSLO 2	CSLO 3	CSLO 4	CSLO 5	CSLO 6	CSLO 7	CSLO 8	CSLO 9	CSLO 10
RT 2543	Test 1-4 research paper final exam	Test 1-4 research paper final exam	Test 1-4 research paper final exam	Test 1-4 research paper final exam	Test 1-4 research paper final exam	Test 2 Lab final exam	Test 2 Lab Final exam	Test 2 Lab Final exam	Lab Final exam	Test 3 research paper final exam
	CSLO 11	CSLO 12	CSLO 13	CSLO 14	CSLO 15	CSLO 16	CSLO 17	CSLO 18	CSLO 19	CSLO 20
	Test 2 research paper final exam	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grading Scale or Policy, Weekly Outline, Topics, or Instructional Activities:

A. Unit Tests 50% (12.5 % per test)

B. Laboratory Experiments 15%

C. Research Paper 15%

D. Final Exam 20%

Chattanooga State Community College
Radiologic Technology Program
Statement of Understanding

<u>Disabilities Statement</u>

Students who have educational, psychological, and/or physical disabilities may be eligible for accommodations that provide equal access to educational programs and activities at Chattanooga State. These students should notify the instructor immediately, and ideally should contact Disabilities Support Services (S-113, phone 697-4452) within the first two weeks of the semester in order to discuss individual needs. The student must provide documentation of the disability so that reasonable accommodations can be requested in a timely manner. All students are expected to fulfill essential course requirements in order to receive a passing grade in a class, with or without reasonable accommodations.

<u>Disruption Statement</u>

Disruption or obstruction of teaching, research, administration, disciplinary proceedings, other college activities, including its public service functions on or off campus, or other authorized non-College activities, when the act occurs on College premises, is subject to disciplinary sanctions.

The terms classroom disruptions means behavior a reasonable person would view as substantially or repeatedly interfering with the conduct of a class. A student who persists in disrupting a class will be directed by the faculty member to leave the classroom for the remainder of the class period. The student will be told the reason(s) for such action and given an opportunity to discuss the matter with the faculty member as soon as possible. Prompt consultation will be undertaken by the faculty with the Department Dean and the College Judicial Officer.

If a disruption is serious, and other reasonable measures have failed, the class may be adjourned and the campus police summoned.

Pagers and Cell Phones – Activated pagers and cell phones are strictly prohibited when class is in session.

The **RADIOLOGY TECHNOLOGY PROGRAM** is a competency-based program. The goal of each instructor is to have students complete the competency requirements of each course. Completion of set competency areas of a course is greatly affected by student's ability to progress through the material. If competencies are not mastered in a specific course, a subsequent course will be structured to assure competency attainment of those areas.

Each topic in each syllabus will indicate a mastery level for the objectives that correlate to the topic. Evaluation is criterion-referenced to the objectives for each topic. **Mastery level criteria for each topic must be met.** Remediation is permitted with restrictions. The first remediation test grade will be averaged with the original test grade. A second remediation will result in ten points being subtracted from the specific topic grade. Subject to the discretion of the instructor, further remediation and testing may result in a reduction of one letter grade for the course for each occurrence, which may lead to failure of the course.

A grade of "C" or better in the following courses is required for progression:

1. All RT prefixed courses
2. Human Anatomy & Physiology I, II (BIOL 2010, BIOL 2020)
3. Radiobiology and Radiation Protection (RT 2543)
4. Math 1710 if required

I hereby acknowledge that I have read the syllabus and understand the policies regarding objectives, grading, performance, participation, absenteeism, tardiness, and conduct

I understand the policy on NO activated cell phones or pagers during class time and agree to keep these devices enclosed in a container (such as a purse or backpack) so that they are not visible to anyone in the classroom.

Chattanooga State is committed to promoting a mode of individual conduct based on the principles of honesty, fairness, trust, respect and responsibility. I understand that academic integrity is demanded in ALL records, exercises, assignments and tests in the classes. Those who falsify records, copy other work or share such information inappropriately will receive an F in the course.

I understand that most courses in this program offer supplemental websites which are required on a routine basis. Computers with web access are readily available on campus and may be used to access this required component of the course.

My signature documents my agreement to abide by all policies and conditions stated in the course syllabus, as well as all program policies.

_____ _____

Name in print Date

_____

Signature