**Animal Form and Function Notes Guide 2019**

**Concept: Animal Form and Function are correlated at all levels of organization**

Overview: Diverse Forms, Common Challenges

-Anatomy is the study of the biological form of an organism

-Physiology is the study of the biological functions an organism performs

-The comparative study of animals reveals that form and function are closely correlated

**Concept: Animal form and function are correlated at all levels of organization**

-Size and shape affect the way an animal interacts with its environment

-Many different animal body plans have evolved and are determined by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Evolution of Animal Size and Shape

-Physical laws constrain strength, diffusion, movement, and heat exchange

-As animals increase in size, their skeletons must be proportionately larger to support their mass

-Evolutionary convergence reflects different species’ adaptations to a similar environmental \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hierarchical Organization of Body Plans

-Most animals are composed of specialized \_\_\_\_\_\_\_\_\_\_\_ organized into tissues that have different functions

-Tissues make up organs, which together make up organ systems

-Some organs, such as the pancreas, belong to more than one organ system

Exploring Structure and Function in Animal Tissues

Different tissues have different structures that are suited to their functions

Tissues are classified into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ main categories: epithelial, connective, muscle, and nervous

Epithelial Tissue

Epithelial tissue covers the outside of the body and \_\_\_\_\_\_\_\_\_\_\_\_\_ the organs and cavities within the body

It contains cells that are closely joined

The shape of epithelial cells may be cuboidal (like dice), columnar (like bricks on end), or squamous (like floor tiles)

The arrangement of epithelial cells may be simple (single cell layer), stratified (multiple tiers of cells), or pseudostratified (a single layer of cells of varying length)

Connective Tissue

Connective tissue mainly binds and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ other tissues

It contains sparsely packed cells scattered throughout an extracellular matrix

The matrix consists of fibers in a liquid, jellylike, or solid foundation

There are three types of connective tissue fiber, all made of protein:

-Collagenous fibers provide strength and flexibility

-Elastic fibers stretch and snap back to their original length

-Reticular fibers join connective tissue to adjacent tissues

In vertebrates, the fibers and foundation combine to form \_\_\_\_\_\_\_\_\_\_\_\_ major types of connective tissue:

Loose connective tissue binds epithelia to underlying tissues and holds organs in place

-Cartilage is a strong and flexible support material

-Fibrous connective tissue is found in tendons, which attach muscles to bones, and ligaments, which connect bones at joints

It is divided in the vertebrate body into three types:

-Skeletal muscle, or striated muscle, is responsible for voluntary movement

-Smooth muscle is responsible for involuntary body activities

-Cardiac muscle is responsible for contraction of the heart

Nervous Tissue

Nervous tissue senses stimuli and transmits \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ throughout the animal

Nervous tissue contains

-Neurons, or nerve cells, that transmit nerve impulses

-Glial cells, or glia, that help nourish, insulate, and replenish neurons

Coordination and Control

-Control and coordination within a body depend on the endocrine system and the nervous system

-The endocrine system transmits chemical signals called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to receptive cells throughout the body via blood

-A hormone may affect one or more regions throughout the body

-Hormones are relatively slow acting, but can have long-lasting effects

**Concept: Feedback control maintains the internal environment in many animals**

Animals manage their internal environment by regulating or conforming to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ environment

Regulating and Conforming

A regulator uses internal control mechanisms to moderate internal change in the face of external, environmental fluctuation

A conformer allows its internal condition to vary with certain external changes

Animals may \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ some environmental variables while conforming to others

Homeostasis

Organisms use homeostasis to maintain a “steady state” or internal \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ regardless of external environment

In humans, body temperature, blood pH, and glucose concentration are each maintained at a constant level

Mechanisms of Homeostasis

Mechanisms of homeostasis moderate changes in the internal environment

For a given variable, fluctuations above or below a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ point serve as a stimulus; these are detected by a sensor and trigger a response

The response returns the variable to the set point

Feedback Control in Homeostasis

The dynamic equilibrium of homeostasis is maintained by negative feedback, which helps to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a variable to a normal range

Most homeostatic control systems function by negative feedback, where buildup of the end product shuts the system off

Positive feedback \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a stimulus and does not usually contribute to homeostasis in animals

Alterations in Homeostasis

Set points and normal ranges can change with age or show cyclic variation

In animals and plants, a circadian rhythm governs physiological changes that occur roughly every \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hours

Homeostasis can adjust to changes in external environment, a process called acclimatization

**Concept: Homeostatic processes for thermoregulation involve form, function, and behavior**

Thermoregulation is the process by which animals maintain an internal temperature within a tolerable \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Endothermy and Ectothermy

Endothermic animals generate heat by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; birds and mammals are endotherms

Ectothermic animals gain heat from external sources; ectotherms include most invertebrates, fishes, amphibians, and nonavian reptiles

In general, ectotherms tolerate greater variation in internal temperature, while endotherms are active at a greater range of external temperatures

Endothermy is more energetically \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than ectothermy

The arrangement of blood vessels in many marine mammals and birds allows for countercurrent exchange

Countercurrent heat exchangers transfer heat between fluids flowing in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ directions and reduce heat loss

Some bony fishes and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ also use countercurrent heat exchanges

Many endothermic insects have countercurrent heat exchangers that help maintain a high temperature in the thorax

**Concept: Energy requirements are related to animal size, activity, and environment**

Bioenergetics is the overall flow and transformation of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in an animal

It determines how much food an animal needs and it relates to an animal’s size, activity, and environment

Energy Allocation and Use

-Animals harvest chemical energy from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

-Energy-containing molecules from food are usually used to make ATP, which powers cellular work

-After the needs of staying alive are met, remaining food molecules can be used in biosynthesis

-Biosynthesis includes body growth and repair, synthesis of storage material such as fat, and production of gametes

Quantifying Energy Use

-Metabolic rate is the amount of energy an animal uses in a unit of time

-Metabolic rate can be determined by

-An animal’s heat loss

-The amount of oxygen consumed or carbon dioxide produced

Minimum Metabolic Rate and Thermoregulation

-Basal metabolic rate (BMR) is the metabolic rate of an endotherm at \_\_\_\_\_\_\_\_\_\_\_\_\_\_ at a “comfortable” temperature

-Standard metabolic rate (SMR) is the metabolic rate of an ectotherm at rest at a specific temperature

-Both rates assume a nongrowing, fasting, and nonstressed animal

-Ectotherms have much lower metabolic rates than endotherms of a comparable size

Influences on Metabolic Rate

-Metabolic rates are affected by many factors besides whether an animal is an endotherm or ectotherm

-Two of these factors are size and activity

Size and Metabolic Rate

-Metabolic rate is proportional to body \_\_\_\_\_\_\_\_\_\_\_\_\_ to the power of three quarters (m3/4)

-Smaller animals have higher metabolic rates per gram than larger animals

-The higher metabolic rate of smaller animals leads to a higher oxygen delivery rate, breathing rate, heart rate, and greater (relative) blood volume, compared with a larger animal

Activity and Metabolic Rate

-\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ greatly affects metabolic rate for endotherms and ectotherms

-In general, the maximum metabolic rate an animal can sustain is inversely related to the duration of the activity

Torpor and Energy Conservation

-Torpor is a physiological state in which activity is low and metabolism decreases

-Torpor enables animals to save energy while avoiding difficult and dangerous conditions

-Hibernation is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-term torpor that is an adaptation to winter cold and food scarcity

-Summer torpor, called estivation, enables animals to survive long periods of high temperatures and scarce water

-Daily torpor is exhibited by many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mammals and birds and seems adapted to feeding patterns

**Concept: Both asexual and sexual reproduction occur in the animal kingdom**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reproduction is the creation of an offspring by fusion of a male gamete (sperm) and female gamete (egg) to form a zygote

Asexual reproduction is creation of offspring without the fusion of egg and sperm

Mechanisms of Asexual Reproduction

-Many invertebrates reproduce asexually by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, separation of a parent into two or more individuals of about the same size

-In budding, new individuals arise from outgrowths of existing ones

-Fragmentation is breaking of the body into pieces, some or all of which develop into adults

-Fragmentation must be accompanied by regeneration, regrowth of lost body parts

-Parthenogenesis is the development of a new individual from an unfertilized egg

Sexual Reproduction: An Evolutionary Enigma

-Sexual females have half as many daughters as asexual females; this is the “twofold cost” of sexual reproduction

-Despite this, almost \_\_\_\_\_\_\_\_\_\_\_\_\_\_ eukaryotic species reproduce sexually

-Sexual reproduction results in genetic recombination, which provides potential advantages

-An increase in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in offspring, providing an increase in the reproductive success of parents in changing environments

-An increase in the rate of adaptation

-A shuffling of genes and the elimination of harmful genes from a population

-Some organisms can reproduce sexually or asexually, depending on conditions

-Several genera of fishes, amphibians, and lizards reproduce only by a complex form of parthenogenesis that involves the doubling of chromosomes after meiosis

-Asexual whiptail lizards are descended from a sexual species, and females still exhibit mating behaviors

Variation in Patterns of Sexual Reproduction

-For many animals, finding a partner for sexual reproduction may be challenging

-One solution is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, in which each individual has male and female reproductive systems

-Two hermaphrodites can mate, and some hermaphrodites can self-fertilize

-Individuals of some species undergo sex reversals

-Some species exhibit male to female reversal (for example, certain oysters), while others exhibit female to male reversal (for example, a coral reef fish)

Concept: Fertilization depends on mechanisms that bring together sperm and eggs of the same species

-The mechanisms of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the union of egg and sperm, play an important part in sexual reproduction

-In external fertilization, eggs shed by the female are fertilized by sperm in the external environment

-In internal fertilization, sperm are deposited in or near the female reproductive tract, and fertilization occurs within the tract

-Internal fertilization requires behavioral interactions and compatible copulatory organs

-All fertilization requires critical timing, often mediated by environmental cues, pheromones, and/or courtship behavior

Ensuring the Survival of Offspring

-Internal fertilization is typically associated with production of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gametes but the survival of a higher fraction of zygotes

-Internal fertilization is also often associated with mechanisms to provide protection of embryos and parental care of young

-The embryos of some terrestrial animals develop in eggs with calcium- and protein-containing shells and several internal membranes

-Some other animals retain the embryo, which develops \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the female

-In many animals, parental care helps ensure survival of offspring

Gamete Production and Delivery

-To reproduce sexually, animals must produce gametes

-In most species individuals have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, organs that produce gametes

-Some simple systems do not have gonads, but gametes form from undifferentiated tissue

-More elaborate systems include sets of accessory tubes and glands that carry, nourish, and protect gametes and developing embryos

-A cloaca is a common opening between the external environment and the digestive, excretory, and reproductive systems

-A cloaca is common in nonmammalian vertebrates; mammals usually have a separate opening to the digestive tract