Example Study Guide: Lehigh University Biology Research.

Sister Chromatids: Structure, Function, and Research at Lehigh University

Short Answer Quiz

Instructions: Please answer the following questions in 2-3 sentences each.

1. What are the two main ways in which DNA interactions are accomplished, according to Dr. Skibbens?
2. What is the focus of Dr. Zappulla's research?
3. Briefly describe Dr. Shropshire's findings regarding the genetic basis of *Wolbachia*-induced cytoplasmic incompatibility (CI).
4. What types of genetic conflicts are being studied in Dr. Lang's lab using yeast as a model organism?
5. Describe the research focus of Dr. Jennifer Swann's lab.
6. What unique aspect of sleep plasticity is Dr. Kowalko investigating in *A. mexicanus*?
7. What is the primary research interest of Dr. Julie Haas's lab, and what brain region is their focus?
8. Briefly explain the role of lynx genes in Dr. Julie Miwa's research.
9. What research area does Dr. Kathy Iovine specialize in?
10. What is the primary research focus of Dr. Linda Lowe-Krentz's lab?

Answer Key

1. DNA interactions can occur through tethering, where one DNA molecule connects to another, or through modifications like histone deposition and condensin recruitment. Sister chromatid tethering during replication is a prime example.
2. Dr. Zappulla's research focuses on telomerase RNA, investigating its physical organization, functional elements, and mechanisms of action in maintaining telomere length and inducing senescence.
3. Dr. Shropshire discovered that *Wolbachia*-induced CI is caused by two genes, *cifA* and *cifB*, encoded by *Wolbachia*'s prophage. These viral genes directly control arthropod reproduction.
4. Dr. Lang's lab uses yeast to study genetic conflicts including sexual conflict, gene drive, and the selfish intracellular "Killer" virus. These studies aim to understand the evolutionary mechanisms resolving such conflicts.
5. Dr. Swann's research investigates the neural and hormonal control of animal behavior, particularly focusing on the regulation of reproductive behaviors in various species.
6. Dr. Kowalko is studying the opposing sleep plasticity observed in different organisms under food-poor conditions. Some organisms reduce sleep, likely to increase foraging, while others increase sleep, potentially to conserve energy.
7. Dr. Haas's lab focuses on electrical synapses, specifically investigating their strength, dynamics, and role in attention. Their research is concentrated on the thalamus, a brain region rich in electrical synapses and involved in sensory gating.

8. Lynx genes are modulators of the cholinergic system, acting as "molecular brakes" on nicotinic acetylcholine receptors. Dr. Miwa's research investigates the role of lynx genes in various neurobiological processes, including learning, plasticity, and anxiety.
9. Dr. Iovine specializes in developmental biology, specifically studying the genetic and developmental mechanisms underlying fin outgrowth and regeneration in zebrafish.
10. Dr. Lowe-Krentz's lab focuses on the identification and characterization of a receptor for heparin in vascular cells. They are studying its signal transduction pathway and its role in modulating smooth muscle and endothelial cell function.

Essay Questions

1. Dr. Skibbens and Dr. Zappulla both study fundamental aspects of DNA and chromosome biology. Compare and contrast their research interests, highlighting the specific questions they address and the methodologies they employ.
2. Dr. Shropshire's research on *Wolbachia*-induced cytoplasmic incompatibility has implications for understanding arthropod evolution and controlling insect populations. Discuss the potential applications of his findings in fields like agriculture and disease vector control.
3. Several Lehigh faculty members, including Dr. Lang, Dr. Kowalko, and Dr. Iovine, utilize model organisms in their research. Discuss the advantages and limitations of using model organisms to study complex biological phenomena.
4. Many researchers in the Lehigh Biology Department investigate the nervous system, utilizing diverse approaches and focusing on various aspects of brain function. Compare and contrast the research interests and methodologies of three neuroscientists at Lehigh, highlighting the specific questions they address and the contributions of their work to the broader field.
5. Summarize the current research being conducted at Lehigh University on the role of cell signaling in regulating cellular processes. Select three faculty members whose work exemplifies this theme and discuss their research in detail, focusing on the specific signaling pathways and cellular responses under investigation.

Glossary of Key Terms

Sister chromatids: Identical copies of a chromosome formed during DNA replication, connected by a centromere. **DNA replication:** The process of copying a DNA molecule to produce two identical DNA molecules. **Telomerase:** An enzyme that adds repetitive DNA sequences (telomeres) to the ends of chromosomes, preventing degradation and loss of genetic information. **Senescence:** The process of cellular aging, characterized by a decline in cellular function and an increased susceptibility to cell death. **Cytoplasmic incompatibility (CI):** A phenomenon in insects where mating between individuals with incompatible *Wolbachia* infections results in reduced offspring viability. **Prophage:** A bacteriophage genome integrated into a bacterial chromosome, replicating alongside the bacterial DNA. **Gene drive:** A genetic engineering technique that aims to spread a particular gene throughout a population, often with the goal of altering or suppressing the population. **Killer virus:** A double-stranded RNA virus found in yeast that produces a toxin that kills uninfected cells. **Phenotypic plasticity:** The ability of a single genotype to produce different phenotypes in response to environmental changes. **Sleep plasticity:** Changes in sleep patterns and duration in response to environmental factors, such as food availability or temperature. **Electrical synapses:** Specialized intercellular junctions that allow for direct electrical communication between adjacent neurons. **Thalamus:** A brain region involved in relaying sensory and motor signals to the cerebral cortex and regulating consciousness, sleep, and alertness. **Lynx genes:** A family of genes that encode proteins that

modulate the activity of nicotinic acetylcholine receptors, impacting various neurological processes. **Cholinergic system:** A neurotransmitter system that uses acetylcholine for communication between neurons, involved in various functions such as learning, memory, and movement. **Zebrafish:** A small freshwater fish widely used as a model organism in developmental biology and genetics due to its transparency during early development and genetic tractability. **Heparin:** A sulfated polysaccharide that acts as an anticoagulant, preventing blood clotting. **Vascular cells:** Cells that make up blood vessels, including endothelial cells (lining the inner surface) and smooth muscle cells (surrounding the endothelial layer). **Angiogenesis:** The formation of new blood vessels from pre-existing vessels, crucial for tissue growth and repair. **Gap junctions:** Intercellular channels that allow for direct communication between adjacent cells, enabling the passage of ions and small molecules. **Model organism:** A species widely studied in research due to its ease of maintenance, genetic tractability, and relevance to understanding biological processes in other organisms, including humans. **Neural circuits:** Networks of interconnected neurons that process and transmit information within the nervous system. **Olfactory system:** The sensory system responsible for the sense of smell, involving the detection and processing of odor molecules. **Olfactory bulb:** The first brain region to receive input from olfactory receptor neurons, responsible for initial odor processing and relaying information to other brain areas. **Androgens:** A group of steroid hormones primarily produced in the testes, responsible for male sexual development and secondary sexual characteristics. **Aggression:** Behavior aimed at causing harm or damage to another individual. **Sensory neurons:** Specialized neurons that detect and transmit sensory information from the environment to the central nervous system. **Auditory system:** The sensory system responsible for hearing, involving the detection and processing of sound waves. **Ribosomes:** Cellular structures responsible for protein synthesis, composed of RNA and protein molecules. **Ribosome heterogeneity:** The existence of distinct ribosome populations with different compositions or functions within a cell. **Spermatogenesis:** The process of sperm cell development in the testes. **Phage biology:** The study of bacteriophages, viruses that infect and replicate within bacteria. **Functional genomics:** A field of biology that studies the functions of genes and their interactions at a genome-wide level.