Introduction to Natural Sciences (SCIE71000)

Test #1 (35%) Outline

TEST DATE: Thursday June 20th, 2019, 8:00 AM

NOTE: I will have time set aside Tuesday before the test to answer any questions

1) CHARACTERISTICS OF LIFE – **do not** worry about, will not be tested

2) THE CELL:

* Organelles of cells and their functions briefly (organelles to know: nucleus, nucleolus, cell membrane, ribosomes, transport system i.e. from nucleus through nuclear pore, endoplasmic reticulum (rough and smooth), Golgi apparatus, mitochondria, chloroplast – do not worry about centrioles, peroxisomes, cytoskeleton, flagella/cilia
* Difference between eukaryotic & prokaryotic cells
* Differences between plant and animal cells
* Chromosomes (DNA & protein packaged together)
* **Do not** worry about cell theory

3) CELL CYCLE / CELL DIVISION/ MITOSIS:

* Process for division of somatic cells (cells of body other than gametes)
* be able to name the phases of the cell cycle [interphase, mitosis (prophase, metaphase, anaphase, and telophase - PMAT) and cytokinesis
* know events occurring during interphase (S phase of it) and the different phases of mitosis and cytokinesis as discussed in class
* Importance of cell cycle checkpoints
* **Do not** worry about different types of chemotherapeutic drugs
* Telomeres repeating sequences ends of chromosomes – briefly know why important

4) NUCLEIC ACIDS (DNA AND RNA):

* three components of DNA (be able to name them: phosphate group, sugar (deoxyribose) and nitrogenous bases adenine, guanine, cytosine and thymine)
* general structure of DNA (double stranded helix, complementary base pairing i.e. A pairs with T; G pair with C
* three components of RNA (phosphate group, sugar (ribose) and nitrogenous bases adenine, guanine, cytosine and uracil)
* 3 types of RNA molecules we’ve discussed, mRNA (in transcription), tRNA (for translation – brings in appropriate amino acid), rRNA (found in ribosomes, ribosomes = site for protein synthesis)

5) DNA REPLICATION:

* DNA replication; function of helicase and DNA polymerase
* semi-conservative replication

6) TRANSCRIPTION & TRANSLATION:

* central dogma of molecular biology DNA 🡪 RNA 🡪 Protein
* process and steps for both transcription and translation, where steps occur in eukaryotic cells i.e. nucleus (transcription) and cytoplasm (translation), know briefly how we go from gene (DNA) to mRNA to protein
* for transcription, mRNA processing/ removal of introns and splicing of exons – mature mRNA
* for translation – occurring at the ribosome; reading mRNA codons, continue elongating protein product until arriving at an mRNA stop codon
* terms codon and anticodon
* NOTE: for translation, **do not** need to memorize amino acid names or structure of each
* **do not** need to memorize 3 nucleotide codons for each amino acid – a chart (GENETIC CODE) will be provided on the test, just know how to go from DNA to mRNA (Uracil instead of Thymine) to amino acid sequence (protein). Remember complementary base pairing is important. **Do not** worry about what happens to protein following translation i.e. from primary to secondary, tertiary or quaternary
* Mutations i.e. *missense point mutation* (one nucleotide change = a different amino acid); *frameshift* (insertion or deletion that alters reading frame and may result in several changes to amino acid sequence); *nonsense mutation* (mutation that creates a premature stop codon so protein is truncated); *silent point mutation* (a point mutation – one nucleotide change - that still codes for the same amino acid i.e. no change to the protein)
* There is redundancy / degeneracy within the genetic code – what does this mean and why is it important?

7) DIFFUSION AND OSMOSIS

* Related terms/concepts: plasma cell membrane, selectively permeable, isotonic, hypertonic, hypotonic
* What happens to a cell if placed in a) an isotonic solution, b) a hypotonic solution c) a hypertonic solution
* animal cells (may burst in hypotonic solution) versus plant cells (protective cell wall)

8) GENETICS

* Meiosis (for production of GAMETES = egg cell & sperm cell), know briefly what happens during meiosis I and II – with focus on what is happening with chromosomes. NOTE: DNA replication only occurs in interphase prior to meiosis I and does not occur prior to meiosis II. Other important points: crossing over during prophase I (importance of crossing over i.e. introduces genetic variation); **homologous chromosomes** separate during meiosis I, **sister chromatids** separate at the centromere in meiosis II. The end result of meiosis: 1 diploid cell has divided twice to produce 4 haploid cells each carrying half the number of chromosomes as the original cell.
* Difference between mitosis and meiosis (when looking at overall process)
* Genetics Terminology Handout – terms to know/understand (chromosome, sister chromosomes, homologous chromosomes, alleles, dominant, recessive, genotype, phenotype, homozygous, heterozygous, diploid, haploid, crossing over, gametes, zygote, autosome, sex chromosome, karyotype – what a normal female and male karyotype would look like)
* Punnett square questions: like examples in class i.e. basic Mendelian genetics, 1 gene, 2 alleles (one allele is dominant, one allele is recessive); determining the likelihood of passing on a trait to next generation, genotype and phenotype ratios
* Human Genetics

1. for humans, somatic cells contain 46 chromosomes (23 pairs = 1 maternal copy and 1 paternal copy for each chromosomal pair) and the gametes (egg and sperm cells) contain 23 chromosomes i.e. only one of each pair
2. autosomal dominant disorders: (**do not** need to memorize different disorders or symptoms, just understand what is meant by autosomal dominant for Punnett square questions like ones done in class)
3. autosomal recessive disorders: (**do not** need to memorize different disorders or symptoms just understand what is meant by autosomal recessive for Punnett square questions like done in class) – and term **carrier**
4. X-linked recessive disorders: (**do not** need to memorize different disorders or symptoms just understand what is meant by X-linked recessive for Punnett square questions like done in class) – and term **carrier**
5. Errors of meiosis (non-disjunction events / diagrams), karyotype analysis (be able to look at a human karyotype and determine if male (XY) or female (XX) and if there are errors such as extra chromosomes or missing chromosomes). Remember that human cells contain 46 chromosomes TOTAL, or 23 pairs of chromosomes, pairs 1 to 22 are the autosomes, and the 23rd pair consists of the sex chromosomes
6. **Do not** worry about other forms of inheritance i.e. codominance, incomplete dominance, multiple alleles, polygenic inheritance

9) MICROBIOLOGY/IMMUNOLOGY

- What is a pathogen?

- Understanding of viruses and bacteria as described – **do not** need to know details of other types of pathogens

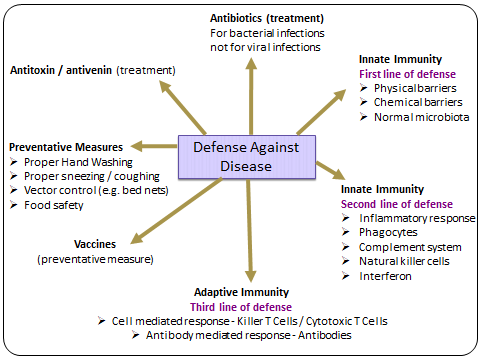
- VIRUSES

* The need for a host cell to replicate
* General structure of a virus
* Lytic and lysogenic (latent) cycles
* How do viruses cause disease?

- BACTERIA

* Prokaryotic cells (what does this mean?)
* Replication by binary fission
* How bacteria cause harm to body – release of toxins etc.
* Antibiotics and antibiotic resistance
* Bactericidal; bacteriostatic; penicillin mechanism of action
* Kirby-Bauer Disc Diffusion Assay – like activity done in class – zone of inhibition – and use of charts “Antibiotic Sensitivity Standards” -- if bacteria are sensitive to antibiotics (what does this mean?); if bacteria are resistant to antibiotics (what does this mean?)

**-** DEFENSE AGAINST DISEASE – summarized here … preventative measures, treatment and our body’s defenses (first, second and third line of defense)



* ***Innate*** - *non-specific* – what does this mean?

Nonspecific defense: *First line of defense*: physical barriers = skin and mucous membranes; chemical barriers = proteins/ enzymes that have antimicrobial activity e.g. lysozyme and acidic environment; normal microbiota, *Second line of defense*: inflammatory response (overview of what happens – don’t worry about symptoms), phagocytic cells, natural killer cells, complement and interferon – **KNOW each nonspecific defense briefly**

* ***Adaptive*** – *specific* – what does this mean?

Specific defense: (our immune system) = **cell-mediated** and **antibody mediated** responses. Focus on cytotoxic T cells, plasma B cells and antibodies (and what antibodies do); also know that memory cells remain after infection is cleared; importance of memory cells? – do not worry about macrophages, antigen presentation and binding of Helper T-cells and cell division

- ANTIBODIES

What do they do – ways they protect / defend against pathogens?

- VACCINATION / IMMUNIZATION

* What is a vaccine? Purpose of; how does a vaccine protect against disease?
* Herd Immunity

- ACTIVE versus PASSIVE immunity

* Difference between the two
* Examples of each as discussed in class

10) EVOLUTION

* Difference between Lamarck’s thinking and Darwin’s
* Definition species / population
* Evolution definition of: change in genetic composition of a population (can also refer to allele frequency; calculating allele frequency); micro-evolution and macroevolution
* Natural selection – necessary conditions i.e. variation in characteristics (i.e. genetic variation), differences in fitness (and know what is meant by term fitness), heritable traits examples of this as discussed in class
* Adaptation - meaning of - related to natural selection
* Origin of Life
* Early Earth (lack of oxygen; photosynthesis increase level of oxygen, ozone formed)
* Origin of Eukaryotic cells – endosymbiotic theory
* Speciation
* Hardy-Weinberg principle and related questions like those done in class (equations will be given to you on the test but you would need to know how to use them); genotype frequency, allele frequency

11) OTHER – Related to DNA technology

* Bacterial plasmid as vectors used for cloning genes – restriction enzymes, ligase, transformation of bacterial cells
* Gel electrophoresis – generating DNA fingerprints – finding restriction enzyme cut sites within a DNA sequence; DNA fragments separated by electrophoresis -- an agarose gel – like example taken up in class