IDX G10 Biology H
Study Guide Issue 3
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10.1 Cell Growth

- the larger a cell becomes, the more demands the cell places on DNA
- cell has more trouble moving enough nutrients and wastes across the cell membrane
- DNA overloads
    - similar to “information crisis”
    - would occur if a cell was to grow without limit
    - insufficient DNA for the large cell
- Exchanging materials
    - rate of exchange depends on the surface area of the cell
    - as the cell grows, surface area and volume will not change in the same way
    - the greater ratio, the more efficient exchange
    - if cell grows too large, insufficient oxygen gas and food in, insufficient wastes out(lead to toxin)
- Division of the cell
    - cell division: a cell divides into 2 new daughter cells, prevent cell grow too large
    - preparing for cell division: cell replicates DNA and solve DNA overloading
    - after cell division: daughter cells are smaller and solves material exchange problem
- Reproduction
    - sexual production: 2 different parents, egg+sperm-->zygote
    - asexual production: single parent, not involve fusion of gametes, offspring individuals are genetically identical to parent
        - fission: common in single celled organisms like bacteria, archaea, and many protozoa
        - budding: common in yeast and hydra
        - fragmentation: common in invertebrates, fungi, plant, and some reptiles

10.2 The Process of Cell Division

- Chromosomes
    - made up of DNA and protein
    - at the beginning of cell division--chromatin condenses into compact chromosome
    - prokaryotic chromosome, only single circular DNA

    - chromatins condense into compact
        - DNA wraps around histones, form nucleosomes
        - nucleosomes wrap into solenoid
        - solenoid wraps together in looped domain, and form chromatin
        - final coiling of domain and form chromosome
- Replication--before cell division, replicated DNA condense into chromosomes, become visible under microscope
- chromatids: identical sister chromatids attached to centromere in chromosome
- human body: 46 chromosomes
- Cell division in prokaryote, binary fission: copy genetic information before cell division, separate contents of cell into two parts
- Cell cycle--a cell grows, prepares for division, and divides to form 2 daughter cells, each of which then begins the cycle again
- Interphase
    - G1: most of the growing, increase in size, synthesize proteins and organelles
    - S: chromosomes replicate, synthesis of DNA and key proteins of chromosome
    - G2: organelles for division produced, shortest phase
- Mitosis
    - Prophase
        - longest phase
        - chromosomes become visible
        - centrioles are two tiny structures new nuclear envelope, separate and take up positions or opposite side of nucleus
        - nucleolus disappears
        - centrioles lie in centrosome, organize spindle; spindle fibers will attach to chromosomes at centromere during metaphase
        - plant cells also form centrosomes using other organizer
        - near end, chromosomes coil more tightly, nucleolus disappear, nuclear envelope breaks down
    - Metaphase
        - only a few minutes
        - chromosomes line up across cell's center
        - microtubules grow from the centrosome to connect chromosomes at the centromere--kinetochore is a protein complex that assembles on centromere

    - Anaphase
        - shortest
        - centromere seperate: pulling sister chromatids to poles of cell
    - Telephase
        - chromosome disperse into tangle of dense materials
        - Nuclear envelope reforms
        - spindle breaks apart
        - nucleolus appears
        - mitosis ends
    - Cytokinesis
        - division of cytoplasm
        - animal cell: cell membrane drawn inward, cytoplasm pinched into 2 equal parts
        - plant cell: cell plate forms midway between dividing nuclei, separating membrane, form cell wall
- roles of cell division: reproduction, growth and development, tissue renewal

10.3 Regulating the Cell Cycle

- most muscle and nerve cells do not divide
- skin, digestive tract, bone marrows--grow and divide rapidly
- Controls on cell division
    - place some cells in Petri dishes with nutrient broth
    - controls on cell growth and division can be turned on and off
    - cell division will happen quickly at the edge of cut. when healing is almost done, cell cycle returns to normal
- Cell Cycle regulators
    - cyclin
        - discovered by Tim Hunt
        - regulatory protein
        - regulate the timing of cell cycle in eukaryotic cell
    - internal regulator: proteins that respond to events inside the cell, allows cell to proceed only when certain processes have happened
- Internal regulator

    - a cyclinically operating set of molecules in cell that triggers and coordinates key events in cell cycle
    - checkpoint: a control point where the cell stops until go ahead signals come
    - regulatory proteins: cyclins and Cdks
- Cyclin and Cdks
    - Cdk always present but inactive by default--become active when bonded to cyclin, Cdk-cyclin complex turn target proteins on by phosphorylation
    - Mitosis promoting factor is one example
        - synthesis of cyclin in the late S phase and accumulates
        - cyclin combine with recycled cdk, producing enough MPF for passing the G2 checkpoint, promoting mitosis
        - cyclin is degraded in anaphase, terminating M phase
        - Cdk maintains and is recycled
- External regulator
    - proteins that respond to events outside the cell
    - direct cell to speed up or slow down cell cycle
    - e.g. growing factors: stimulate growth and division, embryonic development and wound healing
    - e.g. molecules on neighboring cells: slow down or stop cell cycle, prevent excessive cell growth
- Cancer
    - cells lose ability to control growth
    - cancer cells do not respond to the signals that regulate the growth of most cells: divide uncontrollably, form masses of cells called tumors
    - may break loose from tumor and spread--metastasis
    - benign tumors do not spread
    - malignant tumors invade, destroy surrounding healthy tissue and forms secondary tumor
    - no longer respond to external growth regulator
    - fail to produce internal regulator
    - P53: cellular tumor protein, tumor suppressor, prevent cancer
    - treatment: radiotherapy, chemotherapy, surgery
- Apoptosis
    - programmed cell death

    - can occur in cells that are damaged beyond repair, including cells with DNA damage that could otherwise led to cancer
    - shape the structure of tissues and organs
        - webbing in hands/ feets
        - cell shrivel and die in development
        - in plant, the localized death of cell causes leaves to fall in autumn

11.1 Work of Gregor Mendel

- genetics: study of heredity
- heredity: delivery of features from parent to offspring
- traits: a specific characteristic determined by genes
- genes: unit of heredity determine traits; specific fragment of DNA on chromosomes
- Locus: position of a gene on a chromosome
- alleles: different form of a gene, determine different forms of a trait
- Gregor mendel's peas
    - father of genetics
    - peas--small, easy to grow, produce many offspring
    - pollen: male sex cells
    - ovule: female sex cells
    - self pollination: pollen fertilizes the egg in the same flower, only one parent, still sexual reproduction
    - model system: can cross/self fertilize, display discrete traits for characters, mating can be well controlled, many known varieties
- P generation: parent
- F1: first filial
- F2: second filial
- true breeding: self pollinated, produce offspring always identical to parents for a specific trait, generation after generation
- Cross pollinate experiment: pollen fertilizes another flower of a different plant, two parents
- hybrid: offspring of a cross between parents with different traits
- Crossing P0
    - start with true breeding strains
    - F1 generation: no blending of colors, F1 all the same

- Self fertilize F1
    - self pollinate F1 to produce F2
    - traits determined by recessive alleles appear
- Conclusion: Biological inheritance is determined by discrete factors passed from one generation to next
- Law of dominance: dominant traits hide recessive trait
- Law of segregation: alleles for different gene are segregated during fermentation of gametes, so each gamete carries only one allele for each gene

11.2 Applying Mendel's Principles

- homozygous: organisms that have 2 identical alleles for the same gene
- heterozygous: organisms that have 2 different alleles for the same gene
- phenotype: physical trait
- genotype: genetic makeup
- punnet square: diagram used to predict the outcome in genetic crosses
- principle of independent assortment: genes for different traits can segregate independently during the formation of gametes