MCDB 4650 (Fall 2021) EXAM #1 review questions

Disclaimer: These answers are based off of what I think is correct, so please feel free to disagree!

-I have included information from Carson's videos as well!

Introduction

What are the core components of cell theory?

Three main principles:

1. **All living things are composed of cells**
2. **The cell is the smallest unit of life that is that can carry out functions necessary for an organism's survival**
3. **New cells are formed from the division of existing cells**

According to cell theory, each cell in your body is how old, approximately?

-Either 3.5 Billion years old, or how old you are plus 9 months

-All of the cells in your body are descended from the zygote.

Why do we believe that LUCA exists and what can we know about LUCA?

Evidence for LUCA:

-We see same conserved processes and core metabolic processes

-Universal genetic code

What we can know about LUCA:

-simple organism, not as complex as the ones we see now, relied on simple metabolism machinery

-likely lived in an anaerobic environment

What kinds of evidence suggest that different types of animals share a common ancestor?

-homologous structures : similar structures across species

-vestigial organs: structures that have lost their original function in an organism's evolutionary history but still exist in a reduced or rudimentary form, like the tailbone in humans

-similarities in embryological development

-conserved genes, such as homeobox genes

-conserved processes, such as metabolic processes, central dogma

-universal genetic code

When is a cell an organism?

It does not rely on other cells for its survival, and can carry out essential processes on its own like:
-Reproduce
-Respond to surroundings
-Grow
-Carry out metabolic processes
-Maintain internal environment

What does it mean that unicellular organisms (and cells within a multicellular organism) are social?

This means that cells are being cooperative, as well as interacting and communicating with one another.

Example of communication: quorum sensing
- cells release signaling molecules into their environment
-when the concentration of these molecules reaches a certain threshold coordinated behaviors in the population are triggered

How can cells be social without forming (or being part of) a single organism?

Cells can be social without forming a single organism by participating in cooperative processes, such as those seen in quorum sensing.

Explain why the connections between genotype and phenotype are generally complex.

-Most systems require many genes to be generated to create a phenotype
-Many genes serves many different functions
-phenotypic plasticity: a single genotype can produce different phenotypes in different environments
-Existence of non-coding regions of DNA

Genes, experimental methods & outcomes
What is the evidence that genetic information is encoded in molecules (of DNA)?

Griffith's Transformation Experiment (1928):

-studied two strains of the bacterium Streptococcus pneumoniae: a virulent (disease-causing) strain and a non-virulent strain

-heat-killed the virulent strain and mixed its DNA with the live non-virulent strain, the non-virulent bacteria could become virulent

-suggested that some hereditary factor from the dead cells (DNA) was transferred to the live cells, transforming their phenotype

Avery, MacLeod, and McCarty's Experiment (1944):

-found that DNA extracted from the virulent strain could transform the non-virulent strain, demonstrating that DNA carries the genetic information.

Hershey and Chase's Bacteriophage Experiment (1952):

-labeled the DNA of the phages with radioactive phosphorus-32 (32P) and the protein coat with radioactive sulfur-35 (35S)

-results showed that only the DNA, not the protein coat, entered the host bacterial cells and played a role in viral replication

-supported the idea that DNA, not proteins, carries genetic instructions.

How is it recognized within a cell, how can it be "hidden"?

DNA Packaging:

-Molecules need to interact with their regulatory region

-DNA is packed into chromatin (DNA wrapped around histones)

-In heterochromatin, the DNA is inaccessible to many cellular processes and is effectively "hidden

-Chromatin Remodeling: you can control which genes are turned on and which ones are turned off

Epigenetic Modifications:

-DNA methylation: adding methyl groups to DNA to silence them

-Histone modifications: acetylation and methylation

Nucleosomes:

-Definition: the basic packing unit of genomic DNA built from histone proteins around which DNA is coiled

-Nucleosomes can block access to specific DNA sequences, making them less accessible for transcription factors or polymerases.

Where does genetic information come from (originally)?

Genetic information: information that is passed from one generation to the next

Must have been simpler than DNA but still able to

1. **Store information vital to the patterning/development/persistence of the organism**
2. **Was self-replicating**
3. **Was passed on from generation to generation**

Some molecule that meets above criteria

What is the role of gene / genome duplication in evolutionary change?

Gene: the hereditary units transferred from parent to offspring

Gene Duplication: when a region of DNA is duplicated, resulting in the presence of two or more copies of the same gene

Genome Duplication: When an organism or a species gains one or more additional sets of chromosomes, resulting in an increase in the total amount of genetic information in the cell. In other words: occurs when the entire genome is duplicated. Organisms now have multiple copies of each gene

Example Response: Genetic redundancy leading to subfunctionalization

Subfunctionalization: after a gene duplication event, the duplicated genes initially identical or similar in function, undergo changes that lead to specialization of their functions

Gene duplication allows you to do multiple things

What are the possible fates of a newly generated gene?

-Might provide a beneficial function to the organism

-Subfunctionalization

-Neofunctionalization: one of the duplicated genes acquires a completely new and beneficial function that was not present in the ancestral gene

-Some genes may become redundant

-Pseudogenization: non-functional gene

What is meant by the terms homolog, ortholog, paralog, and convergence in the context of genes?

Homolog: related evolutionarily

Ortholog: related evolutionarily, typically retain similar functions across different species

Paralog: homologous genes that are found within the same species or lineage. They arise from gene duplication events

Convergence: unrelated or distantly related species independently evolve similar traits or genes in

response to similar environmental pressures or selective forces

What is a null mutation, an antimorphic, hypomorphic, hypermorphic, or a neomorphic mutation?

Null mutation: not making the gene product

Antimorphic: interferes with the normal function of the wild-type allele of the same gene, even when present in a single copy

Hypomorphic: reduces the function of a gene but does not completely eliminate it

Hypermorphic: increases the normal function of a gene. It leads to an enhanced or increased level of gene activity

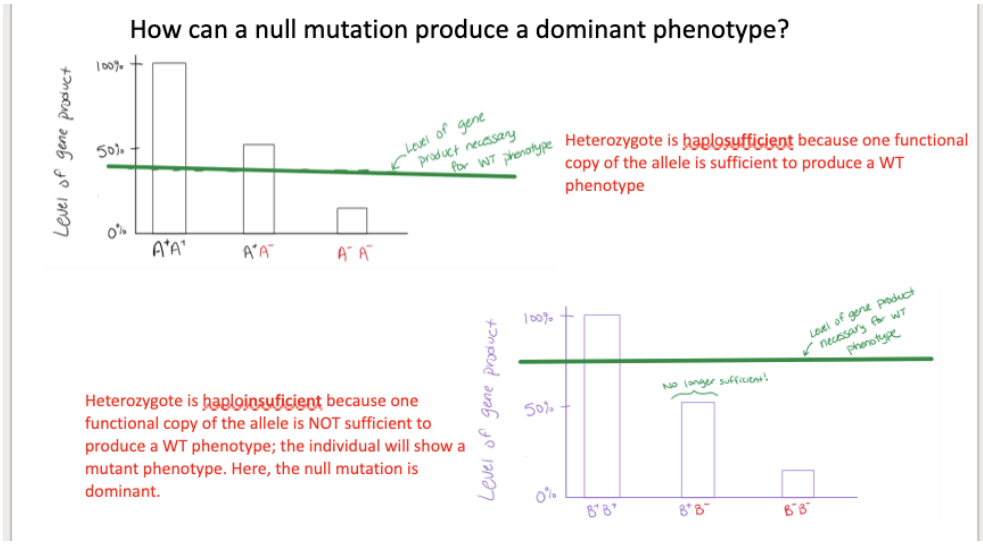
Neomorphic: gives rise to a completely new and abnormal function that is not present in the wild-type gene. Gain of function mutation

How could a null mutation produce a dominant phenotype?

-Null does not always mean recessive

-Haploinsufficiency: when the remaining, functional copy of the gene cannot fully compensate for the loss of function in the null allele.

- **-only refers to heterozygote**
- **-results in a dominant phenotype in individuals with only one copy of the mutant gene**



What are common features (parts) of a gene?

-Promoter Region
-Transcription Start Site
-Start and stop codon
-Exons
-Introns (eukaryotes)
-Terminator region

-Enhancer and Silencer sequences
-UTRs
-Poly-A tail

What are common aspects of polypeptide/protein structure? How do they help you predict the effects of a mutation?

-Primary, secondary, tertiary and quaternary structures
-mutations in primary can affect which amino acid is added to the chain, which can subsequently affect folding and binding properties
-Domains
-mutations may inactivate or hyperactivate certain domains
-Active/binding sites
-mutations can affect substrate binding. Substrates might bind too tightly, or have a lower affinity for binding

What are the common characteristics of a molecular machine?

-specific functions
-conserved
-can undergo dynamic conformational changes
-rely on cooperative processes

Stochastic gene expression: sampling phenotypic space with a single genotype

How might changing the number of lac repressor molecules in a cell influence the expression of the lac operon?

-Increased amount of repressor: if there is a high amount of repressor molecules, it is more likely that they will bind to the operator. The lac repressor blocks RNA polymerase from accessing the promoter, and thus the transcription of the lac operon. Increased amount of repressor molecules will lead to decreased expression of the lac operon, even in the presence of lactose.
-Decreased amount of repressor: if there is a low amount of repressor molecules, it is less likely that they will bind to the operator. RNA polymerase will more easily access the promoter, and so there will be increased expression of the lac operon

How might the cell benefit by turning the lac operon on stochastically, even in the absence of lactose?

-Bet-hedging
-Helps the cell adapt to changes in the environment
-Resource utilization

Why isn't the lac operon always (constitutively) expressed?
-conserve energy and resources
-allows the cell to respond to environmental changes

What (generically) determines the threshold concentration of a cellular response?

-Threshold: the point at which the response or effect becomes detectable or exceeds a predefined baseline level
-Needs to overcome the back reaction
-Lower levels of signaling, back reaction is stronger than the forward reaction

What is meant by the "half-life" of a molecule? What factors influence it?

Half-life: the time it takes for half of a population of identical molecules to undergo a specific process or decay, leading to a decrease in their quantity or activity by half

Factors that influence it:
-initial concentration
-presence of enzymes
-environmental conditions

How does it differ from the half-life of an isotope?

-time it takes for half of a sample of radioactive atoms of that isotope to undergo radioactive decay, leading to the transformation of those atoms into different isotopes or elements
-intrinsic to the structure

How does the half-life of key regulatory molecules influence cellular response behaviors?

- fine-tune their responses
-reduce noise
-ensure efficient resource utilization
-easier to maintain homeostasis through feedback loops
-less sensitive to fluctuations in signaling

How (and why) do stochastic effects influence molecular and cellular systems?

In the context of the Lac Operon:

There is a stochastic induction of transcription. Even when lactose is present in the environment, not all cells activate the lac operon at the same time. Some cells might take longer than others to induce transcription because induction is a stochastic process due to the random events of individual cells. This depends on transcription factor binding, how quickly the lac repressor can leave the operator, etc. When the lac operon will be active is hard to predict at the individual cell level, thus its induction is stochastic.

There is a random, low level expression of the lac operon components, even when lactose is present. Due to brownian motion, transcription factors might bind to the operator if the repressor randomly associates away.

Even with a population of genetically identical cells, there can be cell to cell variation in gene expression. The variation increases stochasticity and influences the organism's response to its environment.

Lactose being present is a stochastic event.

What is monoallelic expression and what is the evidence that it exists?

Monoallelic Expression: where a gene is expressed from only one of the two alleles (gene copies) in a diploid organism, while the other allele remains silenced or inactivated. This results in the expression of a single allele of a gene, even though both alleles are present in the organism's genome

Evidence:

-X chromosome inactivation

In the Elowitz et al experiment, what processes determine which fluorescent proteins are expressed: are these reversible or irreversible events?

-Elowitz: experiment demonstrated that the stochastic nature of gene expression can lead to significant cell-to-cell variability in protein expression levels, even among genetically identical cells

-processes are stochastic, not deterministic

-events are reversible

How would your answer change if instead of fluorescent proteins, they used transcription factors?

- Binding of transcription factors is still stochastic

How might gene expression events become (effectively) irreversible?

- terminal differentiation of cells into specialized cell types can result in irreversible gene expression patterns
-cells are committed to their specific functions and maintain their gene expression profiles throughout their lifetimes

Quorum sensing & aggregative multicellularity

What is meant by evolutionary "costs and benefits"?

-advantages and disadvantages associated with particular traits, behaviors, or genetic changes in an organism's fitness and survival

How do social factors influence such costs and benefits?

Cooperation:
Benefits: individuals within a social group may collaborate, cooperative behaviors can increase the overall fitness of the group members.
Costs: invest time and energy in helping others or sharing resources

Communication:
Benefits: coordinating group activities, signaling threats. Can enhance group cohesion and survival.
Costs: developing and maintaining communication systems can be energetically costly

What is quorum sensing and why is it useful?

-exchange of chemical signals or molecules between individual microorganisms within a population
-chemical signals allow microorganisms to monitor their population density and coordinate group behaviors in response to reaching a certain threshold population density
-want to make sure a type of behavior makes sense to not expend resources

What types of bacterial responses might be under the control of quorum sensing control and why?

-DNA uptake: is it worth using the machinery needed if there are not enough cells to benefit?
-Sporulation: very energy-intensive, will it contribute to the survival of the organism or its relatives?
-Enzyme production: bacteria can optimize resource utilization when they are present in sufficient numbers to effectively break down complex molecules and scavenge nutrients

What, if anything, is the value of stochastic decision making?

-If a process is stochastic it is harder for cells to "cheat" and prioritize their own survival, instead of producing self-sacrificing behaviors.

Why is a typical biological response curve not linear?

Due to Brownian motion, molecules within a cell will interact with one another. You will have a forward reaction and a back reaction. The rate of the reaction must proceed above a certain threshold of its reverse reaction to have a significant effect. There is a plateau in the curve because there are a finite number of molecules in the cell, i.e. saturated enzymes with signaling molecules.

How is the threshold for a quorum (signal) response set?

Receptor Sensitivity: do not need as much signal to induce response, or might need more signal to induce a response

How might a mutation in the receptor change quorum sensing responses? For example, if the mutation reduced ligand-receptor binding affinity?

-You might expect to see more ligand needed to turn the receptor on.

What is a (social) cheater, how does selection influence their prevalence in a population?

-Social Cheater: benefits from cooperative behavior of others, but does not contribute to cooperative behavior itself

-In environments where resources are scarce, cooperative behavior may be more beneficial, and thus social cheaters may not be as prevalent, and selected against.

Why would (scientific) people come to think that humans, sponges, and unicellular choanoflagellates share a common ancestor?

-similar structures and organizations of cells

-conservation of genes

-common developmental pathways

-conserved machinery and processes

What kind of behavior(s) emerged when *Chlorella vulgaris* was exposed to the predator *Ochromonas vallescia* and why? (Borass et al)

-Evolved to become bigger

-Remove predator, go back to original cells: adaptive
-Remove predator, same behavior: evolutionary change

How would you determine, experimentally, whether a multicellular structure was a colony or a single organism?

-Are cells genetically identical or are they genetically diverse?
Identical: colony
Diverse: single organism

What distinguishes a somatic cell from a germ line cell?
Somatic cells:
-make up various tissues and organs
-mutations in somatic cells are not passed onto offspring
-continue to divide and differentiate

Germ-line cells:
-specialized cells that give rise to gametes
-mutations in germline are passed onto offspring
-do not differentiate

What processes are involved in cell differentiation?

-Cell fate specification: what will the cell become?
-Gene regulation: certain genes are turned on and off in cells
-Cell signaling: trigger signaling cascades that tell the cell what to do
-Migration: some cells need to migrate to their final positions (neurons)
-Division: some cells exit cell cycle and focus on specialized functions

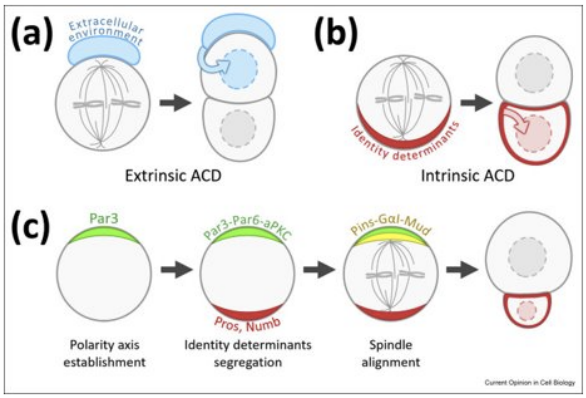
Cellular polarity & asymmetries
Are cells inherently asymmetric? What does that mean?

Cells can adopt an asymmetry based on how they are moving and where they are moving. The cell is not uniform, and can exploit asymmetries by putting them in different environments.

How can cellular asymmetries be generated?

Some protein directs the cell to generate asymmetries

How can cellular asymmetries be generated?



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Asymmetry refers to things that are different from each other.

In the case of cells, this refers to the process by which two daughter cells are not the same as each other through differential distribution of cellular components (RNA, proteins, organelles, etc.)

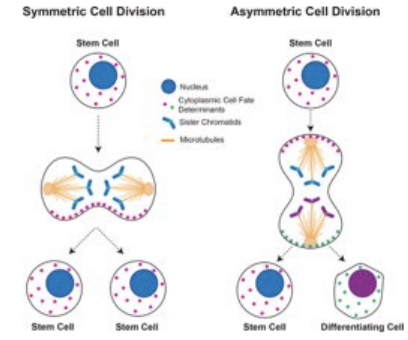
(A) Extracellular cues
- External signals from the cell's microenvironment help determine polarity
- Ex) Tissues and developmental gradients

(B) Intrinsic cues
- Cues for cell fate determination are found within the cell itself
- Unequal distribution of cellular components/molecules
- Ex) Spindle orientation

(C) Polarity axis establishment via polarity proteins

-After asymmetries, daughter cells can go on to have distinct functions

What happens once they are generated - how do they affect sibling cells?



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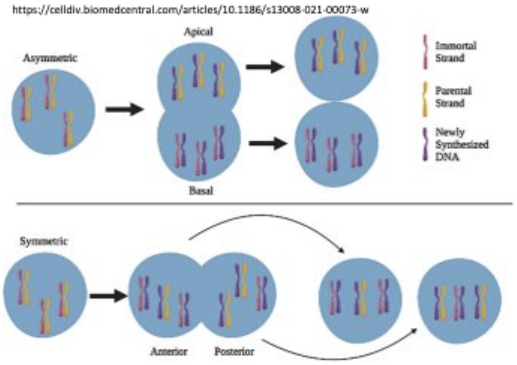


Differential distribution of cellular components leads to different cell fates

How do, generally, asymmetries arise in multicellular organisms?

What could asymmetric determinants be? In what situation(s) could there be problems with these determinants and how would that affect the early embryo?

-Asymmetric determinants are involved in asymmetric cell division, and are supposed to be unevenly distributed.

-If daughter cells receive similar sets of determinants which might lead to similar fates. This can

disrupt the generation of diverse cell types needed for development
-Also involved in cell polarity, if they are mislocalized, cellular axes
-Division may also be impacted, as it can affect the proper segregation of chromosomes

How might asymmetries arise from DNA replication? DNA modification? Cell division plane? Centrosome inheritance? Sperm entry site?

DNA replication: new strand and old strand, two strands are different and they differ in modifications

DNA modification: DNA methylation and histone modifications

Cell division plane: one daughter cell retains specific molecular components or organelles while the other does not, can lead to functional differences

Centrosome inheritance: unequal centrosome inheritance can lead to differences in spindle orientation and cell fate determination in daughter cells

Sperm entry site: involved in the establishment of axes

What types of cellular systems display chirality (left-right handedness)?

-L and D amino acids
-motor proteins, such as myosin, move in a specific direction
-left-right axis
-movement of cilia and flagella

How might we visualize cellular asymmetries, experimentally?

-Immunofluorescence
-FRAP
-In vivo imaging

Establishing Asymmetries / Left-Right
How might different myosins have arisen molecularly (evolutionarily)?

-gene duplication
-selective pressures

Why does muscle contract rather than expand (or both)?

- contraction is essential for generating force, producing movement, and performing a wide range of physiological functions that are necessary for the organism

Does the microfilament system have a handedness?

-polarity, (+) and (-) end

What does it mean that a "phenotype is 100% penetrant and is specific to Myosin1D"?

-a particular trait or characteristic associated with the gene Myosin 1D is always expressed in individuals who carry a mutation or variation in that gene

Penetrant: proportion of individuals with a specific gene mutation or variant who actually display the associated phenotype

Expressivity: strength of phenotype

What is a "chimera"? What is a chimeric protein (polypeptide)?

Chimera: organism that contains cells or tissues with different genetic compositions.

Chimeric Protein: protein molecule composed of two or more distinct protein domains or polypeptide sequences

Why (from a protein structure perspective) are "functional" chimeric proteins possible?

-Domains are able to fold into stable structures

What is the implication that myoD1 has a similar role in L/R determination in Drosophila, zebrafish and Xenopus?

-Pathways leading to L/R determination are conserved

Signaling systems

How do feedback networks work?

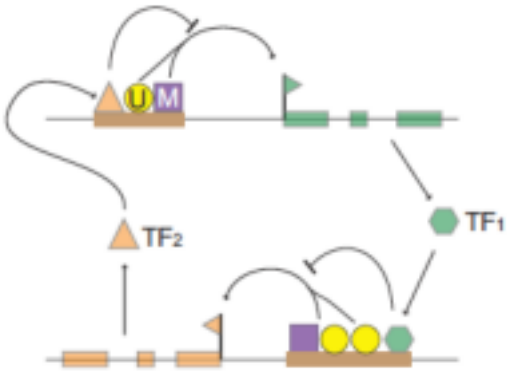
Positive Feedback: Amplification Effect
Definition: output amplifies the activity of the process that led to the output
Function: Involved in processes that need to reach an endpoint or threshold quickly. Does not stabilizes systems, but pushed it towards a specific outcome
Example: blood clotting. Platelets adhere to the site and release chemicals that attract more platelets until the clot is formed

Negative Feedback: Dampening Effect
Definition: output inhibits or reduces the activity of the process that led to the output.
Function: help maintain stability and homeostasis by counteracting deviations from a setpoint.
Example: Body temperature. If the body temperature rises above a certain threshold, the body initiates mechanisms to cool down (such as sweating)

Generate plausible predictions (and explanations) for the effects of mutations or inhibitors on the outcomes of various signaling pathways (when you are given the pathway - no memorization).

-What are your assumptions?

-What factors are influencing the pathway?



What is going on (what is described) in this picture (→)? Which interactions might be cooperative?

-Cooperative: Interacting units

-cooperative complex binds differently than unit

How would you find the enhancers of a gene & determine which were active in a particular cell?

Enhancers:

-can be upstream, downstream, or within introns

-contain binding sites for transcription factors

-they increase the transcription on gene

-Knockout candidate region, analyze influence on cell

Be able to provide plausible predictions (and explanations) for how changes in a transcription factor binding motif lead to changes in response to a morphogen gradient?

Morphogen Gradient: Differential spatial distribution of a signaling molecule within a cell.

-They play crucial roles in embryonic development by providing positional information

Changing a TF binding motif means you are changing a DNA sequence

Altered affinity:

-Prediction: the affinity of the TF for its binding motif on the DNA strand will be decreased due to a random mutation in the genome

-Explanation: now, the TF has a lower affinity for its DNA binding site. With a lower affinity for its binding site, the TF might require higher morphogen concentration to yield a response comparable to WT levels

-Prediction 2: affinity due to a mutation will be increased

-Explanation 2: higher affinity could result in enhanced gene expression in response to lower morphogen concentration

Steeper Response Gradient:

-Prediction: altering the DNA binding motif will make it so TFs can bind cooperatively at the same site and yield a steeper response curve

-Explanation: cooperative binding results in an amplification of the signal. With more TFs bound to a single site and acting cooperatively. They can enhance gene expression more effectively making cells respond more strongly to smaller changes in morphogen concentration

How is the response of a cell to a morphogen gradient similar to or different from a bacterium's quorum sensing response?

-the response of a cell to a morphogen gradient is a developmental process in multicellular organisms where cells interpret spatial information to determine their fates

-quorum sensing in bacteria is a population-dependent mechanism that coordinates collective behaviors in response to changes in cell density

Beside the distribution of the morphogen, what other factors might influence the behavior (read out) of a morphogen gradient?

1. **Receptor expression and sensitivity**
    a. **If you have a lot of receptors, you can induce a certain response in response to a lower concentration of morphogen, as you have many receptors around. If you have a sensitive receptor, it is easier to induce a response, even with less morphogen around.**
2. **Feedback Loops**
    a. **Negative feedback loops can modulate the strength and duration of the response to a morphogen, maintaining homeostasis**
3. **Genetic/epigenetic factors**
    a. **Epigenetic factors: change in gene function not due to changes in DNA sequence**
        i. **Ex: DNA methylation, histone modification, chromatin remodeling, etc.**

    b. **Mutations to receptors or morphogens themselves might make morphogens more/less effective**

Carson's example answer: Perhaps the DNA strand containing the gene for a specific transcription factor is tightly coiled around a histone. This makes it difficult for the TF's to access the gene and initiate transcription of the morphogen. Due to Brownian motion, it is possible that some TF's are able to interact with the morphogen gene and initiate transcription, but it is harder to do so. Therefore the morphogen will be present at a lower concentration than normal and will interact with fewer receptors.

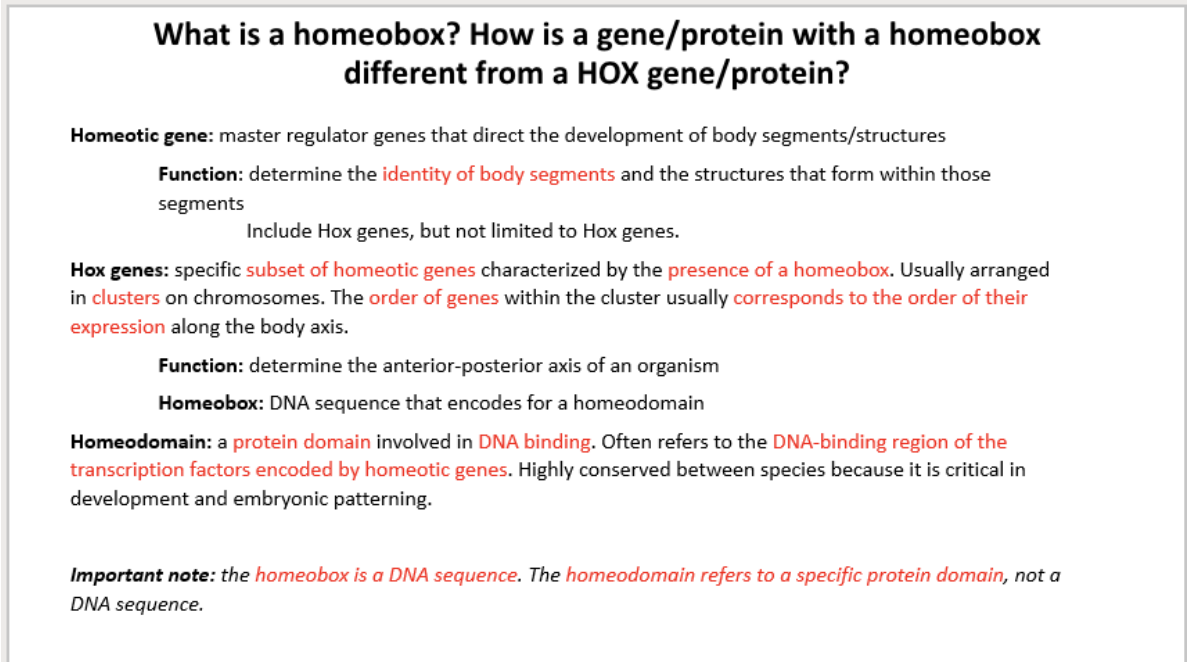
This will result in a decreased response to the morphogen within the cell.

Establishing embryonic axes and HOX genes

What is a homeobox?

Homeobox: DNA sequence that encodes for a homeodomain.

How is a gene/protein with a homeobox different from a HOX gene/protein?



What is a homeobox? How is a gene/protein with a homeobox different from a HOX gene/protein?

Homeotic gene: master regulator genes that direct the development of body segments/structures

Function: determine the identity of body segments and the structures that form within those segments

Include Hox genes, but not limited to Hox genes.

Hox genes: specific subset of homeotic genes characterized by the presence of a homeobox. Usually arranged in clusters on chromosomes. The order of genes within the cluster usually corresponds to the order of their expression along the body axis.

Function: determine the anterior-posterior axis of an organism

Homeobox: DNA sequence that encodes for a homeodomain

Homeodomain: a protein domain involved in DNA binding. Often refers to the DNA-binding region of the transcription factors encoded by homeotic genes. Highly conserved between species because it is critical in development and embryonic patterning.

Important note: *the homeobox is a DNA sequence. The homeodomain refers to a specific protein domain, not a DNA sequence.*

-Hox genes are conserved between species because they are critically involved in embryonic pattering and development.

-3' end: expressed more anteriorly

-5' end: expressed more posteriorly

-Position on body correlates to where they are on the chromosome

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Consider the role of Hox genes in anterior-posterior axis specification: what evidence suggests that the common ancestor of all bilaterian animals had a HOX cluster.

-conservation of Hox genes

-role in specifying the anterior-posterior axis in diverse bilaterian animals

How might changing the orientation of a gene in a Hox cluster influence gene expression?

-Hox genes are organized in a specific order along a chromosome

-If you change orientation, going to get mis-expression and disrupt activation pattern, disruption of structures on the organism

-Changing the position of the genes on the chromosome might affect the proximity of the gene to its regulatory elements, which impacts the efficacy of transcription

If a particular HOX gene is mutated to a null phenotype, what might you expect to be the effect on neighboring HOX genes to be?

You may not get proper A/P patterning. Hox genes are present in a specific order along the chromosome. If you mess with that order, the structures will not be positioned correctly. Other genes might change their expression pattern to compensate for loss of other genes.

Xenopus and Zebrafish

What is genome diminution and how does it emerge from cellular asymmetry?

Genome diminution: specific portions of the genome are eliminated or become inactive in certain cell lineages

How it emerges:
-asymmetric cell division

How does it influence cell behavior?

-creating specialized nuclei with distinct roles within a cell
-efficiently manage their genetic material
-adapt to changing environments
-enhances the overall fitness and survival strategies

How can nuclear transplantation (cloning) be used to determine whether genome diminution is occurring in a species?

-compare the genomes of donor cells and cloned offspring, and analyze if there are observed differences in the genome

What factors might limit the ability of a somatic nucleus to support the development of a "normal clone"?

-Hard to reprogram a differentiated cell
-What proteins are present
-Which regions of the chromatin are accessible
-What modifications are on the DNA

Why do some organisms rely on maternal gradients to pattern the early embryo?

-aid in the establishment of axes in the organism, such as anterior-posterior and dorsal-ventral
-temporal control of development

How can you tell (experimentally) that sperm entry leads to a microtubule-dependent reorganization of vegetal components to produce a dorsal-ventral asymmetry?

- Block microtubule polymerization
-Control where sperm entry goes

What does Li+ induced dorsalization tell you about the potential fates of embryonic blastomeres

- Li+ interferes with the activity of the GSK-3, a key component of the Wnt signaling pathway
-Wnt pathway is essential for dorsal-ventral patterning in embryos
-When Li+ is added to developing embryos, it inhibits GSK-3, leading to increased activation of the Wnt pathway.
-results in dorsalization of the embryos

How does the ability to ventralize or dorsalize a (Xenopus or other type of) embryo make it possible to screen for polypeptides that influence embryonic patterning?

-Introduce polypeptide, does it ventralize or dorsalize the embryo?

What does a morpholino do? How does it influence (maternal versus zygotic) gene expression, compared to CRISPR Cas9?

-Morpholinos: modified polynucleotide, inhibits splicing or translation
-Morpholinos can be introduced into the egg or embryo to block the expression of genes
-CRISPR-Cas9: uses a guide RNA molecule to target specific DNA sequences.
- **-Cas9, an endonuclease enzyme, creates double-strand breaks in the DNA at the target site**
- **-Repair of these breaks can result in gene knockout or modification**

-CRISPR is more suitable for long-term genetic changes