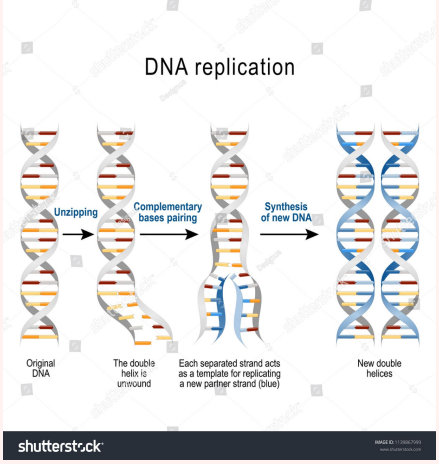
DNA vs. RNA

DNA:	RNA:
double stranded	single stranded
deoxyribose	ribose
A-T	A-U
G-C	G-C

DNA Replication Steps Image



DNA Comparison

Prokaryotic DNA:	Eukaryotic DNA:
double stranded	double stranded
circular	linear
one chromosome	usually more than one chromosome
in cytoplasm	in nucleus

DNA Comparison (cont)

no histones	DNA wrapped around histones (proteins)
supercoiled DNA	forms chromatin

RNA Processing

Eukaryotic modifications to primary transcript (pre mRNA)

~ before it leaves the nucleus

~ bond alterations to the ends

~ removal in intervening sequences

Role of Introns

regulate gene activity

single gene may be able to synthesize more than one protein

Transcription and Translation Image

Translation

RNA -> protein

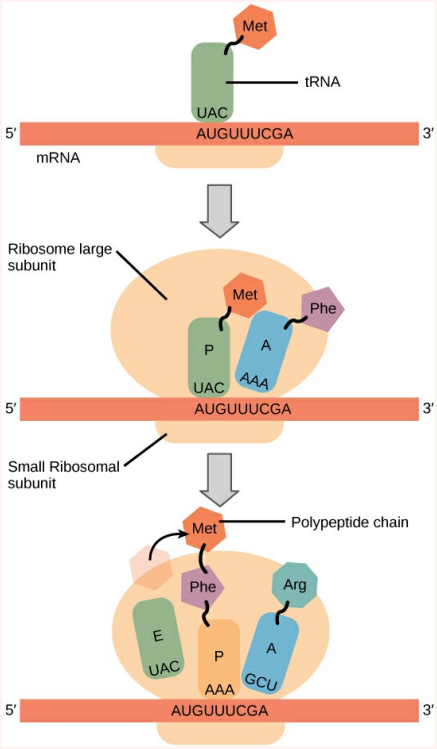
information in RNA is passed to proteins

1) codon recognition

2) peptide bond formation

3) translocation

Translation Image



Regulation of Gene Expression

what makes cells different:

~ cells have different shapes and proteins

~ cells use the DNA in the nucleus differently

~~ some gene are turned on/off

differentation:

~ when a cell changes from one form to another

~ cells become specialized in structure and function

differential gene expression:

Regulation of Gene Expression (cont)

~ the expression of different genes by cells with the same genome

DNA Packing

chromatin: a complex of DNA and protein

histones: proteins associated with DNA packing

DNA methylation

"off switch"

tightly wrapped around histones

genes can not be transcribed

methyl groups are added to the DNA

gene expression is reduced

less transcription

barr bodies: one X chromosome condenses because of DNA methylation

Histone Acetylation

"on switch"

loosely wrapped around histones

genes can be transcribed

acetul groups are added to amino acids of histone proteins

Gene Regulation

DNA is made up of DNA

DNA is used to give instructions for the production of proteins in the process of protein synthesis

Gene Regulation (cont)

gene regulation determines which genes are turned on/off

proteins can increase or decrease transcription

Types of Mutations

point mutations:

~ caused by just one nucleotide base pair substitution of a gene

~ ex:

~~ missense mutation

~~~ still codes, but not properly (sickle cell anemia)

~~ nonsense mutation

~~~ alterations codes for a stop codon

~~ silent mutation

~~~ a change in DNA but not a change in the amino acid sequence

frameshift mutations:

~ caused by insertions and deletions of base pairs

~ alters the three letter reading frame

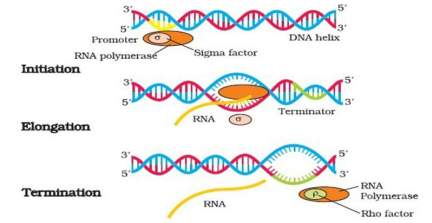
Parts of a Nucleotide

phosphate group

sugar

nitrogenous base

Transcription Image



DNA Replication

in S phase of Mitosis

making DNA from DNA

nucleotides can only be added to the 3' end of a nucleotide

5' to 3' direction

enzymes mediate the process of DNA replication

1) helicase unwinds DNA at origin of replication and creates replication forks

2) topoisomerase prevents overwinding and single-strand binding proteins support the replication bubble

3) primase adds RNA primer

4) DNA polymerase III adds nucleotides in 5' to 3' direction on leading strand

5) lagging strand grows in 3' to 5' direction away from the replication fork by the addition of okazaki fragments

6) DNA ligase seals together okazaki fragments (short segments of DNA that grow 5' to 3' that are added onto the lagging strand)

7) DNA polymerase replaces RNA primers with DNA
~~~

Prokaryotic vs. Eukaryotic Transcription

Prokaryotic:	Eukaryotic:
takes place in cytoplasm	takes place in nucleus
several gene transcribed at one time	single gene transcribed at one time
no modifications before translation	primary transcript modified before translation

Main Types of RNA

mRNA:

~ "messenger"

~ carries genetic code to the ribosome

~ codon

tRNA:

~ "transfer"

~ transfers amino acids to the ribosome

~ anticodon

rRNA:

~ "ribosomal"

~ makes up ribosomes

~ ribosomes build proteins

Ribosomes

made in nucleotide

P site: holds the polypeptide

A site: holds amino acids

E site: exit site

Ribosomes (cont)

some are free and some are fixed

Leading Strand

need RNA primer from DNA primase

RNA primer allows DNA polymerase to add nucleotides at the 3' end

can not add nucleotides at 5' end

Operon

operon: way of regulating genes and is usually made up of a few genes that involve enzymes

RNA polymerase: builder enzyme, needed in order to start transcription, needs a promoter to bind to DNA

operator: a part of the DNA where a repressor can bind, if repressor is bound to operator it blocks RNA polymerase which means mRNA can not be made so neither can proteins

lac operon: operator and promoter region of DNA and three genes that code for enzymes that help in breaking down lactose

~ there is a gene that codes for the repressor production and this gene has its own promoter

~ if lactose is not present, then the repressor binds to the operator and blocks RNA polymerase which means mRNA and proteins can not be produced

Operon (cont)

~ if lactose is present, the lactose (sugar) binds to the repressor (repressor can not bind to operator) and RNA polymerase finds its promoter, binds, and transcribes to make mRNA from the genes on operon, the mRNA will be used to make enzymes to break down the lactose sugar

~ no lactose: "off"

trp operon:

~ evolved in bacteria to deal with absence of tryptophan

~ tryptophan is on amino acid which moves proteins

~ designed to make tryptophan if it is not present

~ if bacteria does not have tryptophan, there is a number of genes that are required to make it

~ tryptophan fits inside the repressor and the repressor will change it's shape to fit in the receptor

~ if a lot of tryptophan is present, then we do not want to make more so the repressor is going to set operator in "off"

Chromosomal Mutations

involves a change in the structure or number of chromosomes

deletion: loss of all or part of a chromosome

duplication: reverses the direction of parts of a chromosome

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Chromosomal Mutations (cont)

inversion: reverses the direction of parts of a chromosome

translocation: part of one chromosome break off and attaches to another chromosome

Differentiation

when a cell changes from one type to another

all specialized cells come from stem cells (unspecialized)

DNA contains genes and genes contain proteins that change the way cells look and act

every somatic cell in your body contain the same DNA

using genes -> expressing -> turned "on"

the specialized cells can not specialize again and can not go backwards to the stem cells

cells decide what they will be based on internal or external environmental cues

internal: transcription factors will activate certain genes and turn them on (factors are bunched up because of when the zygote will divide)

external: (induction) (like peer pressure) a group of cells can induce another group to differentiate by using signals (like diffusion, direct contace, gap junctions)

goal: to change gene expression (turn on/off genes

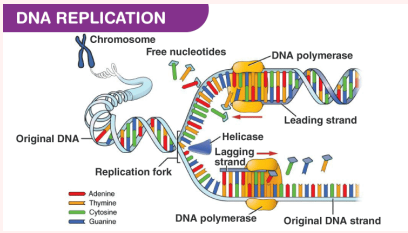
Structure of DNA

double helix

~ "backbone": sugar + phosphate

~ "rungs": nitrogenous bases

DNA Replication Image



DNA Replication Key Factors

Eukaryotic: replication before mitosis or meiosis (interphase)

helicase: unzipping enzyme

~ breaks the hydrogen bonds holding bases together

DNA polymerase: builder

~ replicates DNA molecules to build new strand of DNA

primase: initializer

~ makes the primer so that DNA polymerase can figure out where to go to start to work

ligase: gluer (binder)

~ helps glue/bind DNA fragments together

DNA Replication Process (2nd example)

starts at the origin (identified by DNA sequence)

1) helicase unwinds DNA

~ single stranded binding protein bind to DNA strands to prevent the strands from going back together

~ topoisomerase keeps DNA from superc-oiling

2) primase makes RNA primers on both strands

3) DNA polymerase builds new strand in 5' to 3' direction

~ this means it moves along old template strand in 3' to 5' direction

~ adds new bases to 3' end on new strand

4) ligase takes care of gaps between Okazaki fragments

at the end of replication there is two identical DNA molecules

~ semi-conservative: each copy contain a new and original strand

Transcription

DNA -> RNA

1) Initiation

~ promoter sites: region of the DNA where the RNA polymerase binds

~~ 100 nucleotides long

~~ transcription factors: binding protein

~~ TATA box: promoter sequence

2) Elongation

Transcription (cont)

~ RNA polymerase in action

~~ separates and untwists helix

~~ links nucleotides in a 5' to 3' direction

3) Termination

~ termination sequence: AAUAAA

Transcript Modifications

5' cap: GTP is added

two functions:

1) protects transcript from hydrolytic enzymes

2) tags the end as "leader segment" for the ribosome

s' end: last to be translated

poly(A)tail: 30 to 200 nucleotides added to end

~ inhibits degradation

~ facilitates ribosomal attachment

~ attached to stop codon

RNA splicing

~ removal of introns (noncoding sequences) (intervening sequences)

~ pasting of exons (coded sequences) (exit the nucleus)

small nuclear ribonucleoproteins found in nucleus (snRNP; snurps): complexes of small RNA units and proteins found in nucleus

spliceosome: complex of snurps involved in the locating and cutting out of introns

Codons

codons:

~ mRNA triplet that codes for an amino acid

~ start codon: AUG

~ stop codon: UAA, UAG, UGA

reading frame:

~ start to stop sequence of nitrogen bases

anticodons:

~ complement of the codon found on tRNA

Prokaryotic vs. Eukaryotic Translation

Prokaryotic:	Eukaryotic:
takes place in cytoplasm	takes place in cytoplasm
ribosomes begin transl-ating while mRNA is still transcribing	transcription and translation separate

Redundancy and Ambiguity of the Code

redundancy: more than one codon for an amino acid

ambiguity: codon do not code for more than one amino acid

Evolution of the Codes

early evolution since shared among living species

genes can be transferred within species and among others as well

Lagging Strand

primer is several nucleotides

DNA primase goes along the lagging strand and adds RNA primer

once you have primer, polymerase can add on DNA at 3' end (5' to 3')

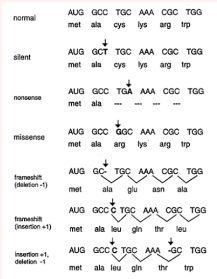
end up with Okazaki fragments

slower process

DNA ligase puts all fragments together as one strand

~ RNA is replaced with DNA

Mutations Image



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