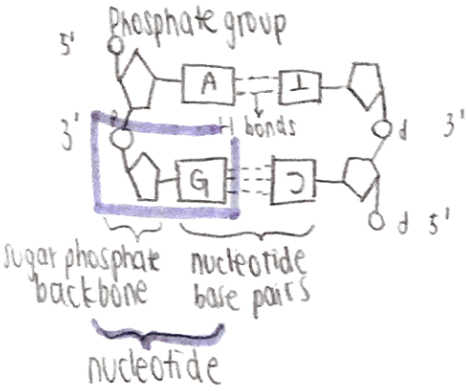
Molecular Genetics

DNA CAT ACT

Basics : Structure



Nitrogenous bases
↓
Purine : Adenine, Guanine
Pyrimidine: Thymine, Cytosine
go through complementary base pairing

segment of DNA containing genetic info to make a protein ← Gene $\xrightarrow{xn}$ DNA $\xrightarrow[\text{histones}]{+}$ Chromatin → Chromosome

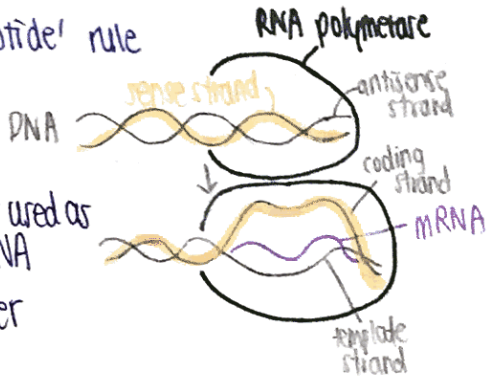
Tri-nucleotide sequences (codon) → A·A. for both DNA & mRNA
(3) (1) (1)

Protein synthesis

- 'One gene one polypeptide' rule

TRANSCRIPTION

- DNA section unwinds
- One DNA strand (out of 2) is used as template to transcribe mRNA
- mRNA small enough to enter cytoplasm



messenger RNA
Transfer RNA
Ribosomal RNA
Ribonucleic acid

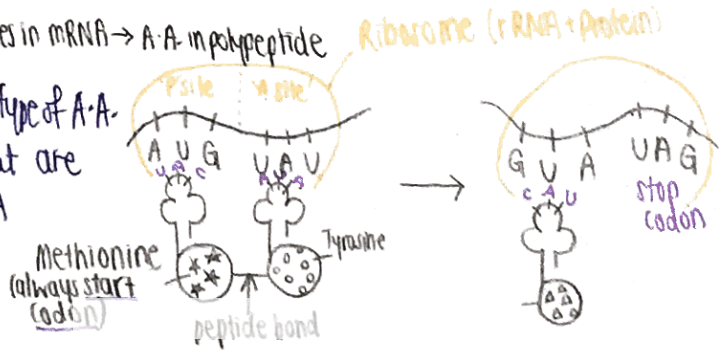
DNA helicase unwinds DNA by breaking H-bonds btwn bases) vs (RNA polymerase reads template strand & transcribes on pre-mRNA molecule) (RNA)

FUN FACT
Cells contain genes to be transcribed & translated.
Some genes are switched off & not expressed.
eg. Insulin genes in pancreas, liver, epidermal cells, but only switched on in pancreas

TRANSLATION

conversion of nucleotides in mRNA → A·A. in polypeptide

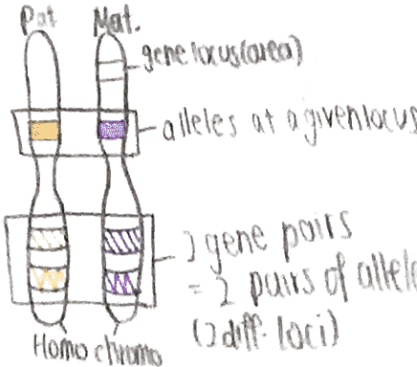
- Each type of tRNA is specific → One type of A·A.
- tRNA has 3 nucleotides (anti-codon) that are complementary to codon on mRNA



① mRNA codons complementary to tRNA anti-codons
② Peptide bonds btwn 2 A·A.
③ Ribosome moves down 3 bases/nucleotides to form more A·A. & peptide bonds
④ Upon reaching stop codon: UAA, UAG, UGA, ribosome detaches from mRNA to go to other mRNA or G.A. to be repackaged etc.

Cell division

- Homologous chromosome → A pair of chromo. of same length & sequence of genes (homo chromo) → Paternal & maternal
- 1st 22 pairs chromo → Autosomal, last → sex chromo arranged by decreasing length ↓
- Alleles are alternative forms of a gene (of same relative posi^n) on a pair of homo chromo

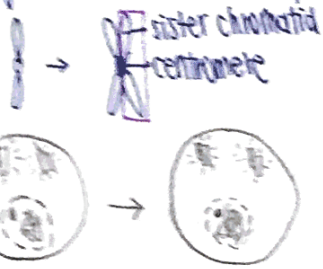


Mitosis

2 daughter nuclei each contains same no. of chromo as parent nucleus

Interphase

- Chromatins present, distinguished
- DNA replicate
- Centrioles in animals, centrosomes (MTOC—microtubule organization center) in plants

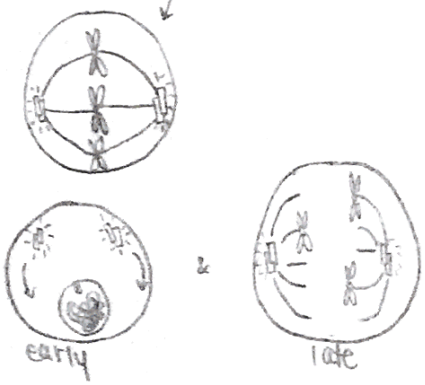


Prophase (break down & form)

- Duplicated chromatin condense & coil → chromo.
- Early prophase ⇒ distinct nuclear envelope
  - Asters form and centrioles (microtubules) move to opp. poles of cell
  - Nucleolus disappears
- Late prophase ⇒ Nuclear envelope disintegrates
  - Spindle fibers form & extend

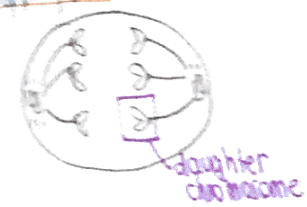
Metaphase (line up)

- Chromo. line up along equator
  - Held in place by spindle fibers at centromere



Anaphase (separate)

- Centromeres separate as spindle fibers shorten & pull sister chromo. to opp. poles

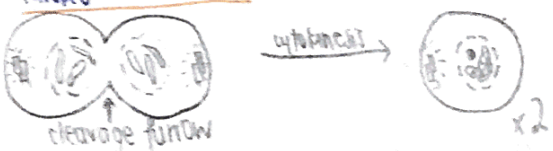


Telophase (opp. of Prop)

- Daughter chromo reach poles
- Spindle fibers break down & nuclear envelope forms and chromo. at ea. pole
- Nucleolus forms & chromo. → chromatin

Cytokinesis

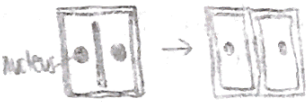
- Division of cytoplasm
- Cleavage furrow appears in cytoplasm btwn 2 nuclei
  - deepens & forms 2 daughter cells



VS

plants

- Vesicles from Golgi A. line up at equator of spindle
  - fuse to form cell plate
- cell plate elongates & fuse w/ cell wall
  - partitions cell into 2



Meiosis I

4 daughter nuclei each contains half the no. of chromo as parent nucleus

Interphase

same as mito! ☺ duplicate--

Prophase I

- Crossing over

- Synapsis
- Centrioles move to opp. poles
- Spindle fibers form
- Nucleolus & nuclear envelope disintegrate

Metaphase I

- Pairs of homo chromo line up along equator
- centromere attached to spindle fiber

RANDOM ARRANGE!

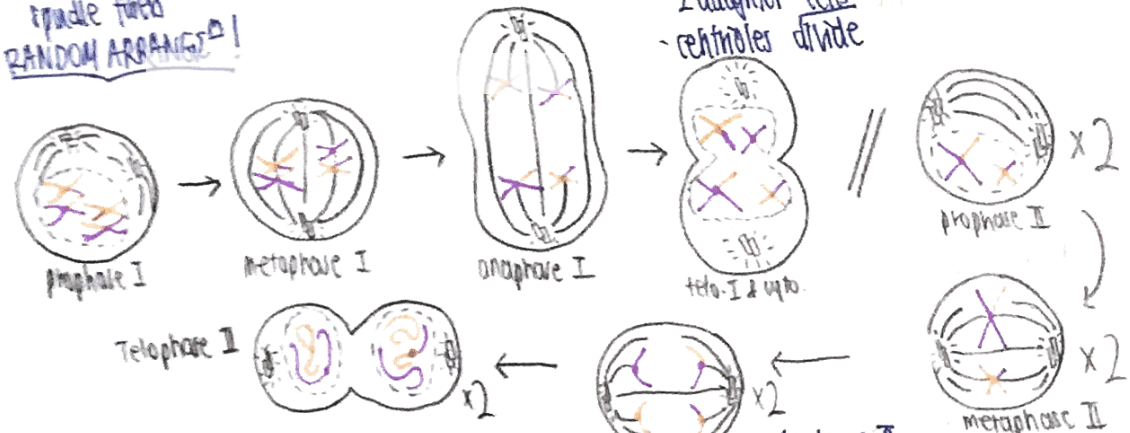
Anaphase I

- Homo chromo pair separate, pulled to opp. poles

no splitting of centromeres!

Telophase I

- Spindle fibers disintegrate
- Nuclear envelope forms and chromo ↓ cytokinesis
- 2 daughter cells
- centrioles divide



Prophase II

no DNA replication

Metaphase II

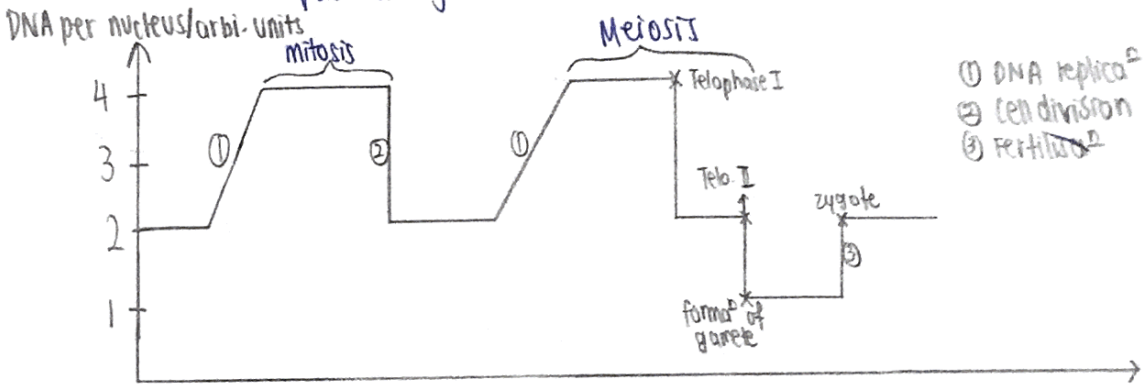
Anaphase II

→ daughter chromo of daughter cells

Telophase II

4 daughter cells formed (n)

	Mitosis	Meiosis
Importance	-Growth of organism -Repair of worn out parts of body -Healing wounds -Asexual reproduction	- Produce haploid gametes ↳ maintains diploid no. in species - Genetic varia^{n} ↳ chiasmata forma^{n} during Prop. I (new combi- of alleles) ↳ Indp. assort^{m} & segrega^{n} of homo. chromo during Meta. I (4 diff. gametes prd. & 4 possible combi.) - Random fusion of gametes (↑ chances of survival, favourable characteristics, changing env.)
Pairing up of homo chromo	✗	✓
Crossing over & chiasmata	✗	✓
Arr. of chromo.	Single row	2 rows (meta-I)
Separa^{n} of chromo	Chromatids move to opp. poles during Ana	Chromo. move during Ana I Chromatids Ana II



INHERITANCE

Genetic Cross diagram

Parents' phenotype	Tall	Tall
genotype	Tt	Tt
gametes	T, t	T, t
Offsprings' genotype	TT, Tt, Tt, tt	
phenotype	← Tall →	Short
ratio	3 : 1	

Punnett's sqr

	T	t
T	TT	Tt
t	Tt	tt

Examples of terms

Homozygous	AA/aa
Heterozygous	Aa (A: dominant, a: recessive)
Chance	75% or 3/4
Probability	3/4

* Expected ratios from genetic crosses will not occur as exp. in small sample sizes.
Ratio based on chance & probability. Only $z > 100$, then ratio appears

* Co-dominance: Both alleles fully expressed (eg. Purple & white flower)
Incomplete dominance: Blend of alleles (eg. light purple flower)

Blood Types

A	I^AI^A, I^Ai	A&B > O
B	I^BI^B, I^Bi	
AB	I^AI^B	
O	ii	

*A&B are muta^{n} of O!

Mutation (spontaneous change in gene structure, chromo or chromo no.)

- May be inheritable, lethal or beneficial
- Somatic muta^{n} (body cells) may be inheritable/cancer
  muta^{n} during gamete prd^{n} inherited by offsprings
- Produces genetic varia^{n}

CASE STUDY: Sickle cellanemia

- HbS instead of HbA (autosomal recessive)
- HbS mol clump gt. → sickle shape, reduce O_2-transporting efficiency, RBC more fragile & block blood vessels. Survives only 10-20 days, ↓ blood count,
  → Anaemia
- GENETIC MUTA^{n}

#2 Case study: Down's syndrome
- Change in chromo. no., extra copy of chromo. 21
- Older mom, ↑ risk
- Happens during gamete prd^n
→ nondisjunction (Ana I / II)
chromo. / chromatids

Factors causing mutation
- mutagens are UV light, radn & chem.

Autosomal recessive (non-sex chromo must both ap...
... dominant (only 1)