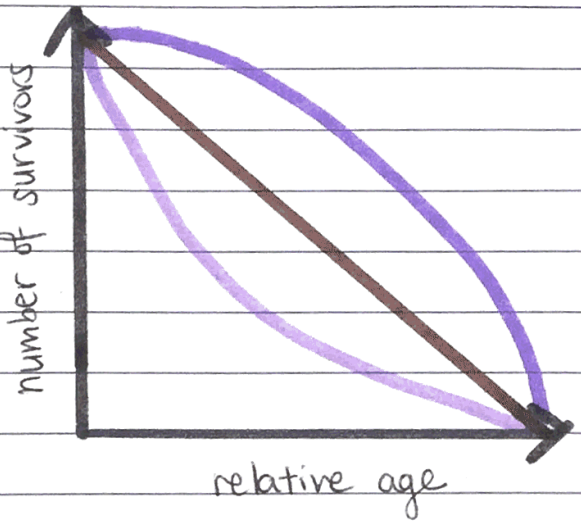
CONTENTS

SCHOOL _____ CLASS _____ DATE _____

NAME/INDEX NO. _____ SUBJECT _____

SURVIVORSHIP



TYPES

1: late loss. mortality = ↓ infant & juvenile, ↑ elders

2: constant loss. mortality rate constant thruout life.

3: early loss. mortality = ↑ infant & juvenile, ↓ elders (lack)

1 2

CLIMATE: variable, unpredictable

MORTALITY: density independent

SURVIVORSHIP: see above diagram

POP^N SIZE: fluctuates wildly

COMPETITION: variable, lax, generalist

LIFE LENGTH: short

SELECTION FAVOURS: rapid dup^± , early reproduction, small body size, ↑ offspring

LEADS TO: productivity

3

CLIMATE: fairly constant/predictable

MORTALITY: density dependent

SURVIVORSHIP: see above diagram

POP^N SIZE: constant, equil. w/ enviro.

COMPETITION: keen, specialist

LIFE LENGTH: long (generally)

SELECTION FAVOURS: slower dup^± , later reproduction, large body size, ↓ offspring

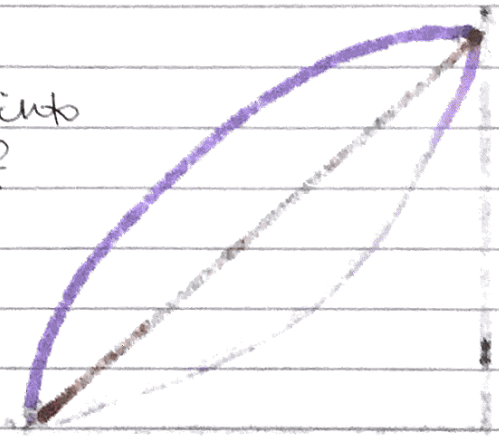
LEADS TO: efficiency

REPRODUCTION

BINARY FISSION

↳ separation of a parent into 2 or more individuals of about equal size

eg. sea anemones



BUDDING

↳ 1 or more individuals formed out of an original

↳ offspring grows out of body of parents

eg. hydra

FRAGMENTATION

↳ parents break into different distinct pieces

↳ each piece forms new individuals by body part regen-

eg. planarians

PARTHOGENESIS

↳ growth/dvpmt of embryos occurs without fertilisation

eg. new mexico whiptail

HERMAPHRODISM

↳ existence of reproductive organs in both sexes in same individuals at same/different times

eg. salamanders

SEXUAL REPRODUCTION

definition: requires 2 parents who donate genes to the young
results in genetically unique offspring

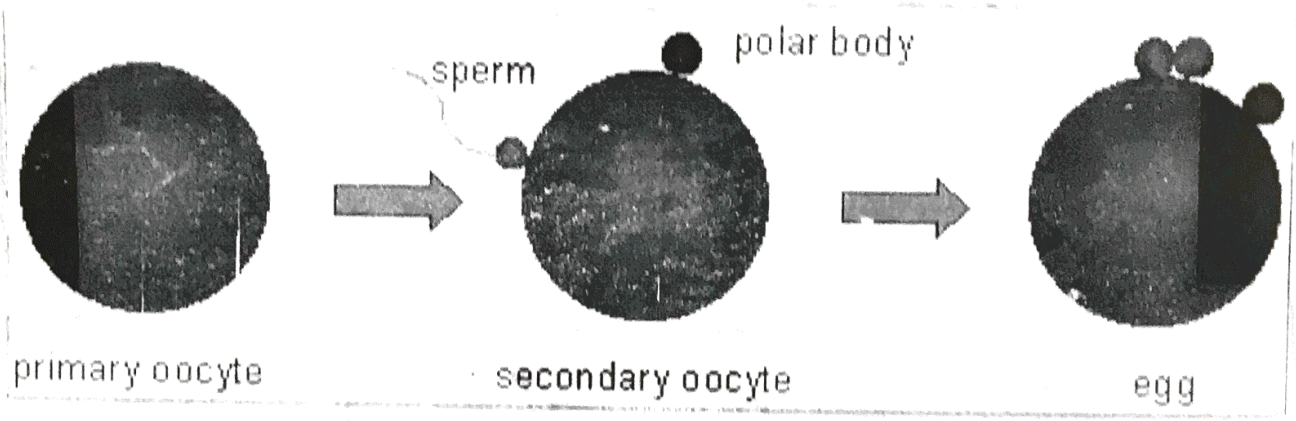
features: fusion of gametes
↑ common in higher organisms
↑ genetic variability among offspring
↳ variations = ↑ ability to adapt to changing conditions
↑ energy expenditure in producing egg/sperm + mating

ASEXUAL REPRODUCTION

definition: creation of genetically identical offspring
by lone parent w/o fertilisation or gametes

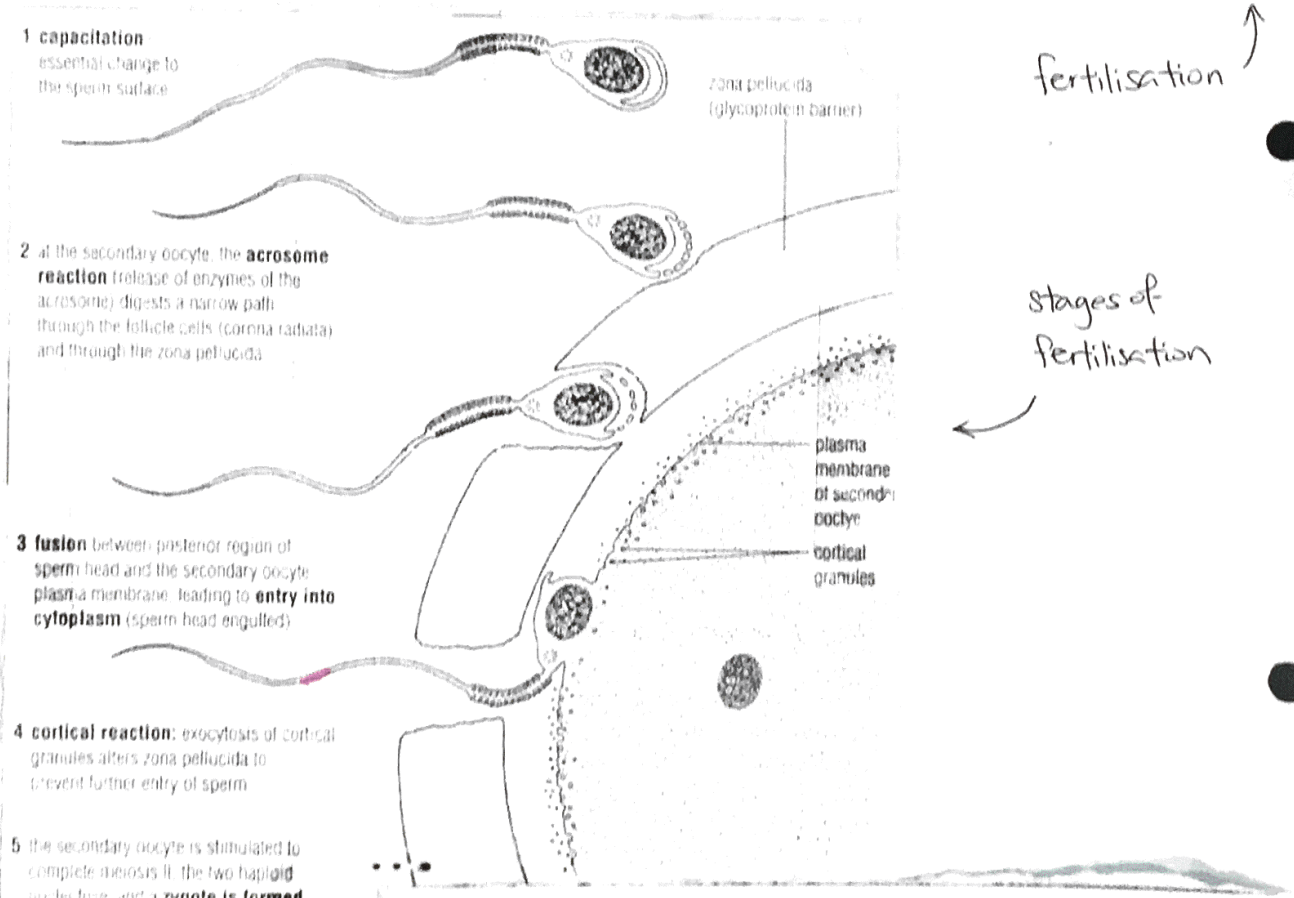
features: offspring produced by mitosis
organisms living in isolation can reproduce w/o mating
rapid reproduction, ↓ energy expenditure
↑ survival rate in stable enviro.
↳ effective way to reproduce if well-suited to enviro,
↑ expand population, exploit available resources
↳ if enviro. becomes unfavourable,
all individuals affected, ↑ risk of extinction

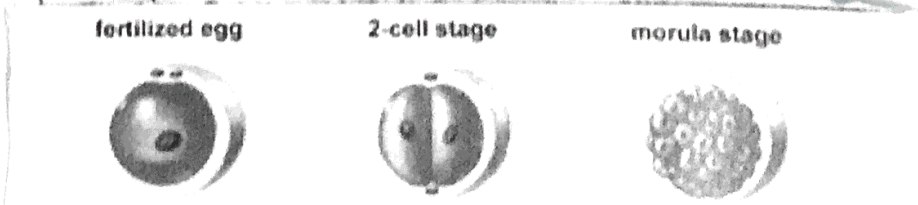
SEXUAL REPRODUCTION: HUMANS



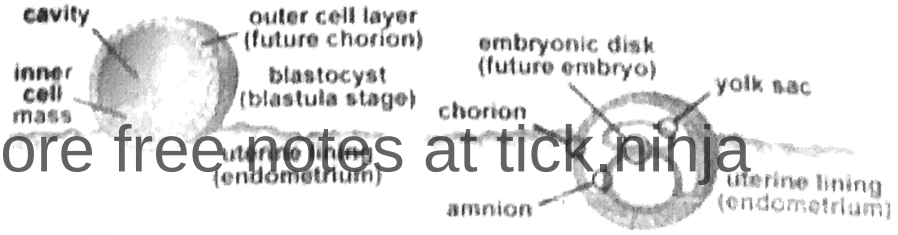
fertilisation

stages of fertilisation

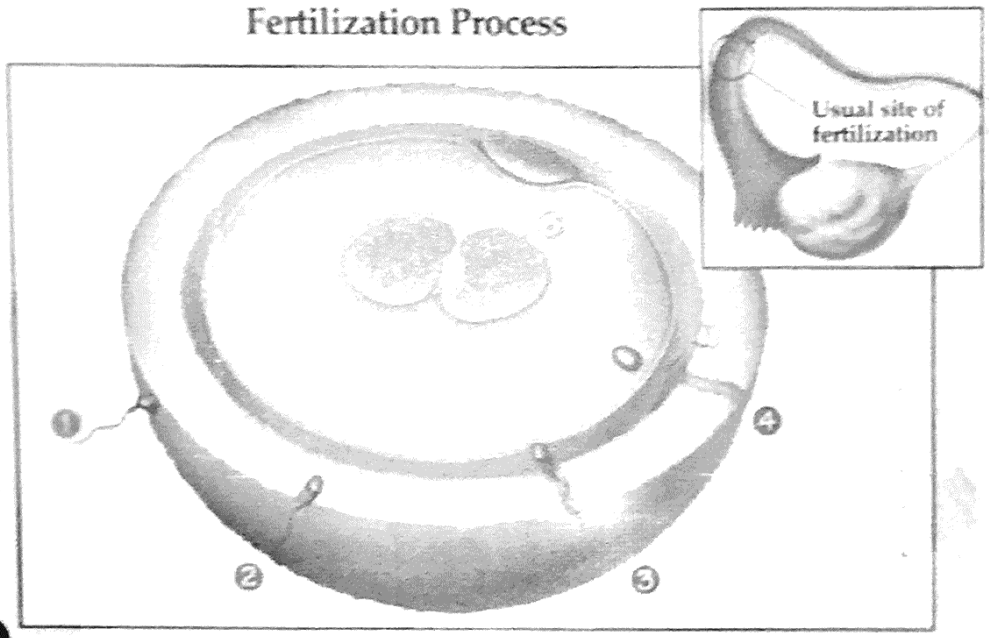




egg dvpmt



If fertilisation occurs ...

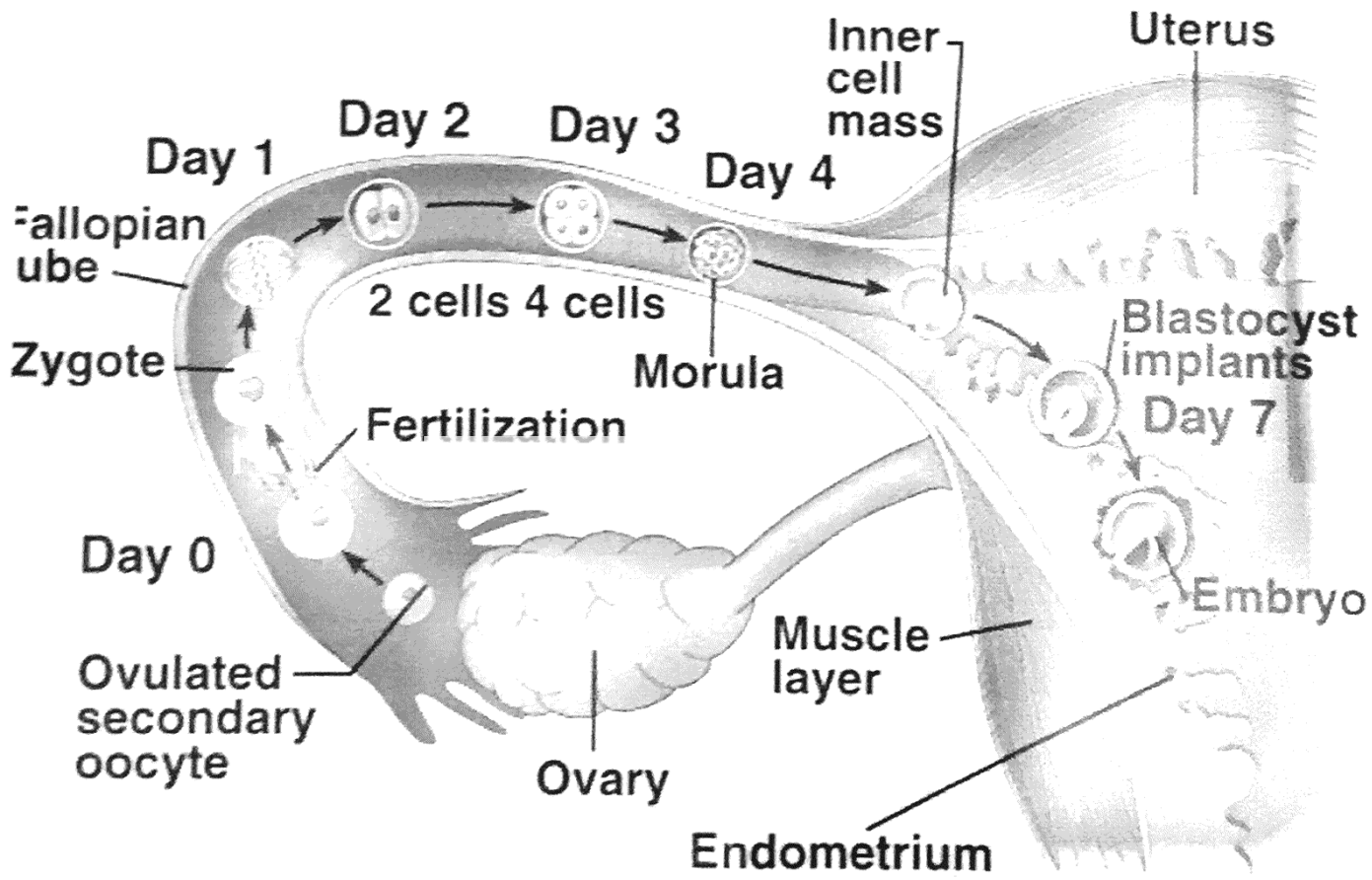


move infore re: fertilisation process

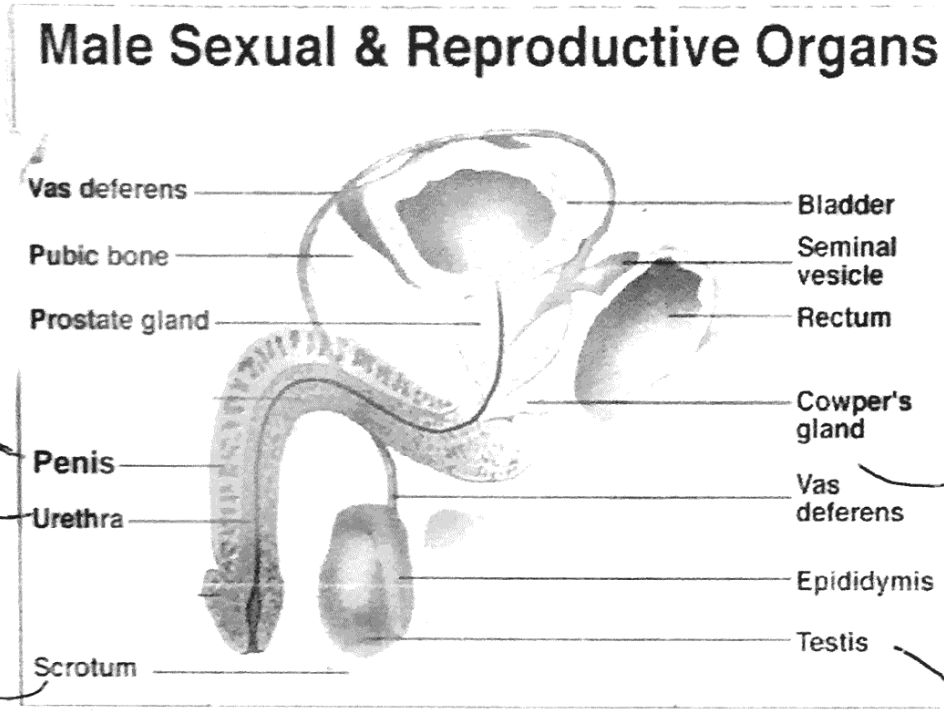
After the sperm enters the uterus, they swim into the fallopian tube. When they encounter an egg that has been released from the ovary, one sperm may enter the egg. The union of a sperm and egg forms a zygote.

1. Sperm binds to egg
2. Sperm begins to penetrate egg
3. Sperm penetration continues
4. Sperm enters egg
5. Chromosomes from sperm and egg unite to form pronuclei

From ovulation to implantation



REPRO. SYSTEM : MALE



erectile organ for ejaculation of semen

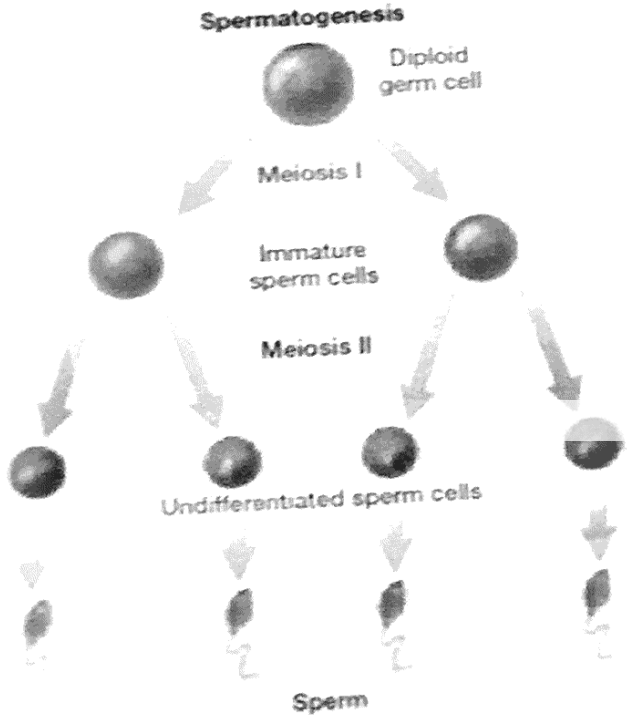
channel allowing urine/semen to pass through

extend outside body - optimum temperature for spermdvpmt

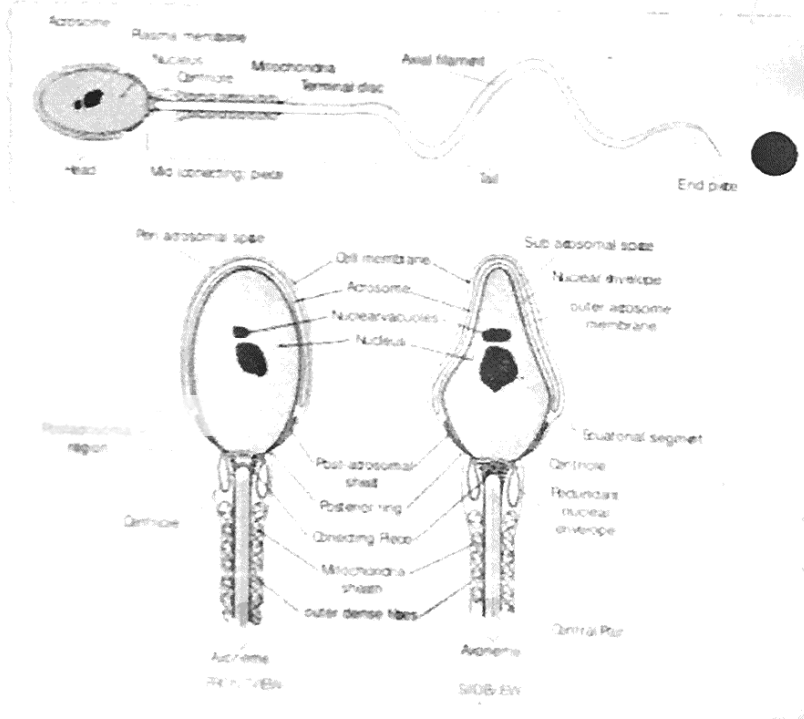
produces alkaline secretion to neutralise acidity of urine & aids mobility

produce sperm

functions: produce/maintain/transport sperm & semen
discharge sperm within female system
produce/secrete male sex hormones



process of sperm creation



sperm structure

REPRO. SYSTEM: FEMALE

conduct egg to uterus

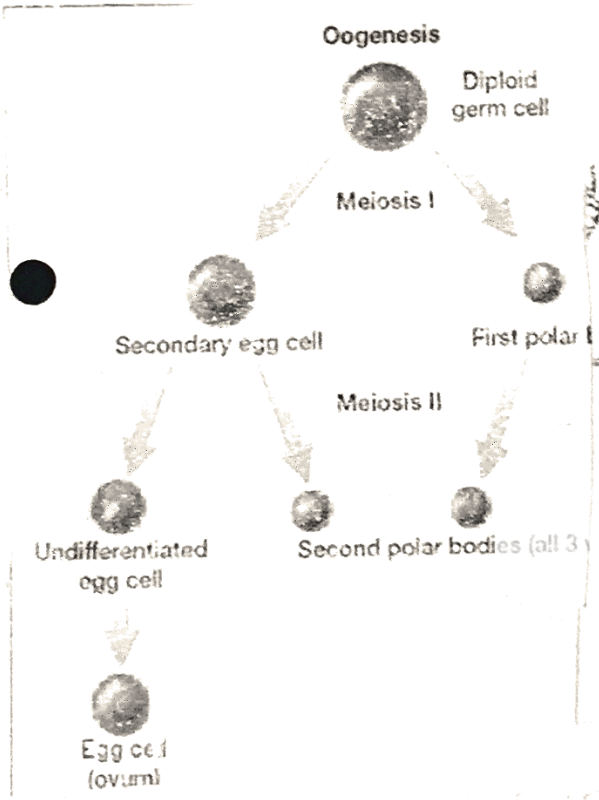
site of fetal dvpmt

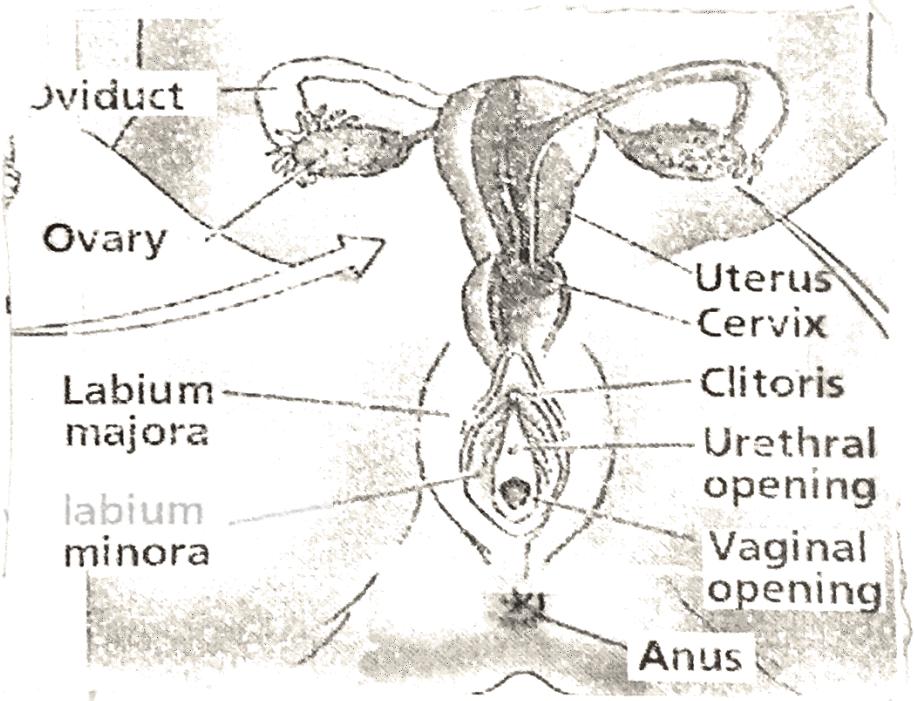
produce eggs, estrogen, progesterone

closes off lower end of vagina, prevents entry of foreign materials

birth cand receptacle of semen

functions:- produces female egg cells for reproduction
designed to transport ova to fertilisation site
uterus = safe envino. for fetus to dvp.
produces female sex hormones





process of egg creation

system structure

SPERM V. OVUM

sperm	ovum
smaller elongated/narrow + distinct structure motile	larger spherical moves by external agents
X/Y chromosome cytoplasm x yolk	X chromsome cytoplasm = yolk granules

spermatogenesis	oogenesis
number of gametes	
principle: continuous production. sperm continuously engendered but quantity/quality subject to extreme fluctuations	principle: use up pre-birth generated oocytes. continual decrease beginning w/ fetal period, ending w/ menopause
meiotic output	
4 functioning, small, motile spermatozoids	1 large immobile oocyte, 3 shriveled polar bodies
fetal period	
no meiotic divisions or germ cell productions	entering into meiosis prod. of entire supply of germ cells

MENSTRUAL CYCLE

function: provides a favourable enviro. for dvpmt of fetus

process: synchronised recurring sequence of changes in endometrium of non-pregnant female (uterine cycle) linked to sequence of changes in ovaries (ovarian cycle)

GMRH → **FSH/LH** → **FOLLICULAR PERIOD**

gonadotropin-releasing hormone from hypothalamus

follicle-stimulating/luteinising hormone from anterior pituary

1st oocyte enlarges (2 weeks)

↓

↑ FSH/LH

follicle produces estrogen, promotes follicle & oocyte growth + endometrium growth

←

↑ LH

meiosis 1 in oocyte ovulation & formation of corpus luteum

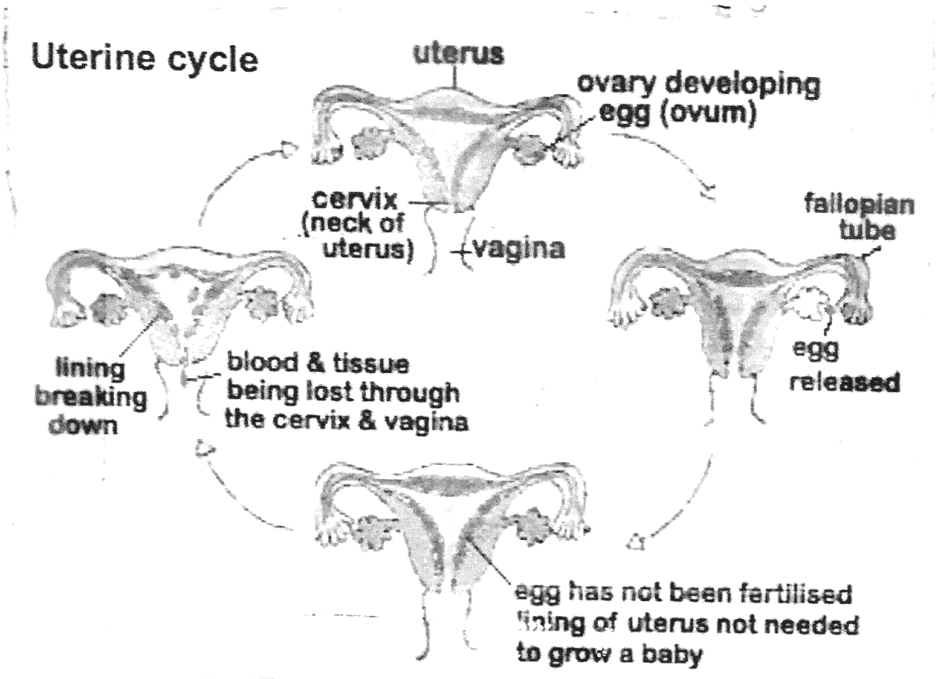
←

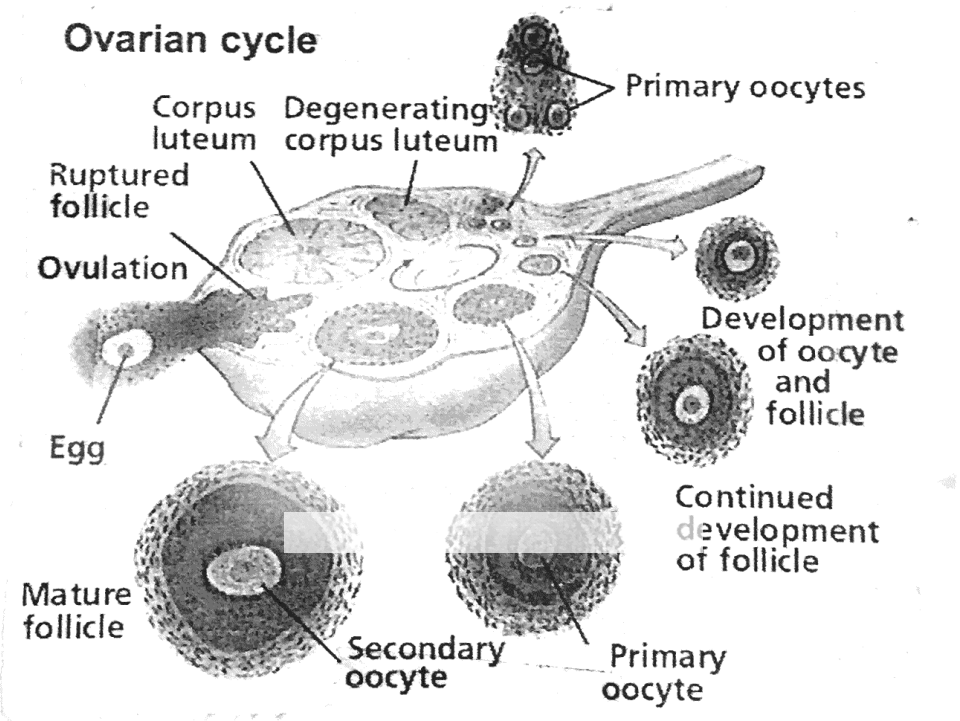
↓ FSH/LH

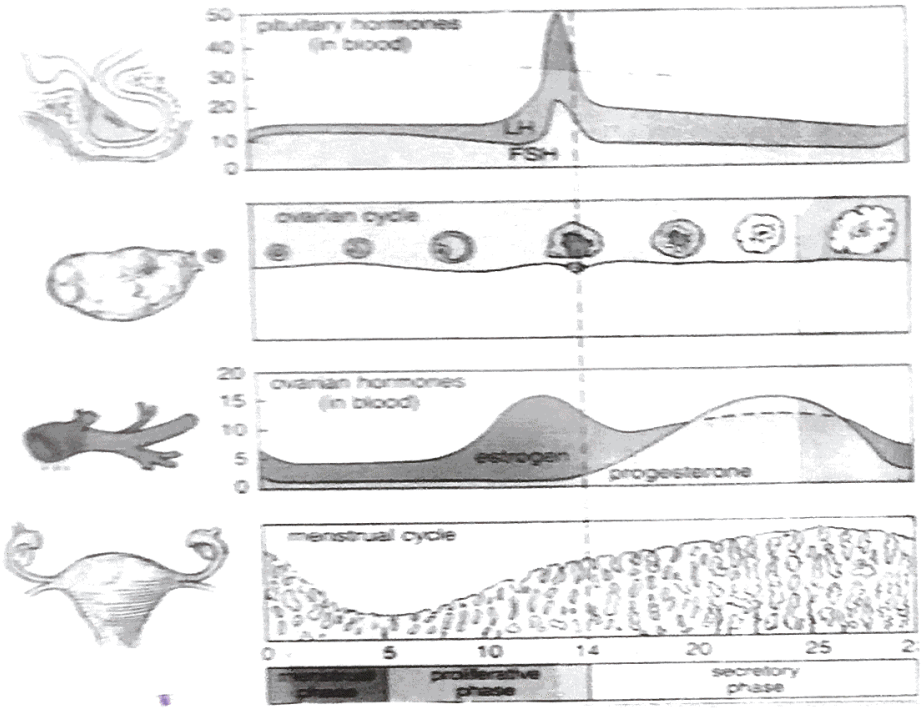
corpus luteum secretes estrogen & progesterone maintain endometrium (1 week post-ovulation) + shut down FSH/LH prod.

↳ **X PREGNANCY**

corpus luteum degenerates, ↓estrogen & progesterone levels, ↑ FSH/LH levels, endometrium lining sheds (28th day)

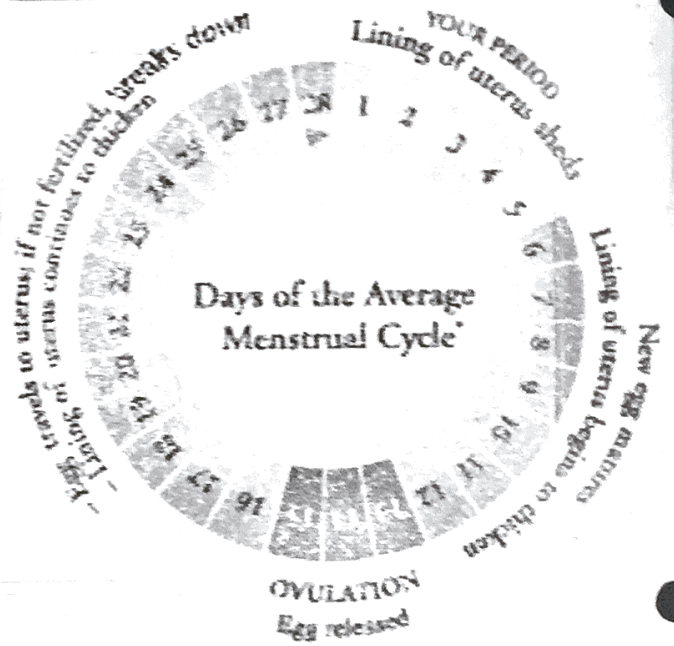


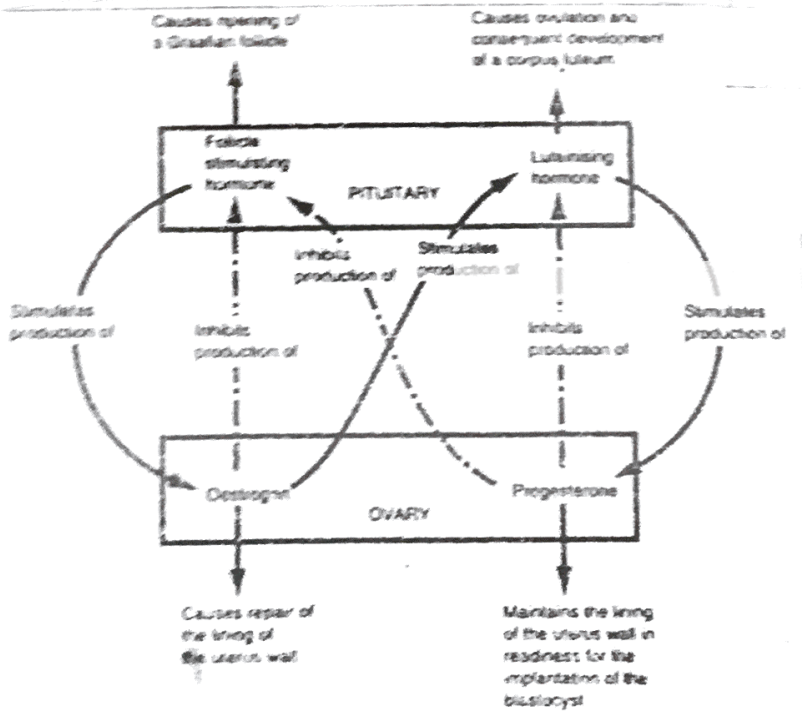




production & secretion periods

menstrual cycle days →





production cycle

FERTILISATION

FERTILISATION → egg & sperm fuse

↓

CLEAVAGE → zygote subdivides into ball of many cells

↓

GASTRULATION → cells rearrange, produce embryo w/ 3 cell layers

↓

NEURULATION → neural tube forms

↓

ORGANOGENESIS → body organs form

GASTRULATION

process: formation of 3 body layers

OUTER: ECTODERM

skin, hair, sweat glands, epithelium, brain, nervous system

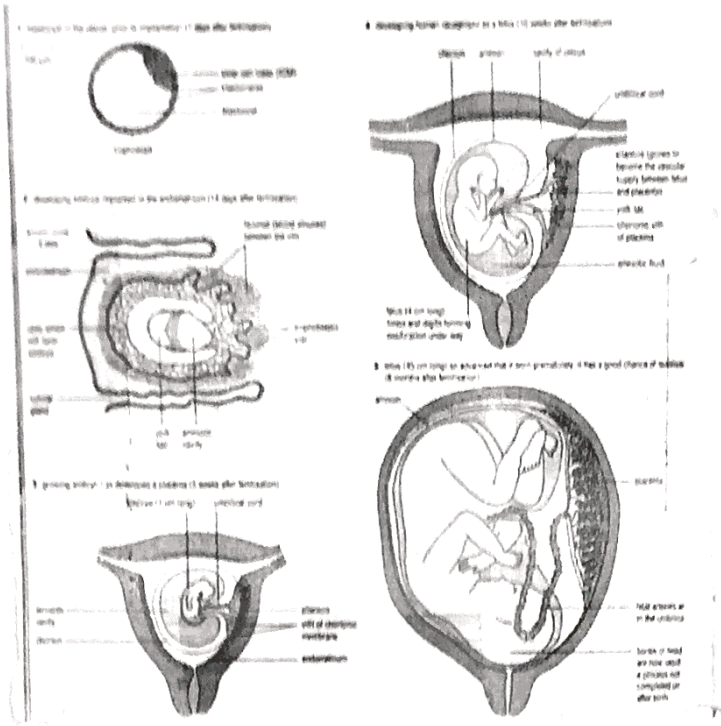
MIDDLE: MESODERM

muscles, cartilage, bone, blood, connective tissue, kidneys, reproductive system

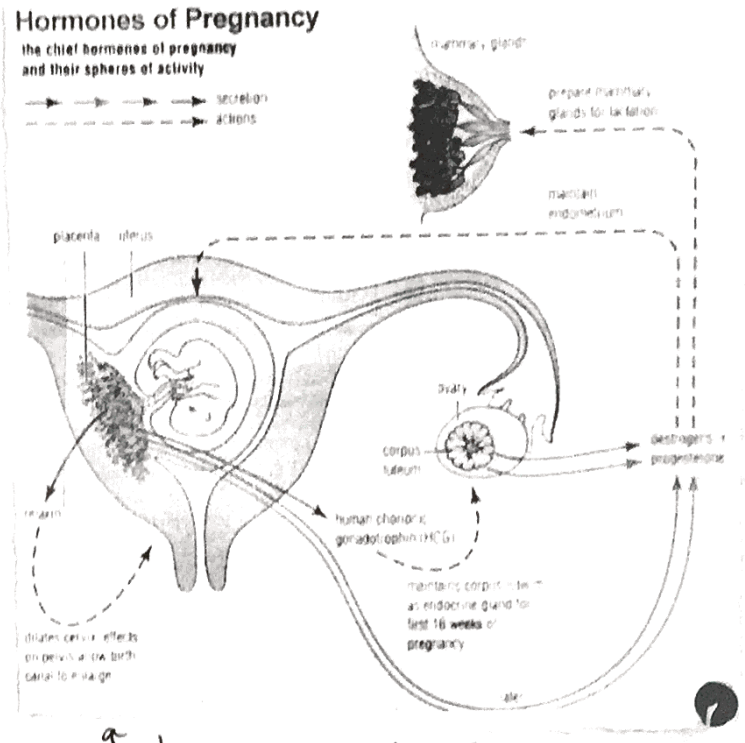
INNER: ENDODERM

digestive system, respiratory system, endocrine structures, liver, pancreas, gall bladder

PREGNANCY

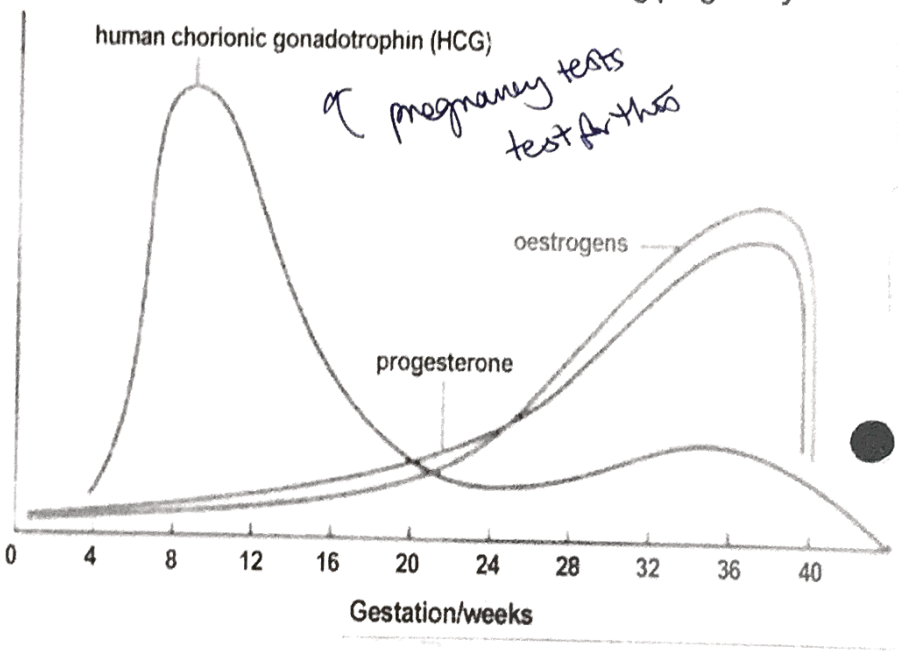


process & structures



↑ hormone production

blood levels of these hormones during pregnancy



1ST TRIMESTER

- 3 embryonic layers formed
- cellular differentiation forms organs (week 3)
- embryo 5mm long, mostly paired somites (month 1)
- embryo → fetus (week 6)
- sex determination process begins (week 7)

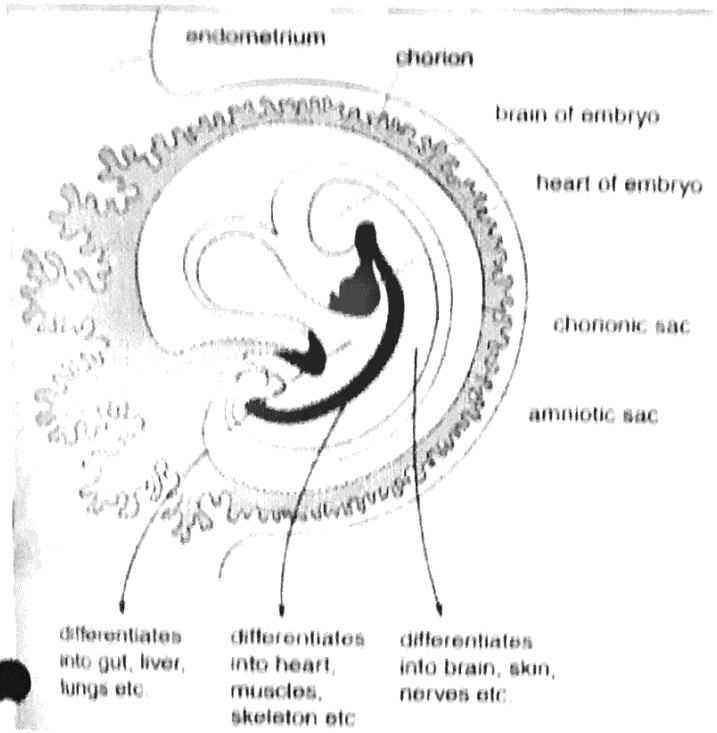
2ND TRIMESTER

- fetus size ↑
- bony parts of skeleton start to form

3RD TRIMESTER

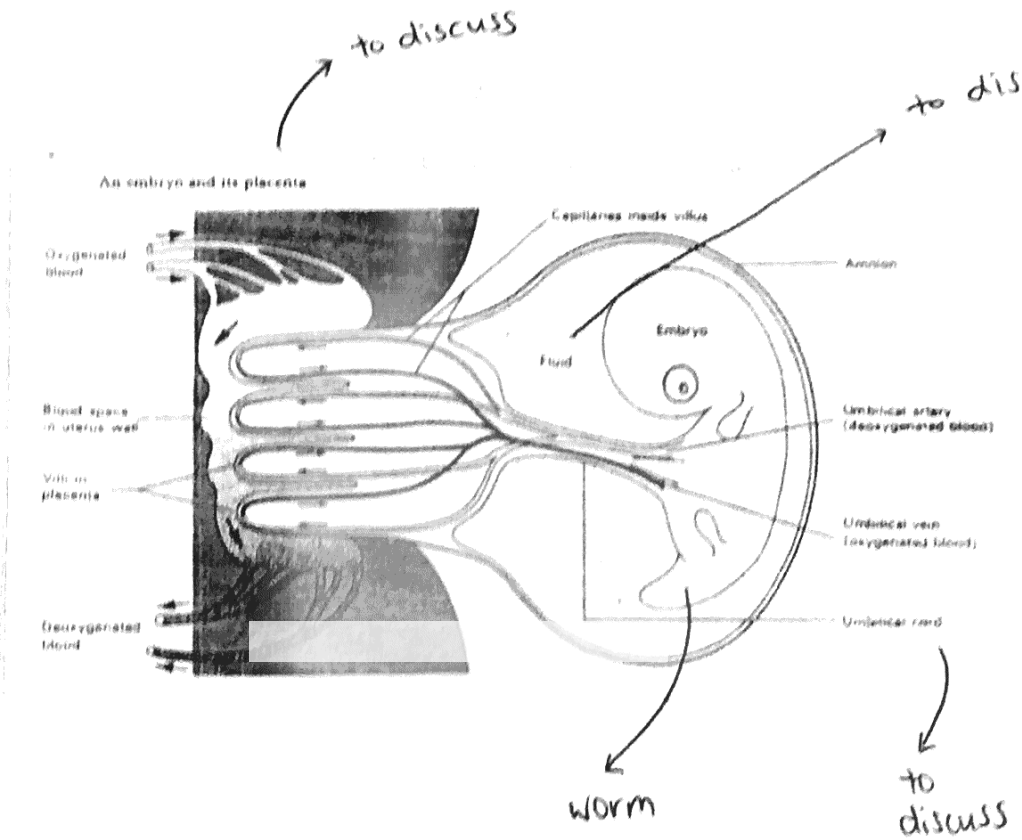
- circulatory & respiratory systems mature

DIFFERENTIATION



process where unspecialised cells become altered & adapted to perform specific functions as part of permanent tissues

WORM PARTS



AMNIOTIC FLUID

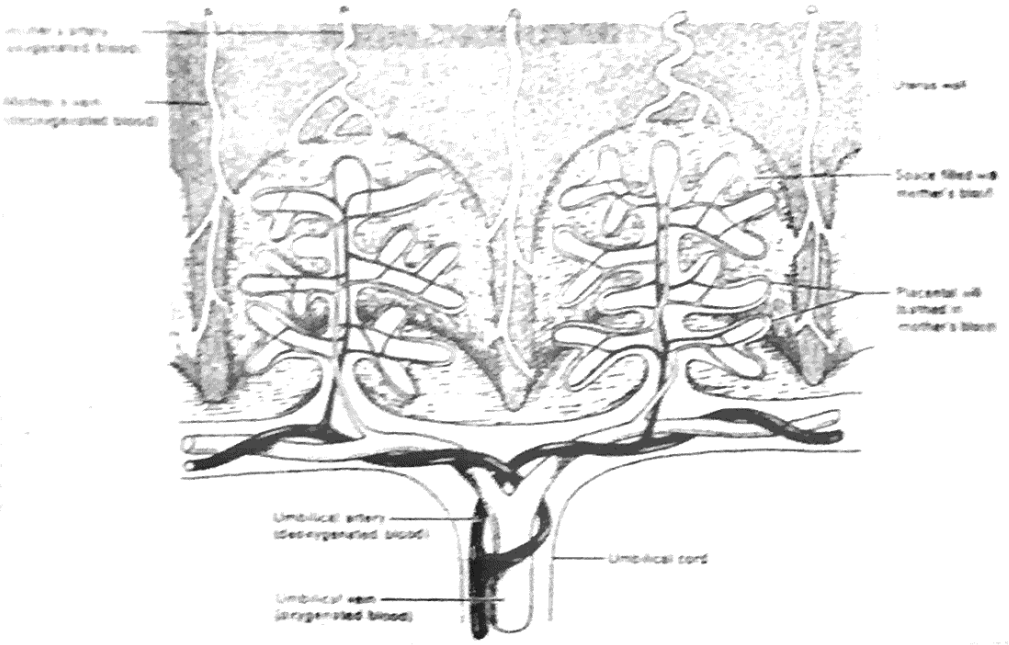
- supports & cushions fetus pre-birth
- shock absorber
- incompressible ∴ protects fetus against mech. injury
- higher temp. than mother's body ∴ keeps fetus warm/cozy

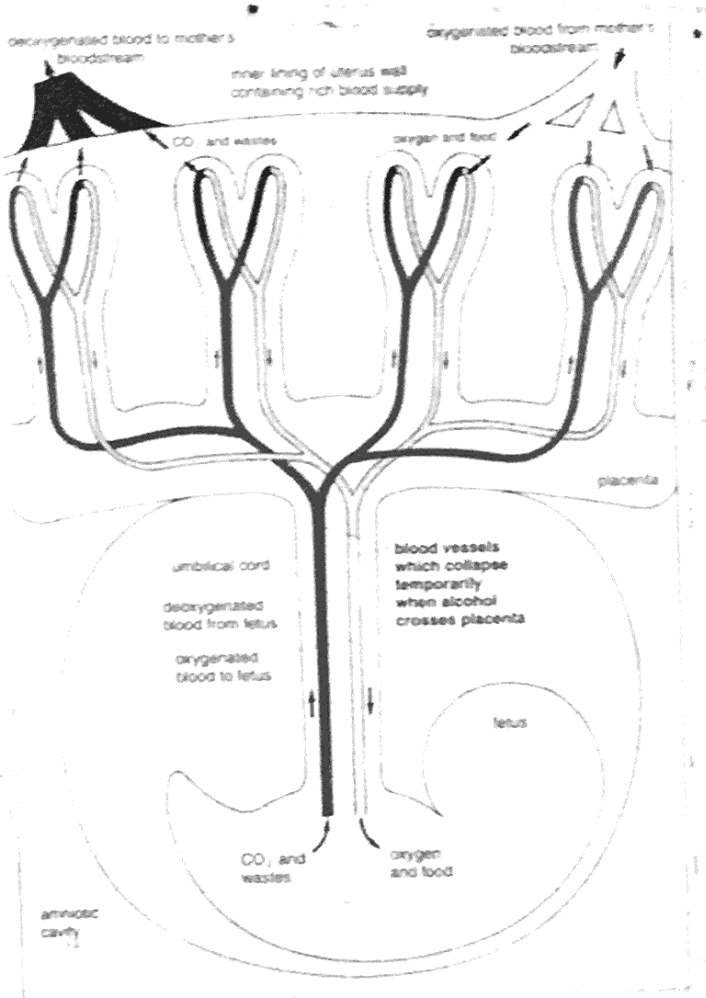
UMBILICAL CORD

- attaches placenta to fetus
- made out of 2 arteries → carries deoxygenated blood; fetus → mother
  larger vein → carries oxygenated blood; mother → fetus

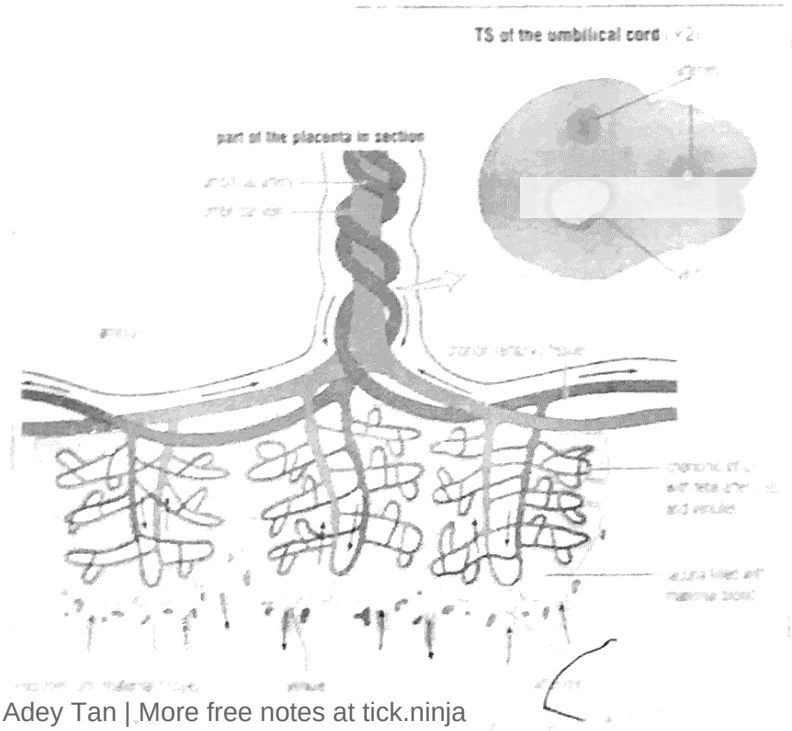
PLACENTA

- allows exchange of materials between fetus & mother w/o blood mixing
- diffusion of food substances from mother to fetus
- rids metabolic waste products from fetus
- diffusion of maternal antibodies to fetus = immunity
- prevents pathogens/toxins from reaching fetus
- barrier to hormones/other chemicals in mother's blood
- permits 2 blood systems to operate @ different pressures
- produces pregnancy related hormones
- produces progesterone preventing menstruation





Blood transfer



umbilical cord structure

DNA & RNA

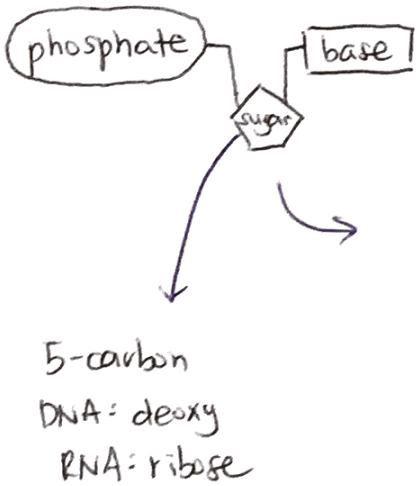
DNA

Stats: 46 chromosomes, 23 pairs
3bil subunits (AT/CG)
30K genes (code for proteins that perform most life functions)
double helix
located in nucleus
made of sugar phosphate backbone + hydrogen bonds + ATCG bases

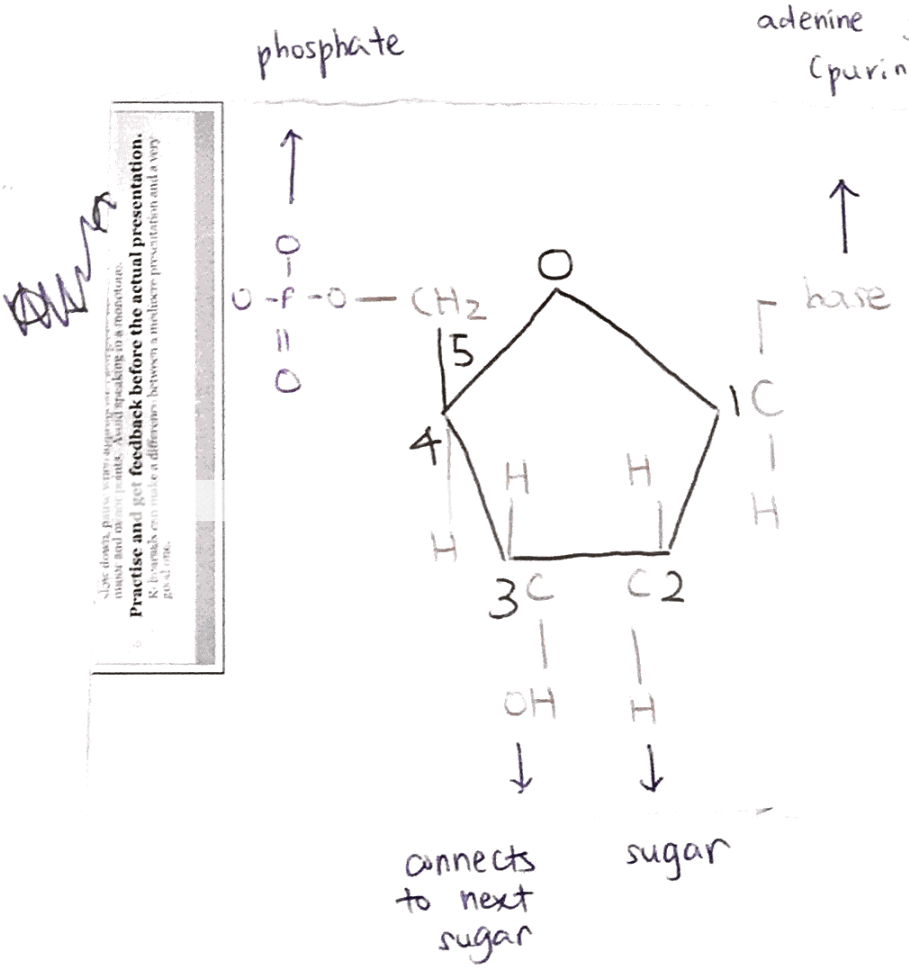
NUCLEIC ACIDS

→ singular polynucleotide
(nucleotide polymer chain)

NUCLEOTIDE



(pyrimidines)
thymine – cytosine
adenine guanine
(purines)



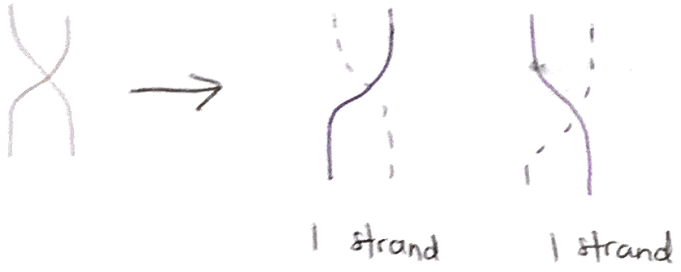
DNA = ACGT → thymine

RNA = ACGU → uracil

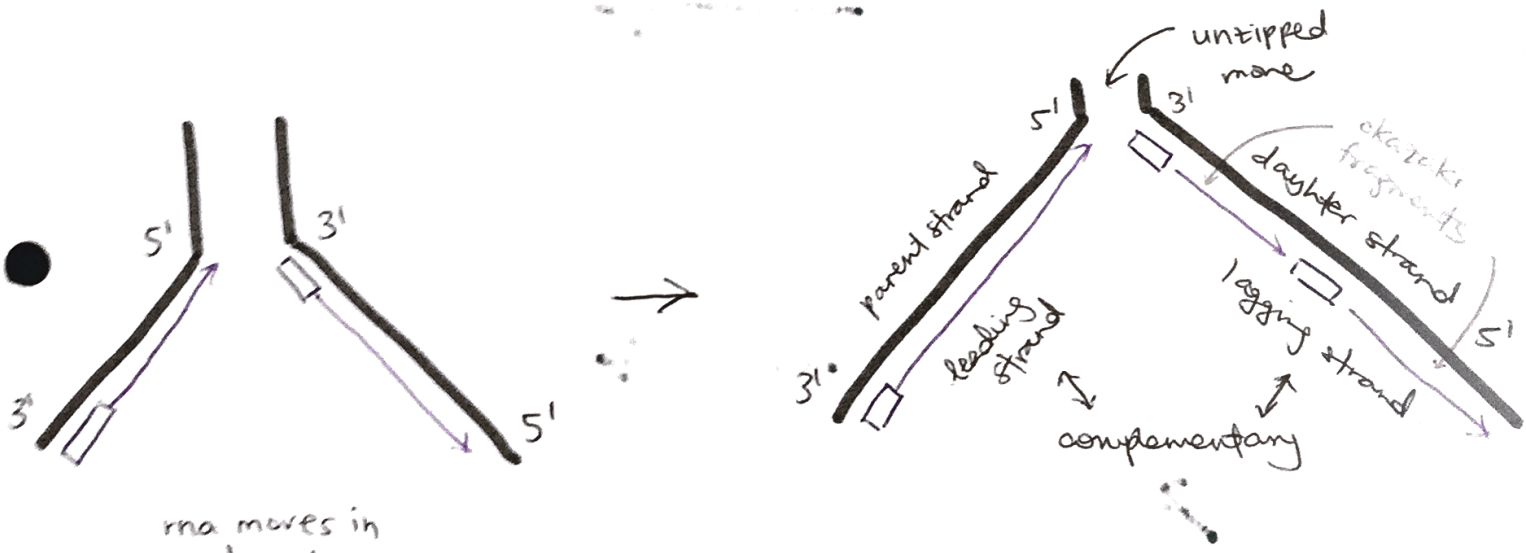
CONDENSATION

Sugar + Base → Nucleoside + H_2O

Strands held together by hydrogen bonds between the nitrogenous bases on both strands.



after division, each parent strand acts as a template for the synthesis of the other strand thru complementary base pairings



rna moves in relation to direction of other strand

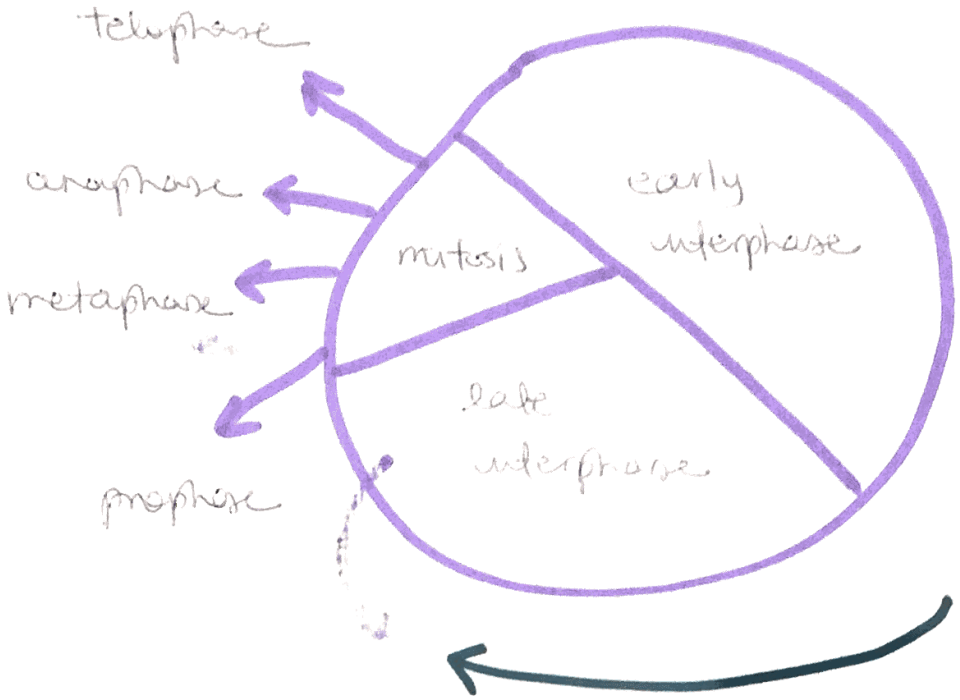
(primase only moves 5' → 3')

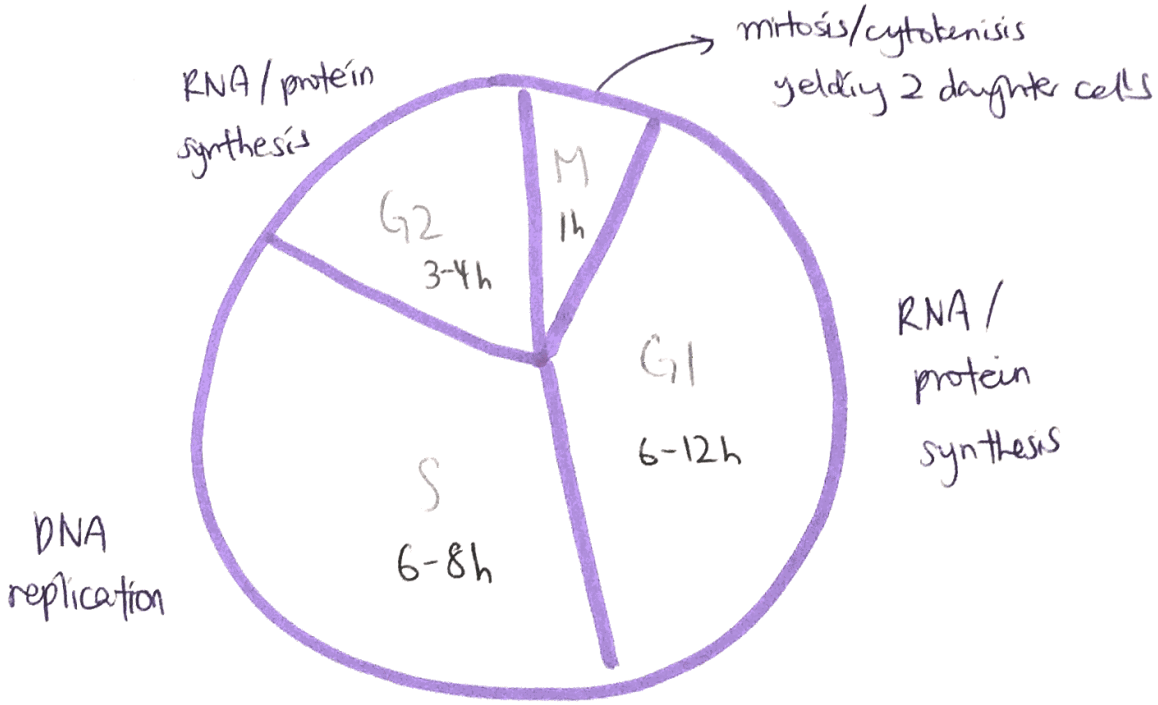
□ primer RNA

→ DNA

	SEMI-CONSERVATIVE √√	CONSERVATIVE	DISPERSIVE
orig	^{15}N ^{15}N → 100% ^{15}N	^{15}N ^{15}N → 100% ^{15}N	^{15}N ^{15}N → 100% ^{15}N
gen 1	^{15}N ^{14}N (new) ^{15}N ^{14}N (new) → (^{14}N) DNA → 50% ^{14}N-^{15}N	^{15}N ^{15}N ^{14}N ^{14}N (totally new) → ^{14}N 50% ^{15}N 50%	→ ^{14}N-^{15}N 100%
gen 2	→ 50% ^{14}N 50% ^{14}N-^{15}N	→ ^{14}N 75% ^{15}N 15%	× 4 → ^{14}N-^{15}N 100%

CELL CYCLE


telophase
anaphase
metaphase
prophase
mitosis
early interphase
late interphase


RNA / protein synthesis
mitosis/cytokenisis yelding 2 daughter cells
M
1h
G2
3-4h
G1
6-12h
S
6-8h
RNA / protein synthesis
DNA replication

LEGEND

2n = diploid (set of chromosomes)

n = haploid

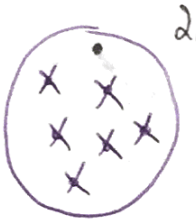
centromeres = no. of chromosomes

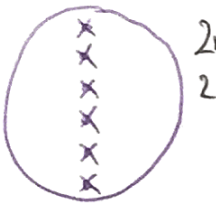
chromatids = dna content

ORDER

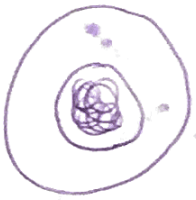
early interphase
↓
late interphase
↓
prophase
↓
metaphase
↓
anaphase
↓
telophase
↓
cytokinesis

MITOSIS

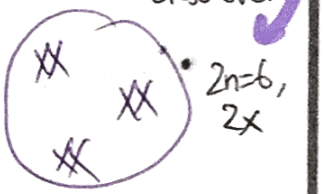




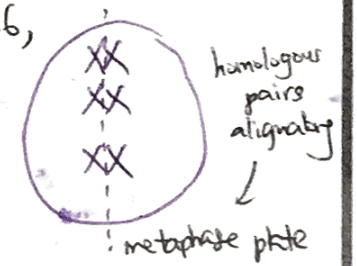
MEIOSIS I

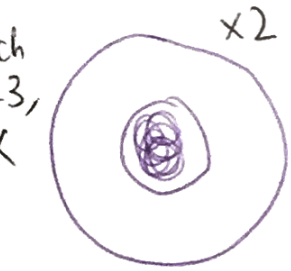


chiasma = sister chromatids non cross over



synapsis = homologous pairing

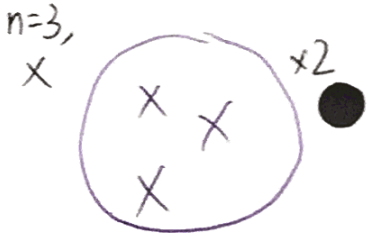


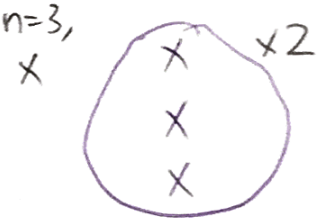


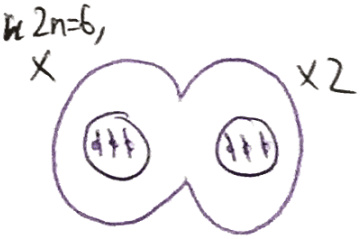
MEIOSIS II

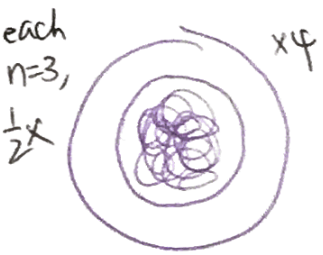
after meiosis I, meiosis II

as → occurs,
- condense chromatin threads to chromosomes
- nuclear membrane disintegrates
- spindle fibres form from centrioles
- centrioles move to poles









DNA v RNA

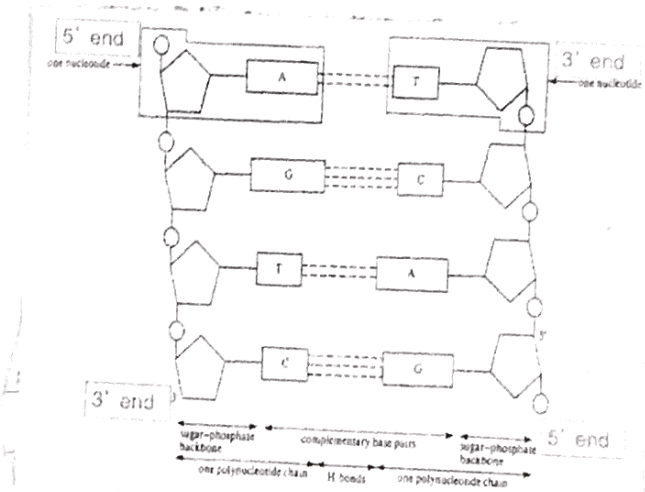
DNA: capable of carrying coded info (base sequence) to direct cell activity & accurate replication bc rule of base pairing

RNA: found in both nucleus & cytoplasm of eukaryotic cells + single stranded macromolecules, made of many nucleotides joined by 3'→5' phosphodiester bonds; more created thru transcription

mRNA	tRNA	rRNA
- messenger - long single stranded polynucleotide - 300 nucleotides, smallest molecule - manufactured in nucleus - base sequence complementary copy of template 2 strand	- transfer - 5'-3' coding - 3'-5' template - any tRNA in coding → mRNA	- ribosomal - ribosome component - synthesised in nucleus

WATSON CRICK MODEL

- 2 polynucleotide chains coiled around each other forming double helix
- each chain made up of a sugar phosphate backbone
- chains run in opposite direction (3' – 5')
- hydrogen bonds formed between corresponding bases of 2 chains
- each base pair = 1 purine 1 pyrimidine



A:T C≡G

DNA REPLICATION

BEFORE: free deoxyribonucleotides synthesised in cytoplasm, replication begins

UNWINDING OF x2 HELIX: ATP-dependent enzyme (helicase) causes DNA molecule to unzip @ origin of replication
hydrogen bonds between complementary bases break
dna strands separate. each strand acts as a template
complementary deoxyribonucleotides assemble alongside partners
sugar phosphate backbone formed thru condensation reactions between nucleotides

FORMATION OF RNA PRIMER STRAND: primase attaches to unwound chains behind replication fork, catalyses formation of short RNA chain complementary to DNA template strand
primer initiates polynucleotide synthesis, consists of ≈10 ribonucleotides
DNA polymerase III adds deoxyribonucleotides to pre existing strand

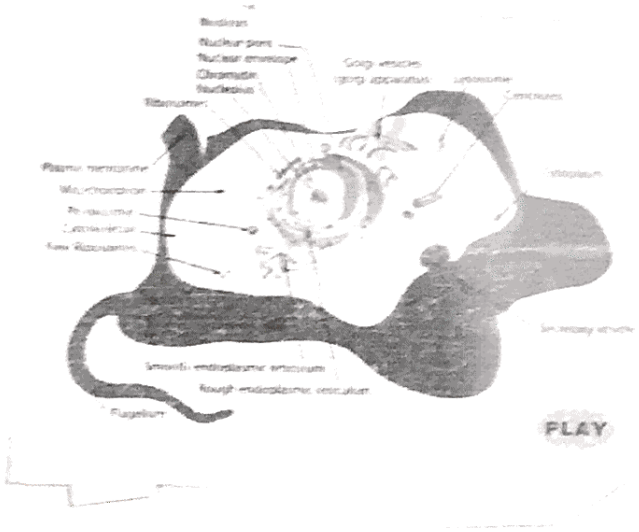
SYNTHESIS OF NEW STRAND: DNA polymerase III synthesises new DNA continuous from RNA primer strand Q fits free deoxyribonucleotides complementary to those on parent strand

REMOVAL OF PRIMER: gaps filled w/ complementary deoxyribonucleotides
DNA ligase joins okazaki fragments thru phosphodiester bonds + hydroxyl group of 3' end to other phosphate group of 5' end

AT THE END: 2 DNA MOLECULES FORMED
each contains a newly synthesised + parent strand in double helix

CELLS

PR



PROKARYOTES

cellular organisms w/o nucleus or membrane bound organelles

- smaller genome cell
- simple
- plasmids present
- continuous gene coding sequence
- small amt of non-coding DNA
- DNA in nucleoid
- 2 lvls of packing - supercoils / looped domains
- single, double stranded closer circular DNA
- cell wall present, chemically complex
- no cytoskeleton or cytoplasmic streaming
- cell division by binary fission
- ribosomes smaller

EUKARYOTES

cellular organisms with nucleus & membrane bound organelles

- larger genome size
- complex
- plasmids absent
- intron-interrupted gene coding sequence
- large amt of non-coding DNA
- DNA in nucleus
- 4 lvls of packing - nucleosomes, solenoid, looped domains, metaphase chromosome
- 2/more double stranded linear DNA
- cell wall only in plant cells, cellulose
- cytoskeleton or cytoplasmic streaming
- cell division by mitosis
- ribosomes larger

MITOSIS SIGFIG.

GENETIC STABILITY

- 2 nuclei of same number/kind of chromosomes as parent cell, preserving chromosome constitution
  - ↳ replication (interphase)
  - ↳ arrangement (metaphase)
  - ↳ separation (anaphase)

ASEXUAL REPRO.

- genetically similar, offspring = same advantages

GROWTH & DVPMT

- ↑ in cell number

REGEN/REPLACEMENT

- regen. missing parts
- wound healing, tissue healing

MITOSIS V MEIOSIS

CROSSING OVER (prophase I)

- synapsis leads to genetic xchange btwn homologous chromosomes

PAIRING & INDIE. ASSORTMENT (metaphase I)

- homologous chromosomes line up in pairs @ equatorial plane not individually

POLES (anaphase)

one homologous ~~pair~~ chromosome from each pair goes to opposite pole instead of separating

MITOSIS → 1 div, 2 daughter cells, genetically identical

MEIOSIS → 2 div, 4 daughter cells, genetically diff.

PCR

ADVANTAGES

Speed - 30 min to 3h

Specificity - can amplify specific DNA fragment from mixture

Sensitivity - can amplify DNA from 1 cell / poor quality DNA

RESTRICTION ENZYMES

- special class of naturally occuring proteins
- cut specific palindromic sequences @ recognition sites
- cleavage occurs thru breaking of phosphodiester bonds, reversible through DNA ligase
- generate ends (sticky or blunt)
  - ↳ if cut closer to 5' end, 5' overhang
  - ↳ if cut closer to 3' end, 3' overhang
  - ↳ if no overhang, blunt

PROCESS

denaturation (94°C / 30 sec) → separates DNA strands

annealing (64°C / 45 sec) → primers target regions within gene + bond

extension (72°C / 45 sec) → DNA polymerase amplifies target region

STUFF

gel electrophoresis: separates DNA by size

glycerol: renders DNA samples denser than buffer so they sink into well

DNA ladder: helps determine DNA BP

IF SUCCESSFUL → one band only

MENDELIAN GENETICS

DEFINITIONS

gene: segments of DNA coding for protein
gene locus: physical location of gene as found in specific chromosome

ALLELES: any of gene's alt. forms, found in pairs
each on 1 pair of homologous chromosomes

DOMINANT	RECESSIVE
heterozygous organism expresses trait from allele E	heterozygous organism does not express trait from allele e

Ee hetero
EE homo

genotype: determined by alleles, determines phenotype
phenotype: expressed, what you see

PUNNET SQ.

STEPS

1. parental pheno/genotype
2. punnet sq.
3. F1 gen pheno/genotype ratio

Parental gen: Aa × Aa
Parental pheno: Hetero Trait × Hetero Trait
(+ Homo) (+ Homo)

F1 gen: 1 2:1 1AA, 2Aa, 1aa
1 homodom
1 homorec
2 hetero
(+ traits)

4. conclude

(replace underlined w/ conte)

Let letter be ALLELE for trait.

Gametes	(A)	(a)
(A)	AA	Aa
(a)	Aa	aa

CROSSES

MONOHYBRID = 1 gene involved eg. Rr
DIHYBRID = 2 genes involved eg. AaBb

LAW OF SEGREGATION = 2 alleles for a heritable character separate during gamete formation ending up in diff gametes

LAW OF INDIE. ASSORTMENT = gene pairs on diff chromosomes assort independently @ meiosis in 9:3:3:1 ratio

INCOMPLETE DOMINANCE = hybrid where both traits disappear by combining into smth new
eg. red flower × white flower = pink flower

CODOMINANCE = hetero where end product exhibits phenotype of both traits
eg. blood type A + blood type B = blood type AB

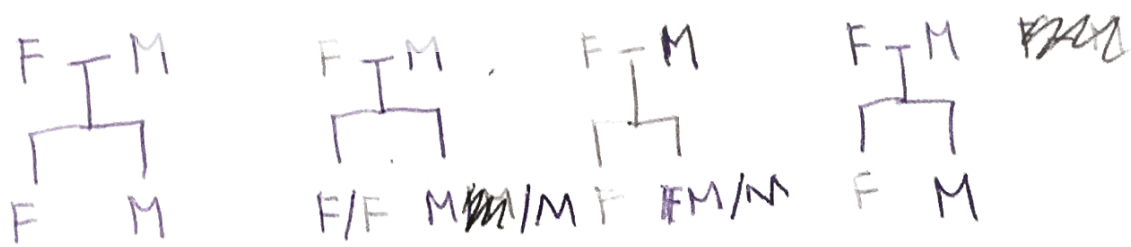
SEX-LINKED

where gene is on X- chromosome (recessive)

♀ express trait
requires 2 copies of allele

♂ express trait
requires 1 copy of allele
because males only have 1 X chromosome

affected
carrier
nil



∴ males ↑ susceptible to sex-linked diseases

NON-DISJUNCTION

when sister chromatids fail to separate @ meiosis II.
= abnormal chromosome number
when chromosomes in a cell fail to separate properly, some gametes end up normal & others have no chromosomes.

↳ TRISOMY: 3 copies of chromosome instead of 2

↳ eg. Down's = chromosome 21 trisomy (1 in 800)
eg. Kinefelter's = sex chromosome trisomy (boys)
eg. Turner's = no Y chromosome (girls)

CHROMOSOMAL MUTATIONS

changes in DNA sequence OR chromosomal number
structural modification of chromosome

DNA REPLICATION ERRORS

BASE SUBSTITUTION
(point mutation)

single base swapped w/ another
usually tolerable re: gene function

- TRANSITION: pyrimidine subs pyrimidine
  purine subs purine
- TRANSVERSION: pyrimidine subs purine
  purine subs pyrimidine
- MISSENSE: codon altered
  alters for ~~amin~~ new amino acid
- NONSENSE: stop codon altered ∴ translation of messenger RNA stops prematurely
  truncated nonfunctional protein
- SILENT: trans- error occurs but same amino acid produced ∴ no change in product & cannot be detected w/o gene sequencing

INSERTION/DELETION
(frameshift mutation)

base inserted/deleted from sequence
alters ALL subsequent codons downstream from mutation site
= nonfunctional protein product

CANCER & CHECKPOINTS

definition: uncontrolled cell division
apoptosis doesn't occur
clones descended from one cell
begins as primary tumour
establishes metastases over body

causes: anything that damages DNA
mutagens
anything that stimulates mitosis rate

checkpoints:-

G1 (end of G1 phase)
decides if cell should divide / delay division / rest

G2 (end of G2 phase)
triggers mitosis

Metaphase
all chromosomes have aligned

STEM CELLS

FEATURES

- capable of continually dividing & reproducing themselves over long periods (proliferation)
- unspecialised cell (no tissue-specific structures)
- differentiate into specific cells under specific conditions

TYPES

TOTIPOTENT: found in zygotes, can convert to all cell types formed thru fusion of 2 haploid nuclei

PLURIPOTENT: found in embryos; can convert to almost all cell types hollow ball of cells (blastocyst embryonic) 4 days after fertilisation + inner cell mass gives rise to specialised cells

MULTIPOTENT: found in umbilical cord; genetically identical to baby a variety of conversions

IN ADULTS: tiny amounts to repair & maintain tissue can remain as stem cells OR develop

GENE MUTATION

the ultimate source of ALL genetic variation, because there is NO other source for ENTIRELY NEW alleles.

MUTAGEN TYPES

Chemical: alter DNA of cell

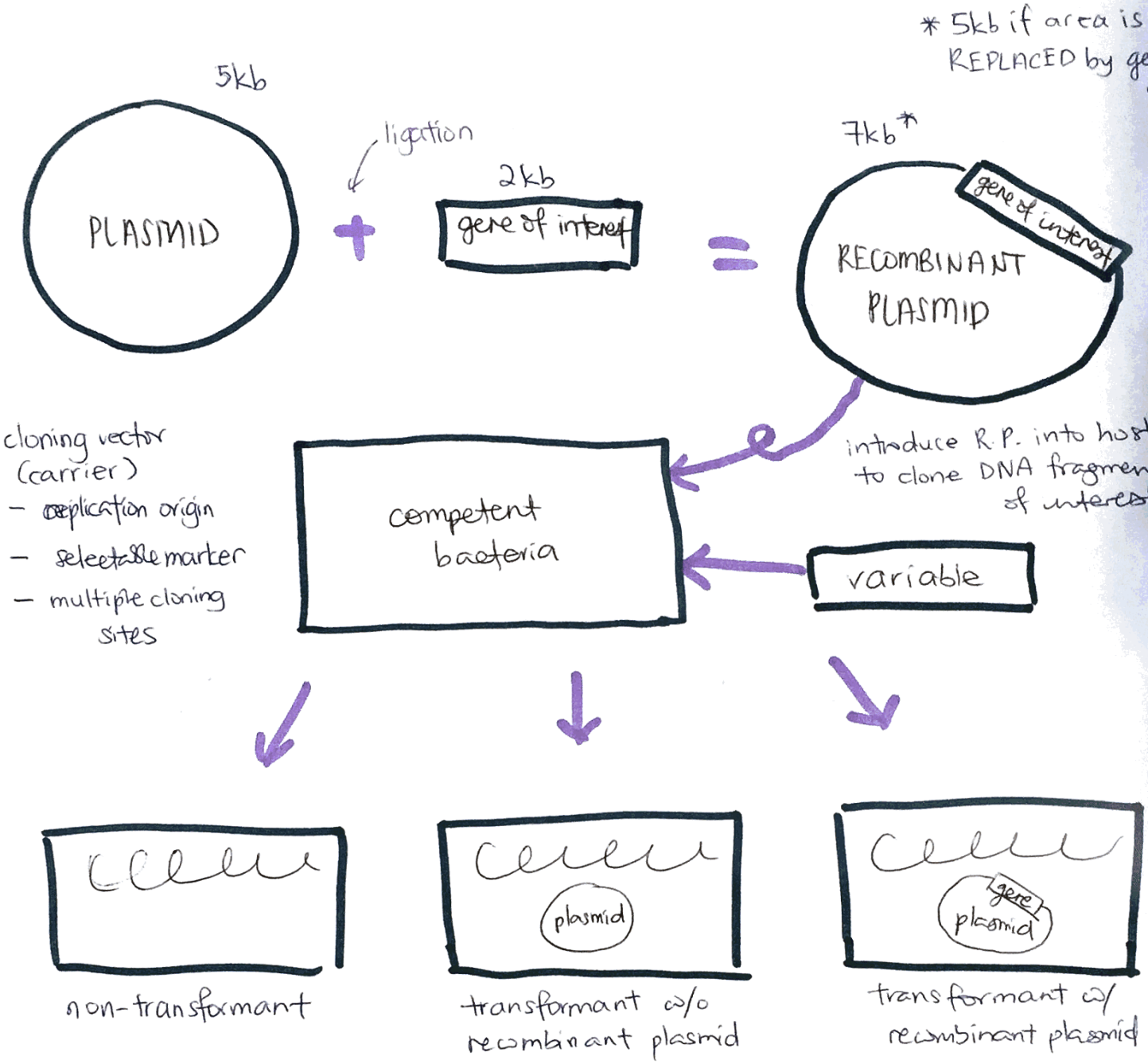
Biological: viruses insert into genome

Radiation: ~~x~~ DNA damage thru radioactivity

MOLECULAR CLONING

PROCESS (replace underlined w/ context)

1. RESTRICTION DIGESTION of plasmid & gene of interest w/ same restriction enzyme
2. LIGATION of digested plasmid & digested gene of interest with DNA ligase to produce recombinant plasmid
3. TRANSFORMATION of recombinant plasmid into calcium chloride treated competent antibiotic-sensitive bacteria to produce transformant
4. SELECTION of transformants with recombinant plasmid on LB agar selection media containing (see question).



MULTIPLE CLONING SITES

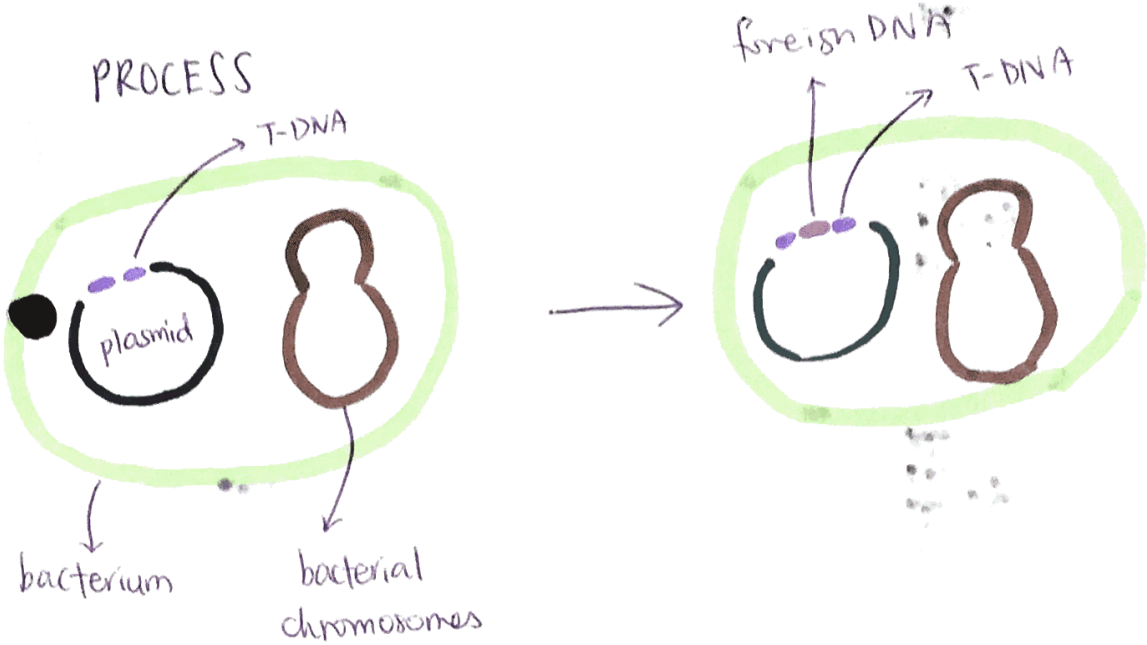
engineered to contain recog. sequences for numerous restriction enzymes. no 2 restriction enzymes in MCS are the same, so when you cut ab a restriction enzyme within MCS, you know for sure that gene of interest will stick in MCS & won't inactivate essential genes. single cuts occuring in enzyme prevent insertions into essential regions of plasmid.

GMOs

organisms w/ artificially altered DNA thru deliberate transfer of genes between species (which need not be closely related)

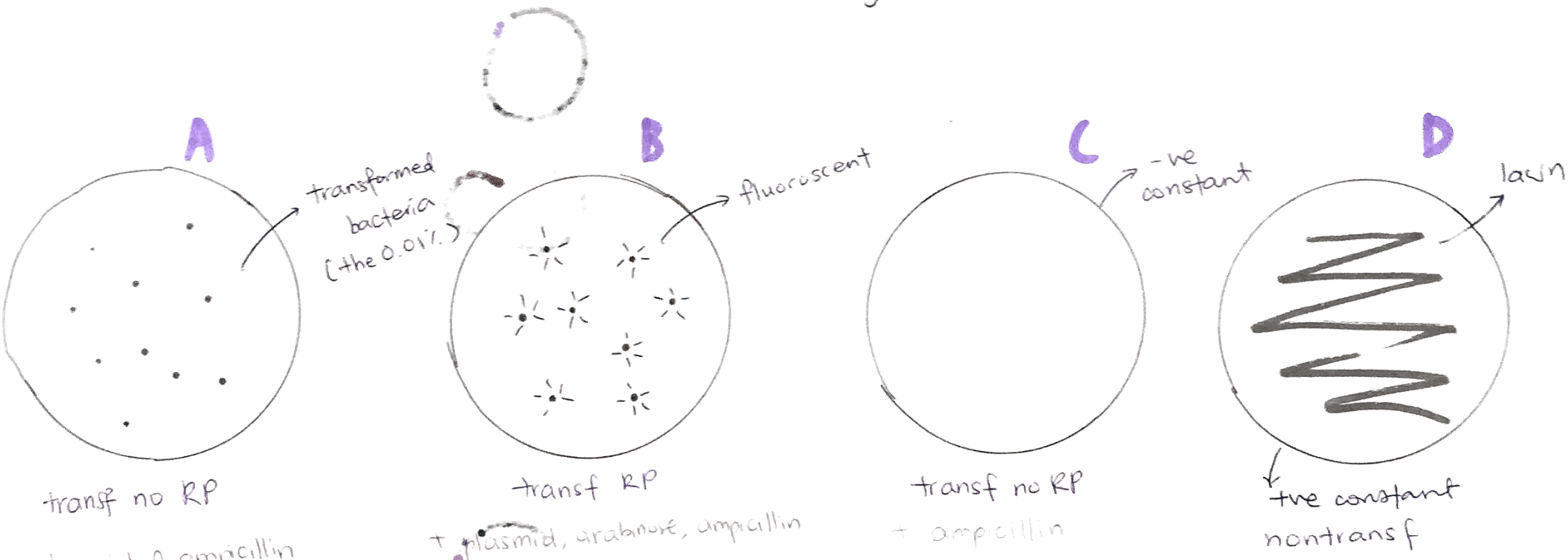
goal is to induce new host to create 1 or more protein that is not normally produced

PROCESS



- restriction enzyme
- plasmid removed T-DNA cut by
- foreign DNA cut w/ same enzyme
- integration - foreign DNA inserted into T-DNA
- plasmid reintegrated w/ DNA

EXPERIMENT RESULTS if they still do this LOL



PLASMID =

BLA ↓ inactivates ampicillin + transformed bacteria has this

GFP ↓ if ARAc on, activated (green flour. protein) + useless unless expressed; once expressed gives you a protein.

ARAc ↓ if arabinose, ARAc switched on

pGLO ↓ transformant

ACCOUNT FOR DIFFERENCES

A v B: presence/absence of arabinose

A v C: presence/absence of pGLO

A v D: transformant efficiency

C v D: presence/absence of ampicillin

REPROGRAMMING

generation of pluripotent stem cells from patients' own somatic cells

NUCLEAR TRANSFER: transfer of nucleus from patients' somatic cells into enucleated egg

FUSION: fuse patients' somatic cells with ES cells
derived pluripotent cells = used for transplantation
= tetraploid
= rejection possible

DEFINED FACTORS: intro. pluripotency factors into somatic cells
leads to IPS cells (induced pluripotent stem cells)

DERIVATION OF IPS CELLS

- pluripotency factors intro. into skin fibroblasts
- only cells harbouring antibiotic resistance gene survive after selection
- colonies resembling ES cells are isolated & expanded in culture to give IPS cell lines
- IPS cells injected into blastocysts of different strain
- IPS cells that give rise to germ line from chimeras

BIO SPA if still relevant

DILUTION FACTOR: $\frac{\text{sample + diluent}}{\text{sample}}$

DNA CONCENTRATION: $(50 \times A_{260} \times \text{dilution factor})$ µg/ml

PURITY: $\frac{\text{Absorbance at 260}}{A_{280}}$ (pure if 1.65–1.85)

YIELD: concentration x vol of sample & dilvent

eg. if 289 µg/ml, ∴ 289 µg/ 1000 ml
for 50µl, $\frac{289}{1000} \times 50$.

- nucleic acids absorb light in the UV region of the electromagnetic spectrum, can be used for quantitation & purity determination thru spectrophotometer.

- DNA's nett -ve charge = it migrates towards anode (+ve)
  larger molecules slower than smaller molecules
  gel electrophoresis separates for size

- loading dye tracks how fast DNA migrates

- glycerol allows samples to sink into wells

- PTC gene amplified in PCR → DNA replication in tube cuts at specific site & amplifies; primer targets replication site

*