From DNA to chromosome

Hossein Jorjani
hossein.jorjani@slu.se
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What did we say last week?

Statistics and Genetics

Galton

Pearson

Fisher

Kempthorne

A statistician's view on QG

"The whole area of selection can be approximated by purely statistical ideas of correlation and regression"

O. Kempthorne (1976)

A statistician's view on QG

- "Let there be a population;
- Let rules of forming mating couples be defined in terms of metric traits of individuals and/or in terms of relationship;
- Let there be selection of individuals on the basis of metric traits or metric traits of related individuals; and finally
- Let the offspring be measured."

A statistician's view on QG

"Then without an atom of formal Mendelism and with a large data set, the joint distribution of offspring and parents can be determined. One can examine this distribution and determine a prediction equation, which one can then apply for a few generations."

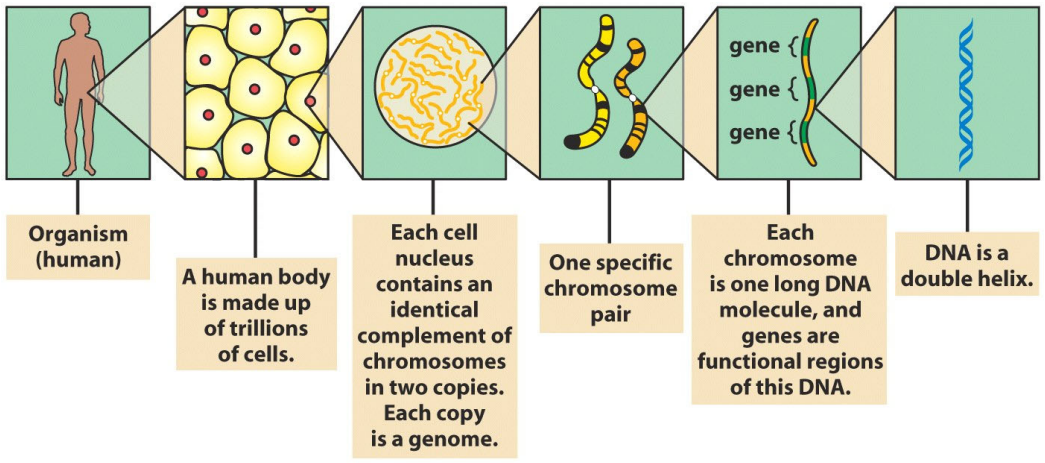
A statistician's view on QG

"I suggest that this type of thinking should not be dismissed as a cranky idea. The reason that some predictions of the results of selection theory seem to work is that they are based on a process rather close to what I have sketched."

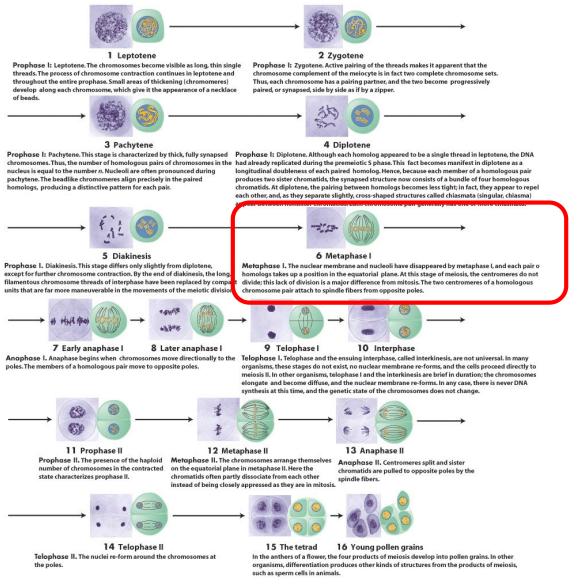
?

From DNA to chromosome

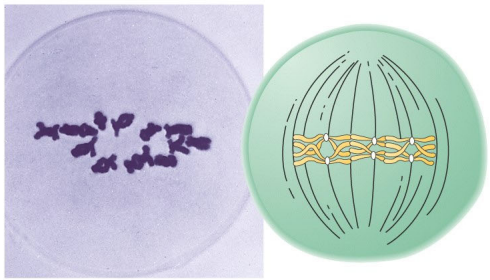
From organism to DNA



Meiosis

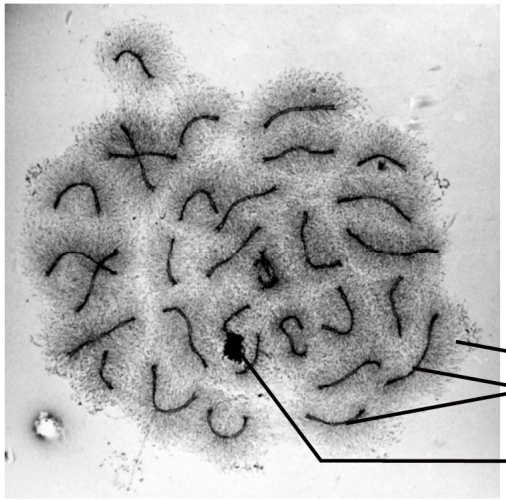


Meiosis: Metaphase I



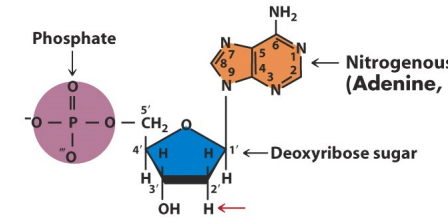
6 Metaphase I

Metaphase I. The nuclear membrane and nucleoli have disappeared by metaphase I, and each pair of homologs takes up a position in the equatorial plane. At this stage of meiosis, the centromeres do not divide; this lack of division is a major difference from mitosis. The two centromeres of a homologous chromosome pair attach to spindle fibers from opposite poles.

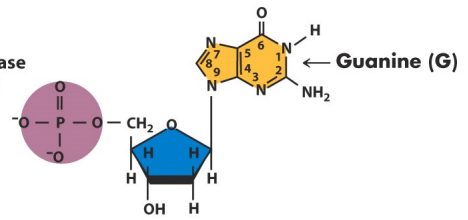


DNA structure

Purine nucleotides

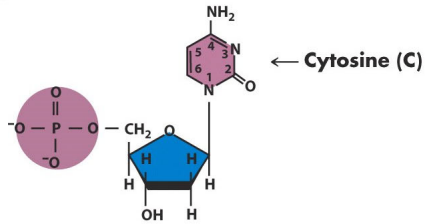


Deoxyadenosine 5′-monophosphate (dAMP)

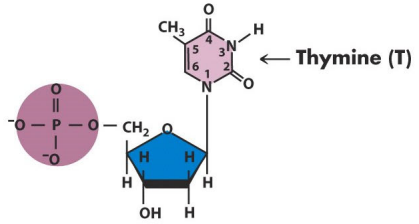


Deoxyguanosine 5′-monophosphate (dGMP)

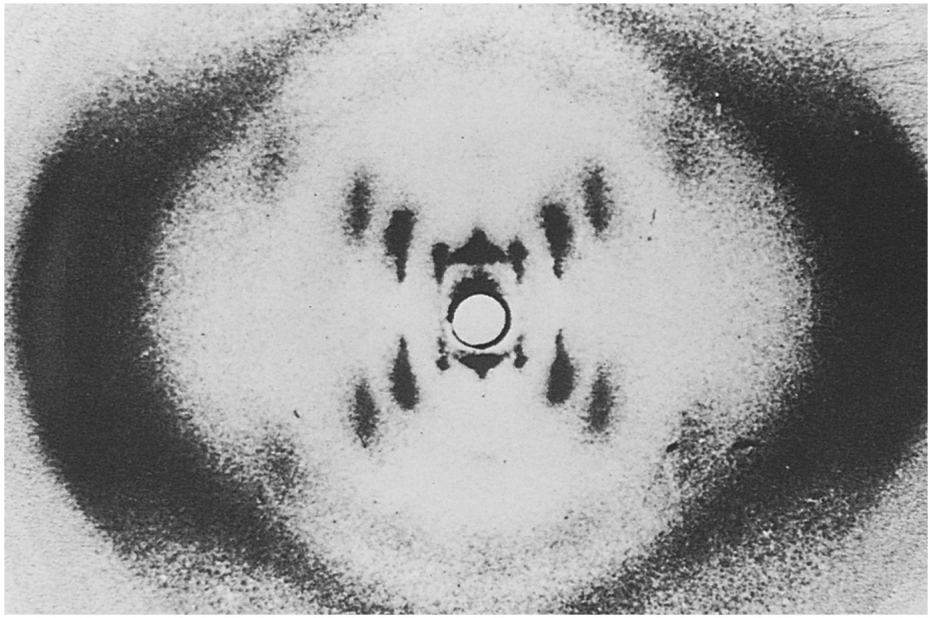
Pyrimidine nucleotides

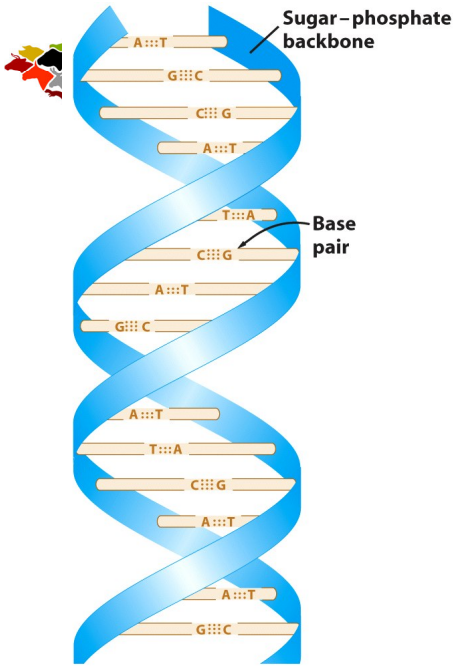


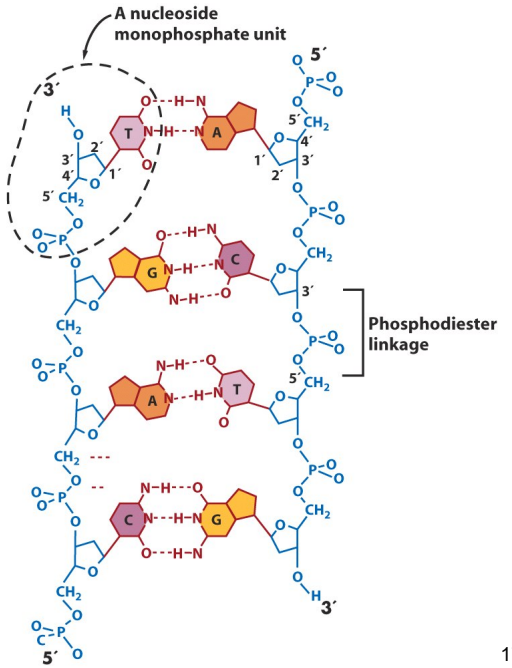
Deoxycytidine 5′-monophosphate (dCMP)



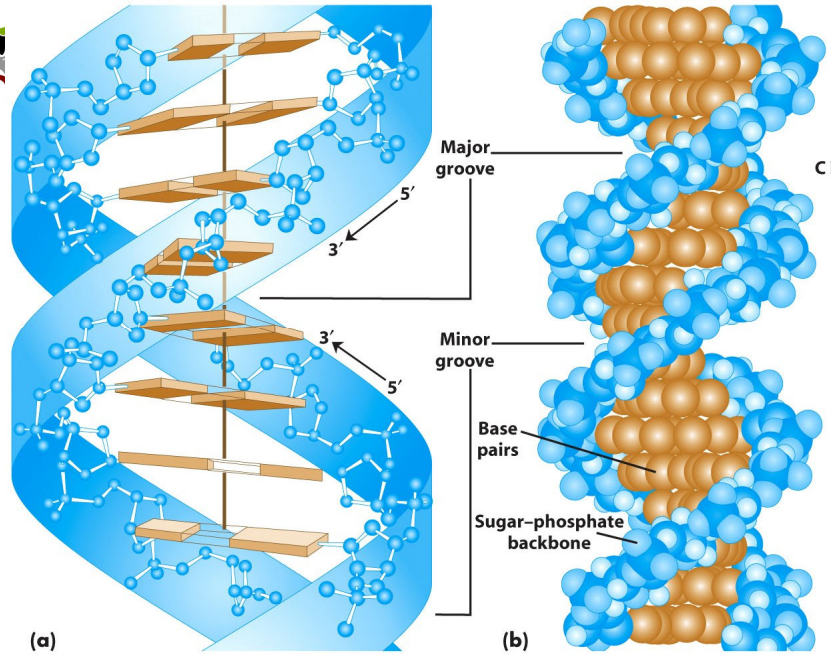
Deoxythymidine 5′-monophosphate (dTMP)



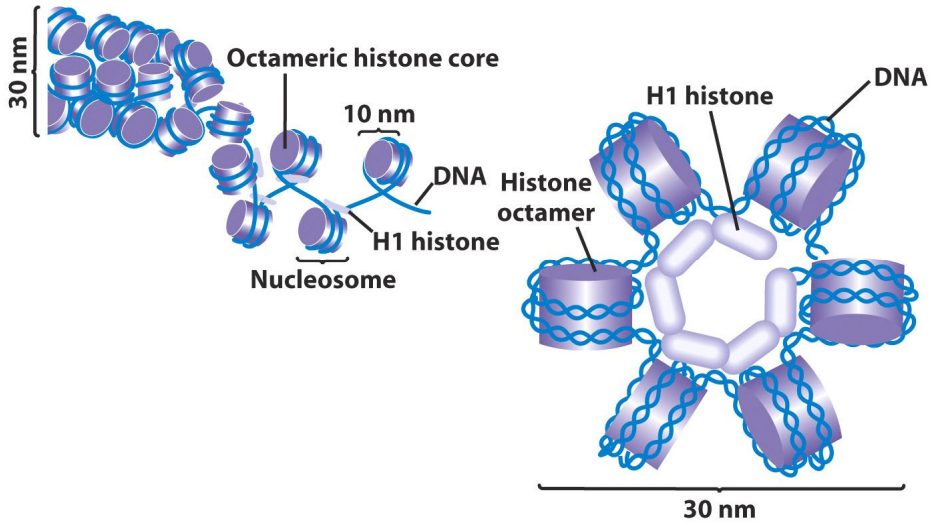

Sugar–phosphate backbone
Base pair
A ::: T
G :::: C
C ::: G
A ::: T
T ::: A
C ::: G
A ::: T
G ::: C
A ::: T
T ::: A
C ::: G
A ::: T
A ::: T
G ::: C


A nucleoside monophosphate unit
Phosphodiester linkage

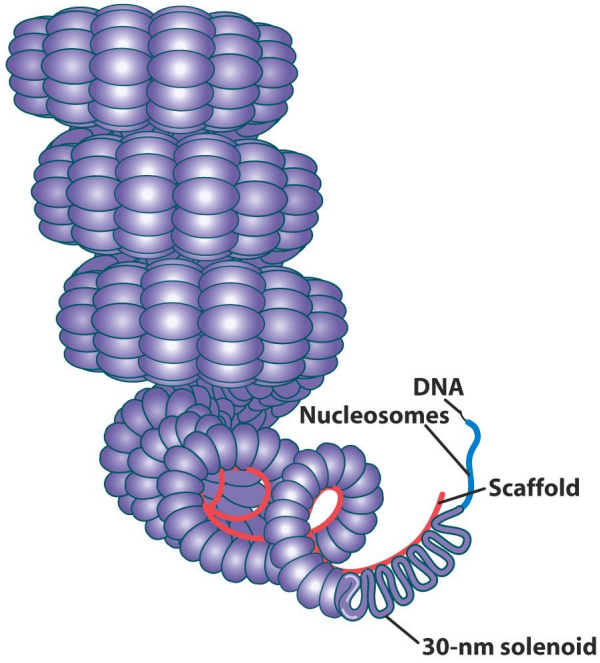
17


Major groove
Minor groove
Base pairs
Sugar–phosphate backbone
H
O
C in phosphate ester chain
P
C and N in bases
(a)
(b)

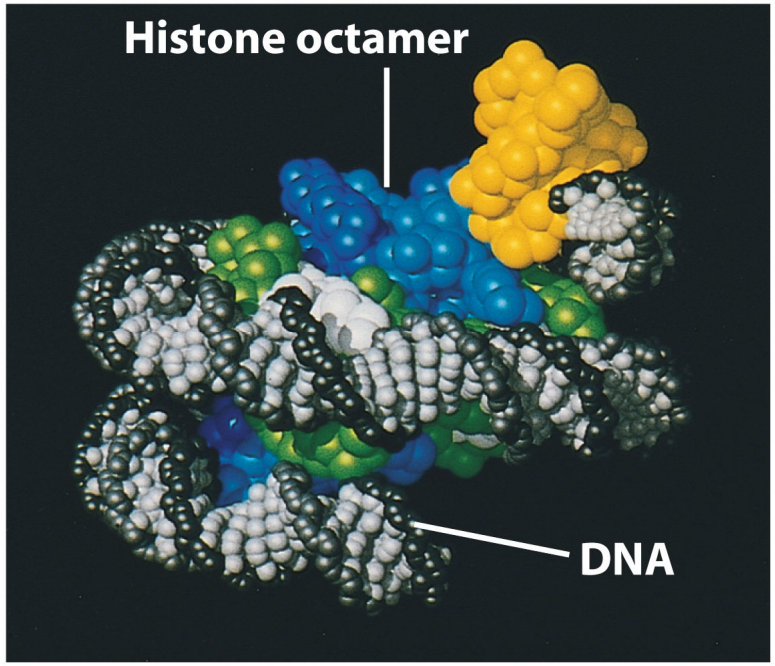
18


30 nm
Octameric histone core
10 nm
DNA
H1 histone
Nucleosome
H1 histone
DNA
Histone octamer
30 nm

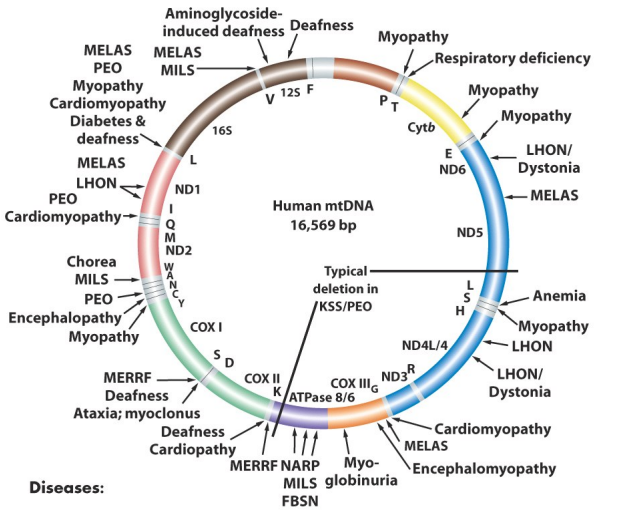
19


DNA
Nucleosomes
Scaffold
30-nm solenoid

20



Mitochondria



Diseases:

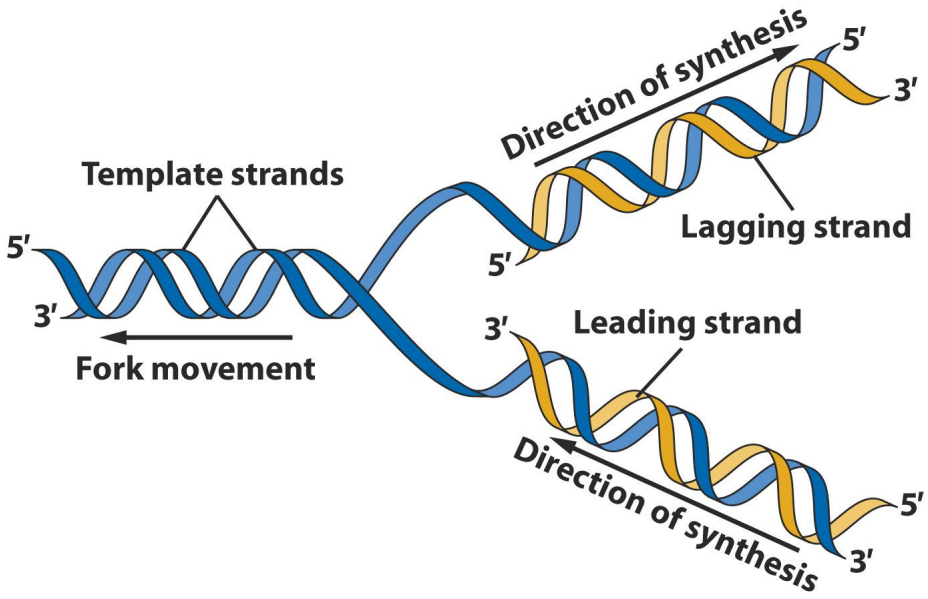
MERRF	Myoclonic epilepsy and ragged red fiber disease
LHON	Leber hereditary optic neuropathy
NARP	Neurogenic muscle weakness, ataxia, and retinitis pigmentosum
MELAS	Mitochondrial encephalomyopathy, lactic acidosis, and strokelike symptoms
MMC	Maternally inherited myopathy and cardiomyopathy
PEO	Progressive external opthalmoplegia
KSS	Kearns-Sayre syndrome
MILS	Maternally inherited Leigh syndrome

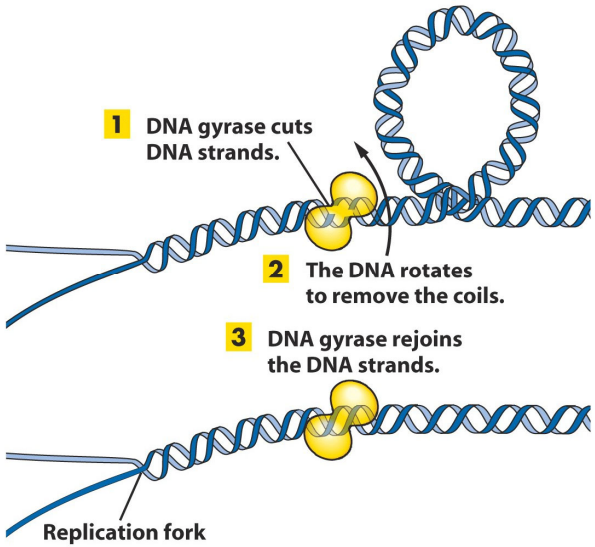
Big packages

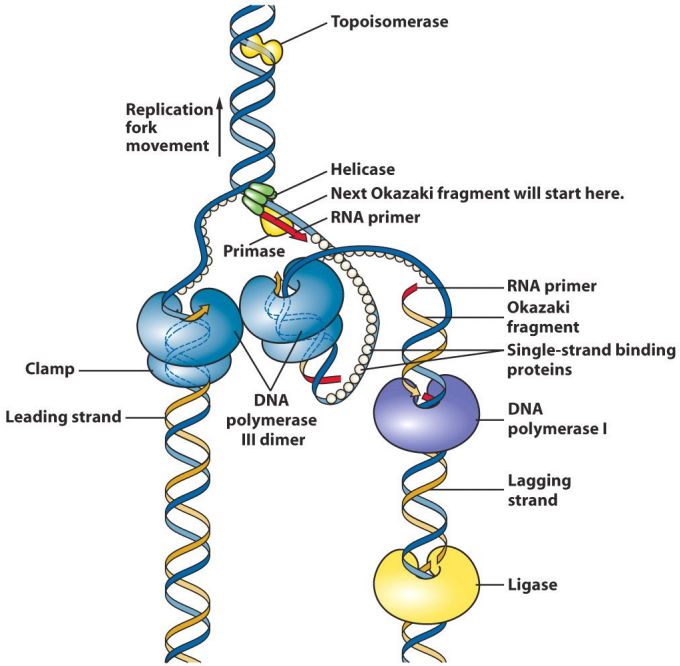
Table 3-2 Numbers of Pairs of Chromosomes in Different Species of Plants and Animals

Common name	Scientific name	Number of chromosome pairs	Common name	Scientific name	Number of chromosome pairs
Mosquito	*Culex pipiens*	3	Wheat	*Triticum aestivum*	21
Housefly	*Musca domestica*	6	Human	*Homo sapiens*	23
Garden onion	*Allium cepa*	8	Potato	*Solanum tuberosum*	24
Toad	*Bufo americanus*	11	Cattle	*Bos taurus*	30
Rice	*Oryza sativa*	12	Donkey	*Equus asinus*	31
Frog	*Rana pipiens*	13	Horse	*Equus caballus*	32
Alligator	*Alligator mississipiensis*	16	Dog	*Canis familiaris*	39
Cat	*Felis domesticus*	19	Chicken	*Gallus domesticus*	39
House mouse	*Mus musculus*	20	Carp	*Cyprinus carpio*	52
Rhesus monkey	*Macaca mulatta*	21			

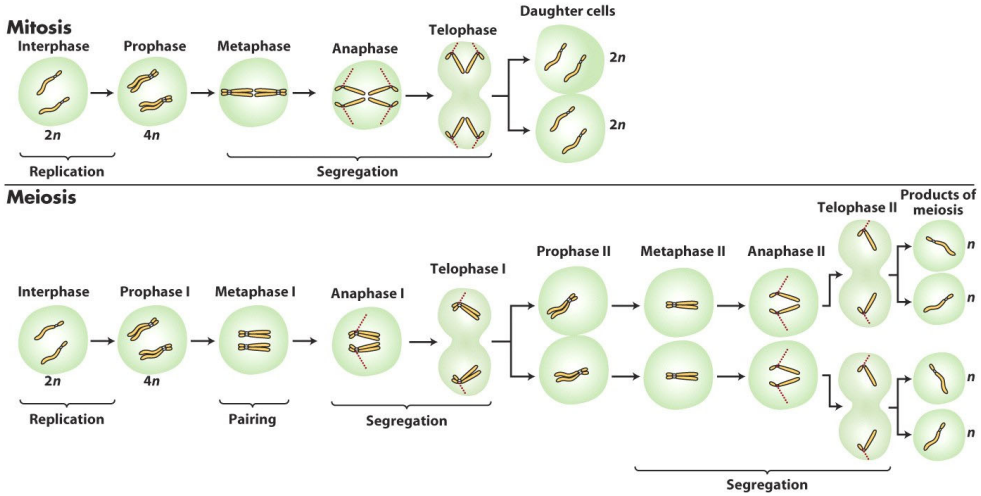
DNA replication

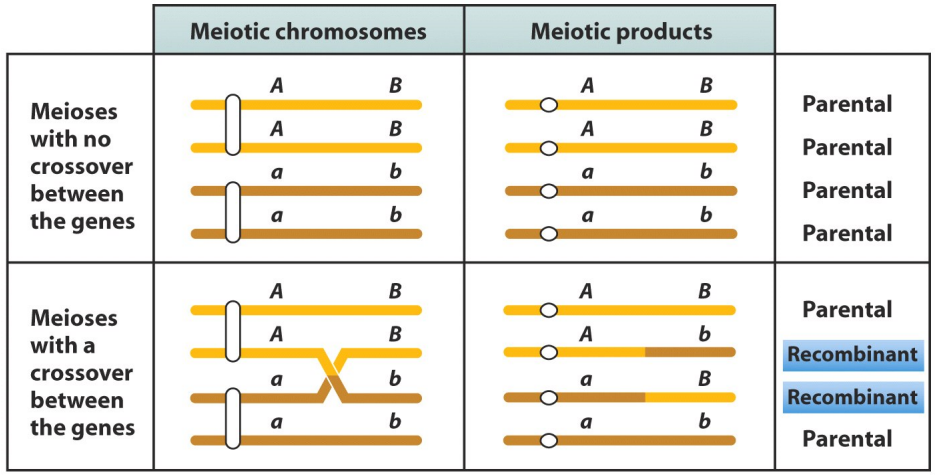


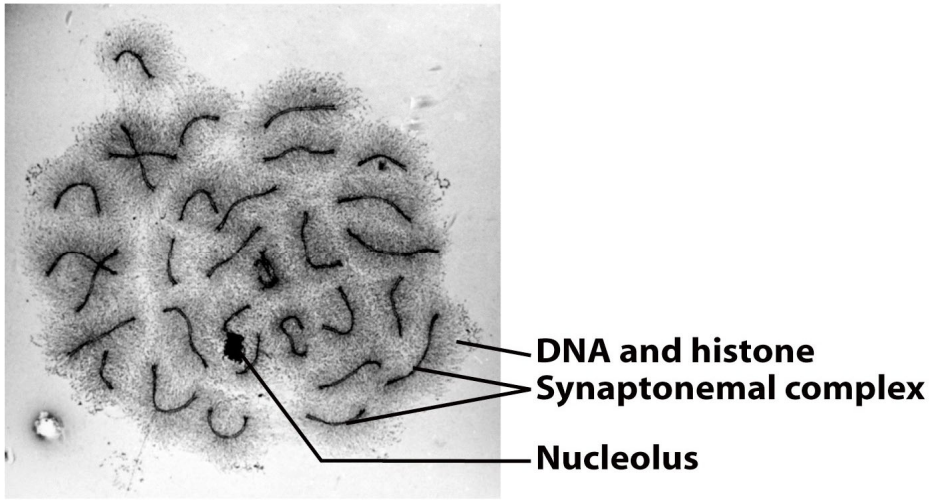




Recombination







Hossein Jorjani

Department of Animal Breeding & Genetics
Swedish University of Agricultural Sciences
Box 7023
S – 750 07 Uppsala, Sweden