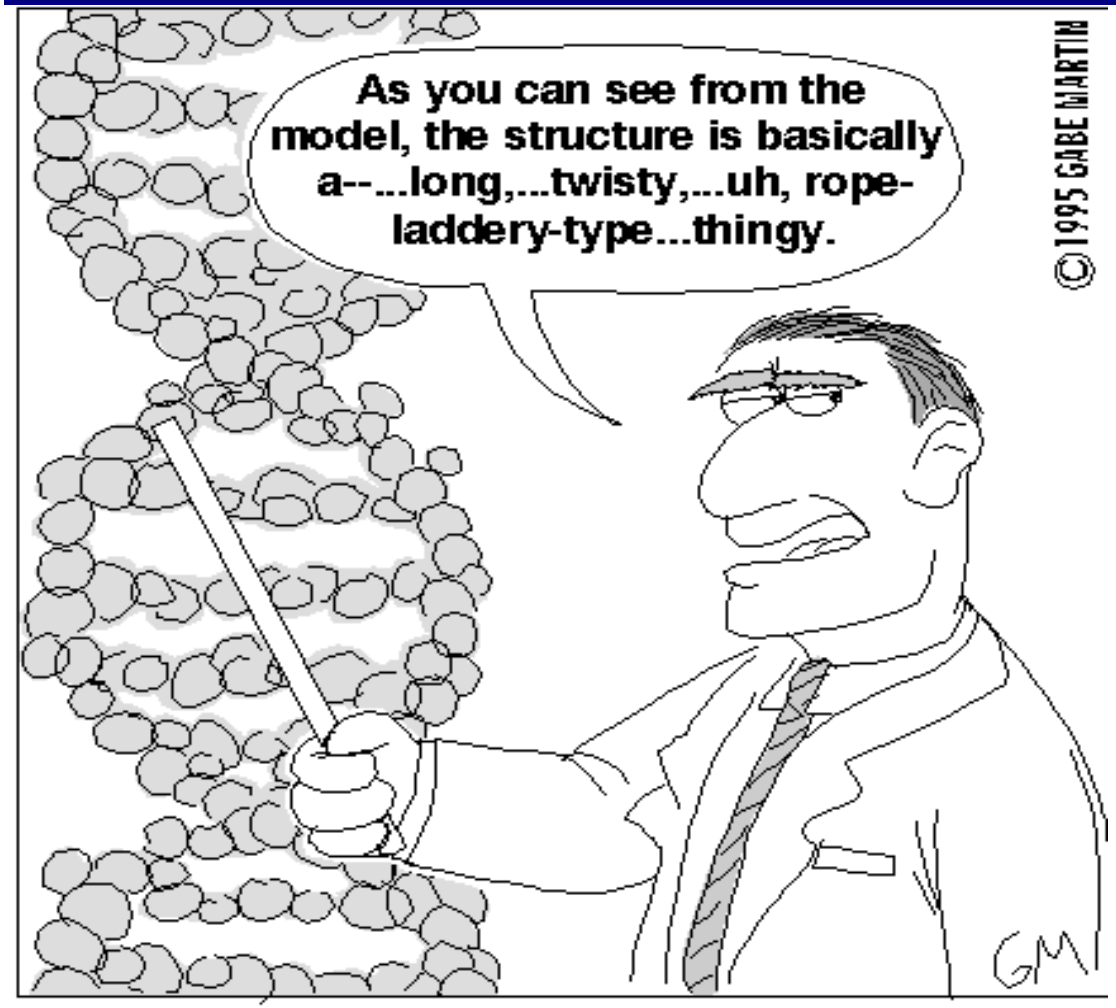
Biology 30 Unit 1

Introduction to Cell Division



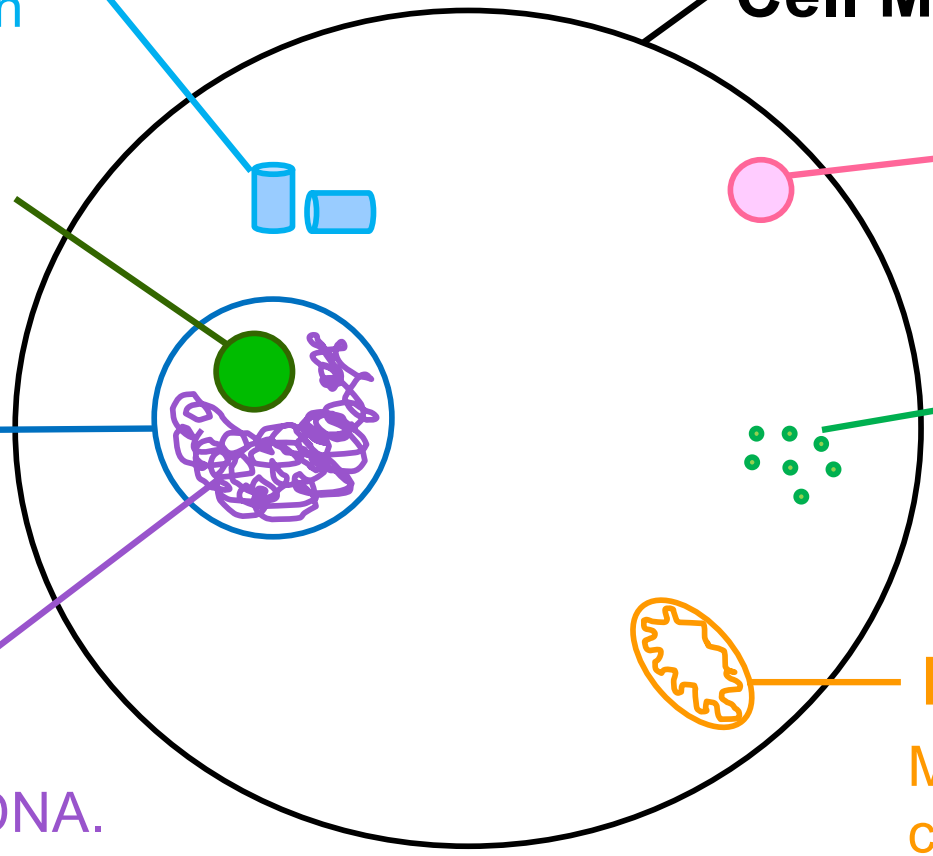
1953: The structure of the DNA molecule is first described.

Learner outcomes…

What you need to know!

- define and explain the significance of chromosome number in somatic and sex cells; i.e., haploidy, diploidy and polyploidy
- explain, in general terms, the events of the cell cycle; i.e., interphase, mitosis and cytokinesis
- describe the process of meiosis (spermatogenesis and oogenesis) and the necessity for the reduction of chromosome number
- compare the processes of mitosis and meiosis
- describe the processes of crossing over and nondisjunction and evaluate their significance to organism inheritance and development
- compare the formation of fraternal and identical offspring in a single birthing event
- describe the diversity of reproductive strategies by comparing the alternation of generations in a range of organisms; *e.g., Daphnia, sea anemone, moss, pine.*

Animal Cell



Centrioles
Cell division

Cell Membrane

Nucleolus
Makes RNA and ribosomes

Vesicle
Storage

Nucleus
Contains DNA

Ribosome
Protein synthesis

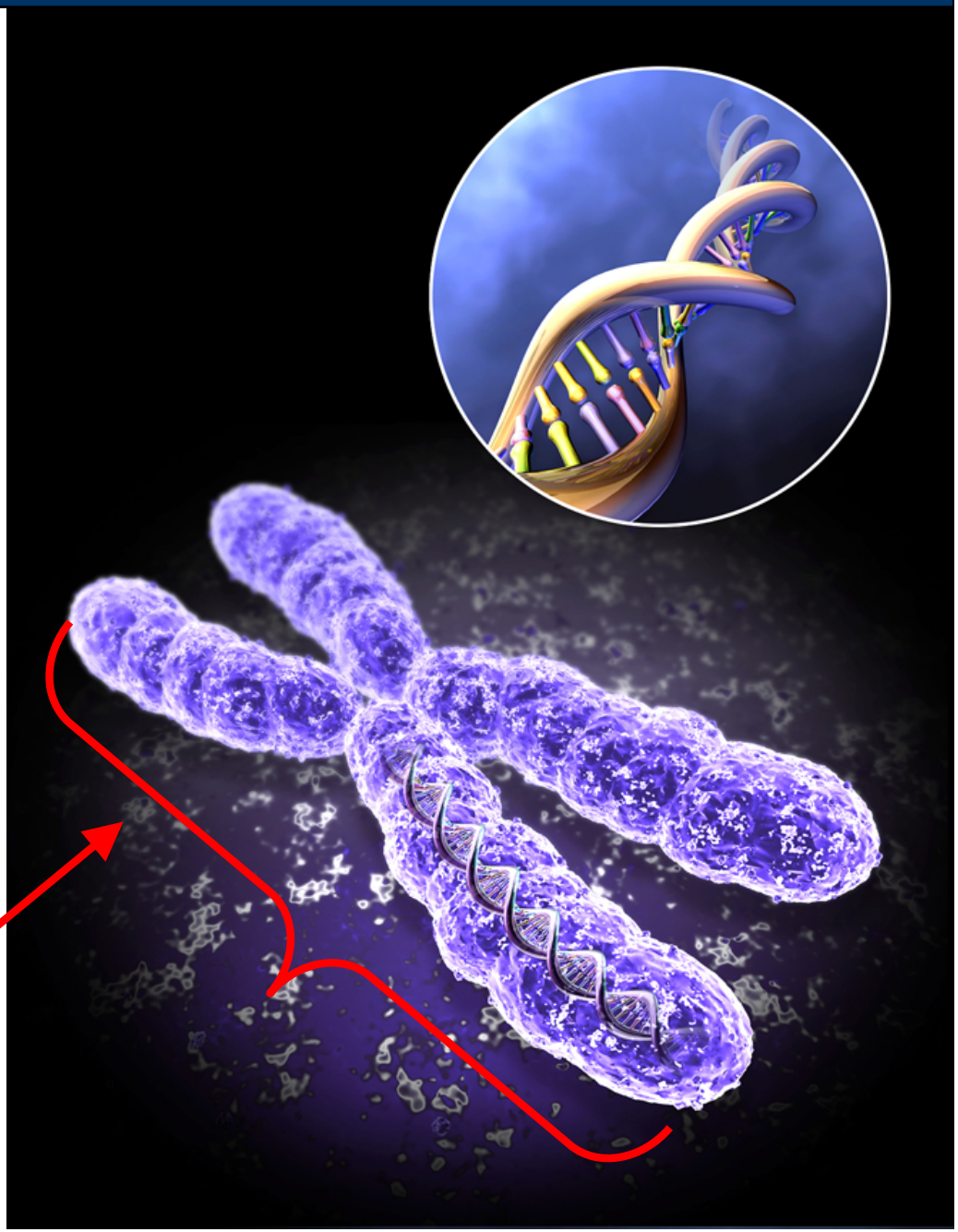
Chromatin
Uncoiled or uncondensed DNA. Present during interphase.

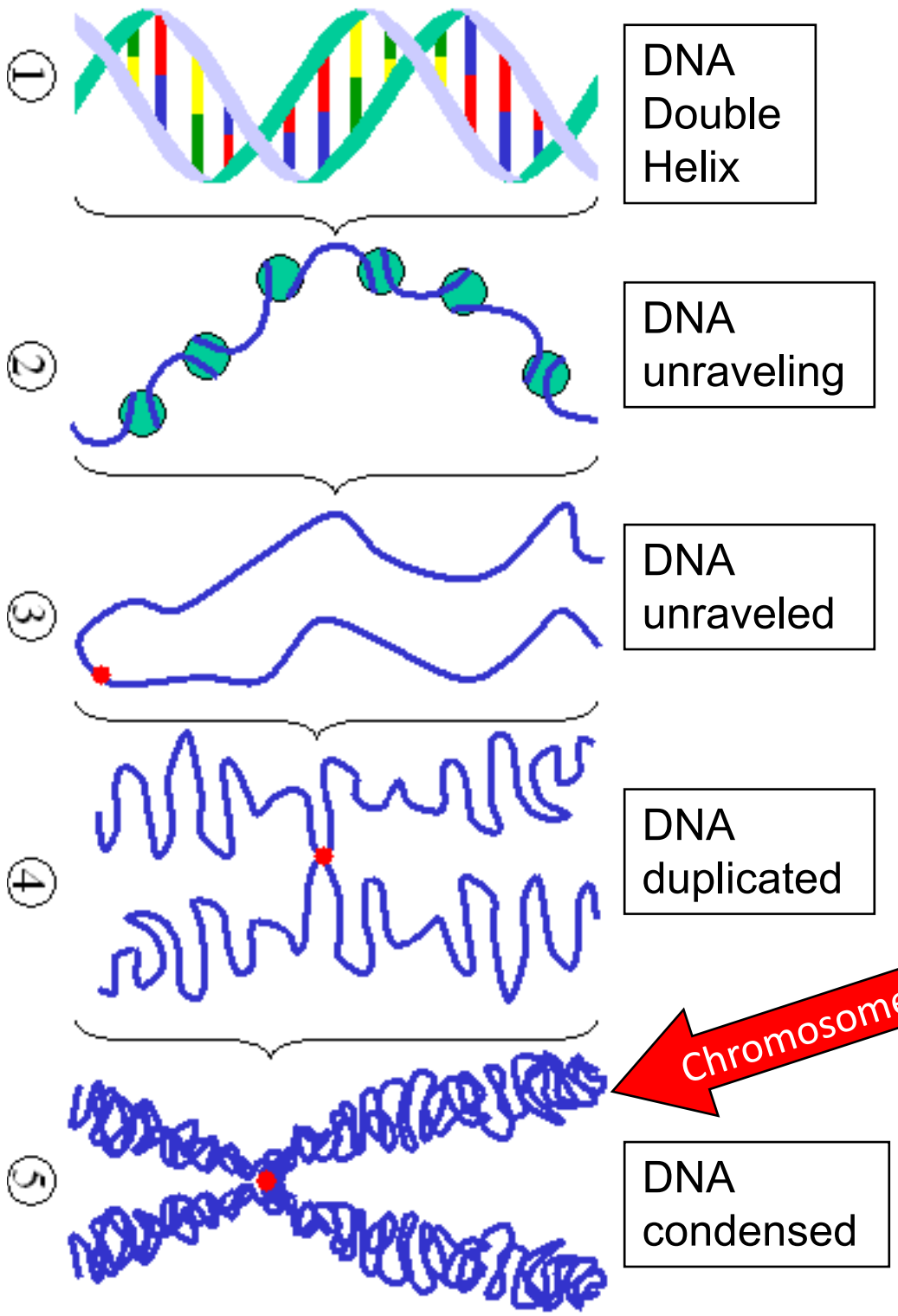
Mitochondrion
Makes energy through cellular respiration

Glucose + oxygen → CO_2 + H_20 + **ATP**

Chromosome

- The genetic information of a cell is contained in its DNA in the nucleus
- When a cell is preparing to divide, DNA is coiled around a histone protein and then condensed and packaged to form a **chromosome**



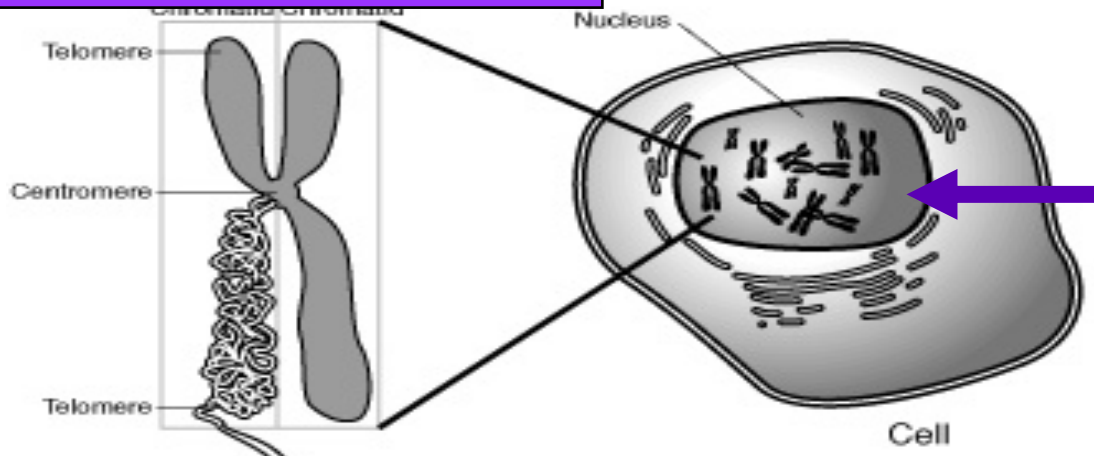


Chromosomes

- long threads of **DNA** wrapped around a bead of protein (**a histone**) to form **chromatin** (threadlike)

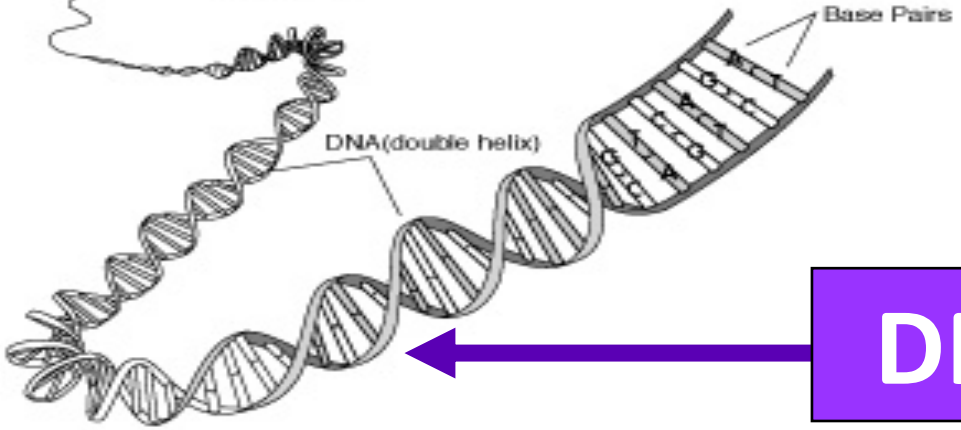
- When a cell is getting ready to divide the **chromatin coils up and forms thicker strands of chromosomes** and later replicate to look like X's.

Chromosome



Nucleus

Chromatin
(thin strands)

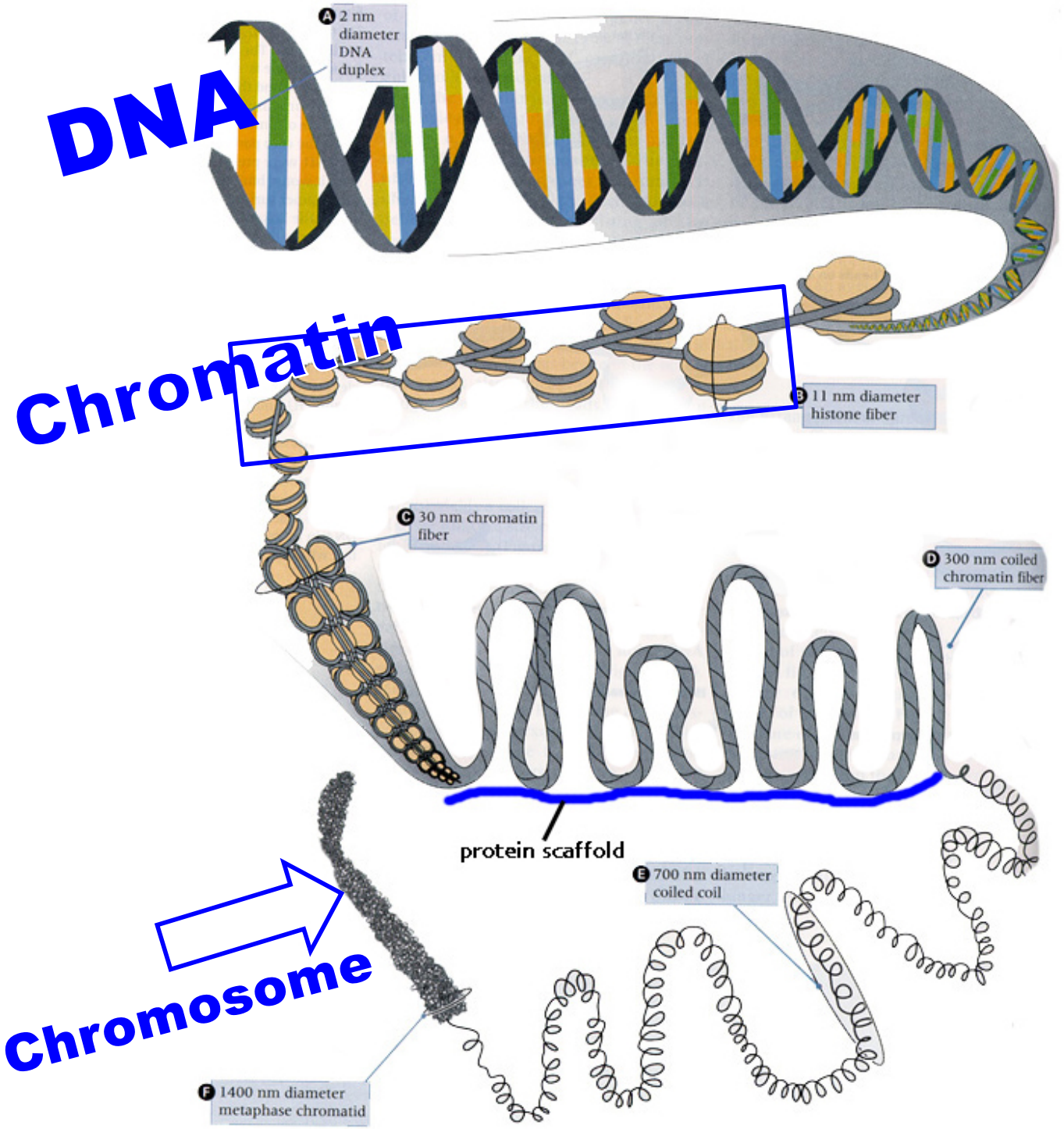


DNA

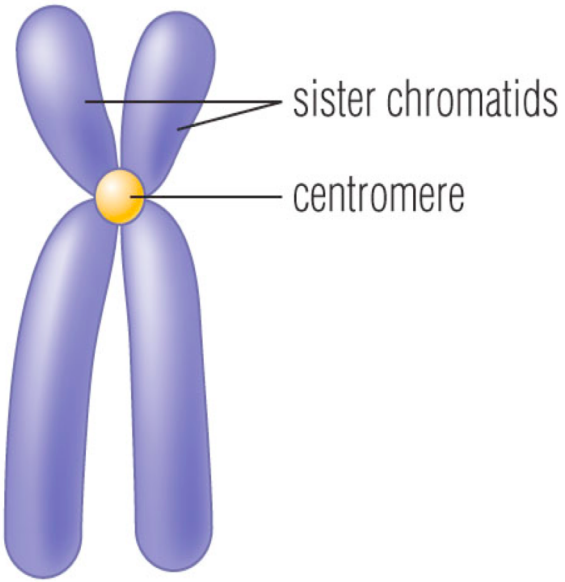
DNA

Chromatin

Chromosome



Chromosomes depicted in this X-shaped form

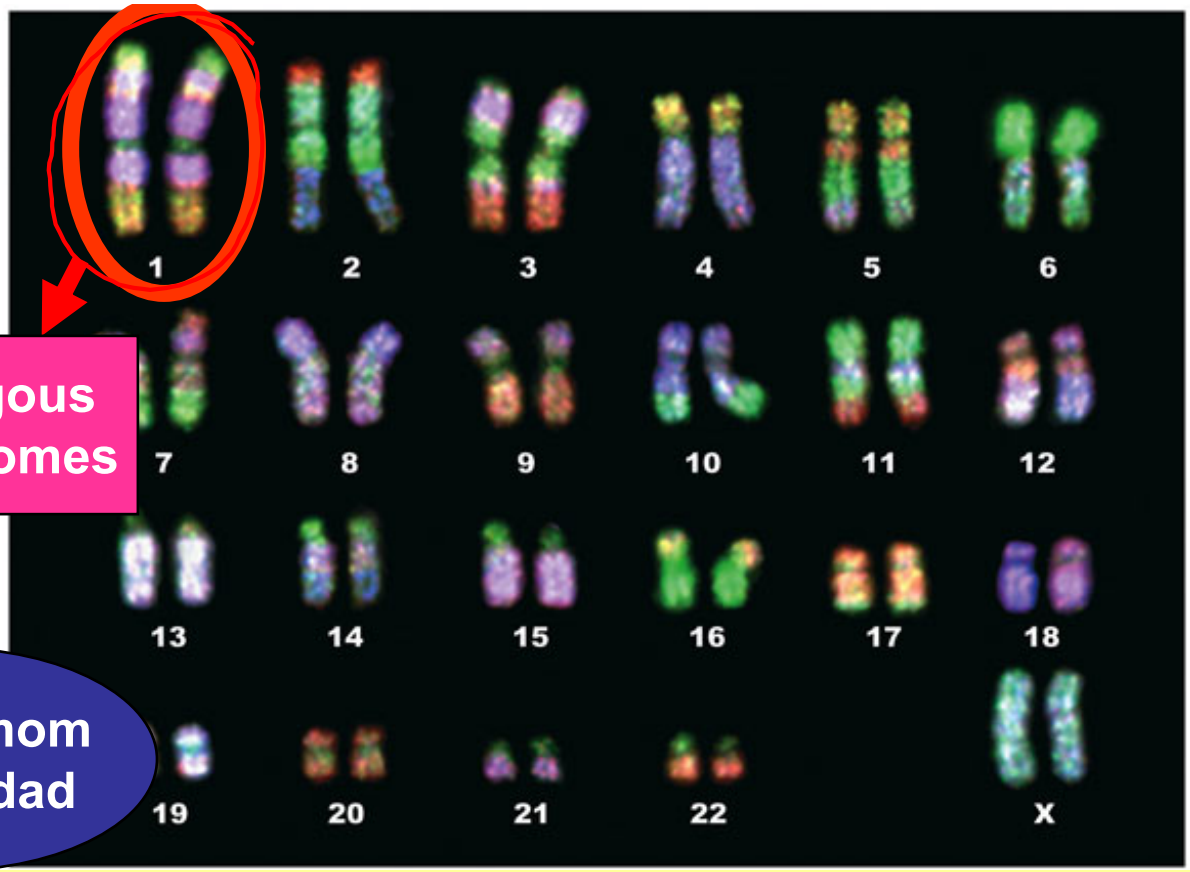


...have already been duplicated in preparation for mitosis (or meiosis).

The two identical copies (sister chromatids) are connected at the centromere.

-DNA is found in chromatin / chromosomes
-Chromosomes = condensed(bundled) chromatin

Chromosomes look like X's only when they are replicated!

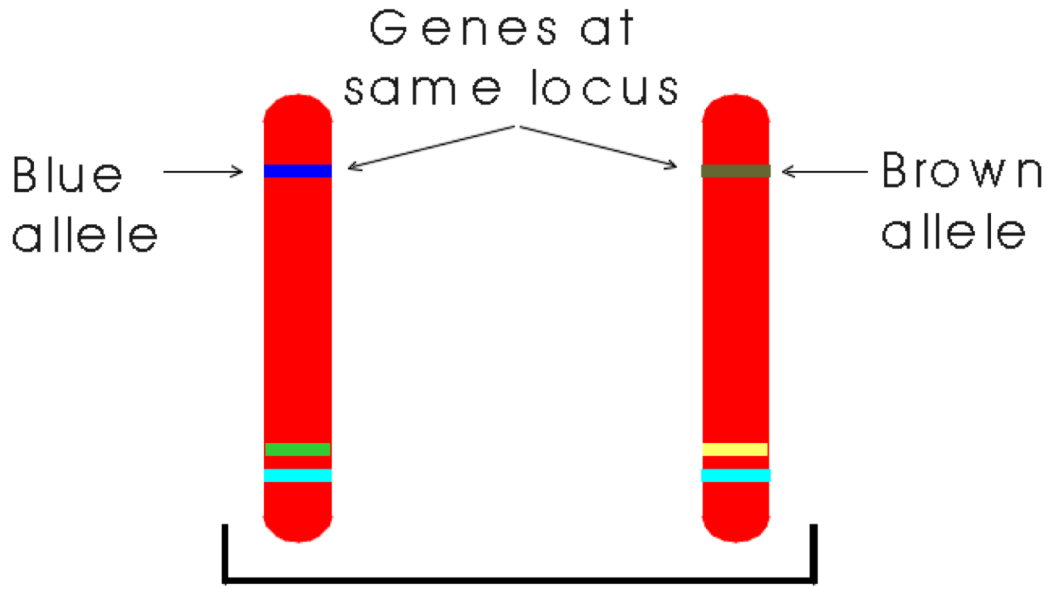


Humans have **46** chromosomes (**23 pairs**).
44 are **autosomes** (not sex controlling).
Autosomes are chromosomes #1-22.
2 are sex chromosomes (# 23 pair)

Females = XX Males = XY

Homologous Chromosomes

<u>Homologous chromosomes</u> carry the same **genes** at the same location or **locus. One from mom and one from dad**



Even though homologous chromosomes look alike they are **NOT IDENTICAL** because they carry different forms or **alleles** of the same gene.

-but essentially they are "talking" about the same thing

Diploid (2n)

DIPLOID is the number of chromosomes IN EACH SET of somatic(body) cells

or in other words

having two complete sets chromosomes in each somatic(body) cell

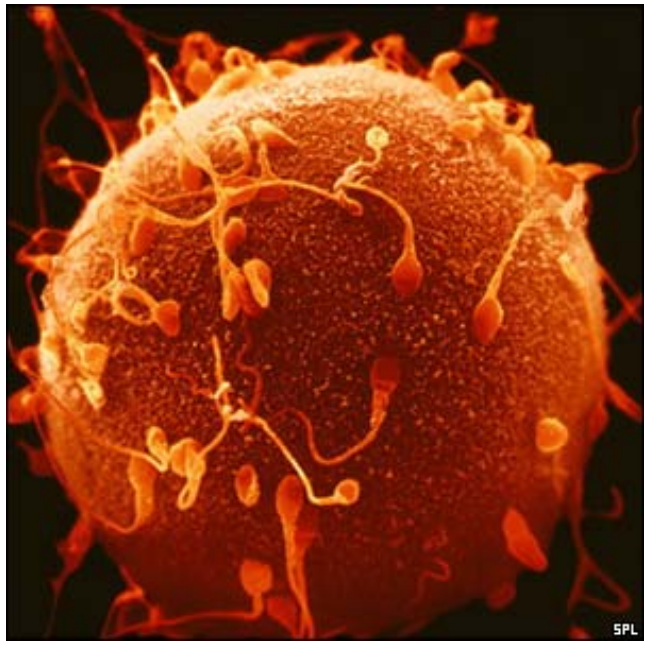
- Humans obtain ½ their chromosomes from their mom**(n)** and ½ from dad **(n)**
- **n + n = 2n**
- In humans,

  -total **diploid number of chromosomes is 46**

2n=46

Haploid (n)

- **<u>In humans</u> the total number of chromosomes in the gametes (egg or sperm) of an organism**
- In humans,
  - sperm have 23 chromosomes
  - eggs have 23 chromosomes
  - Therefore, the **haploid (n) number is 23**



n=23

"n" means…

NUMBER OF UNIQUE CHROMOSOMES

Haploid (n)

- HAPLOID number is NOT ALWAYS the number of chromosomes in gametes

- In humans,
  - sperm have 23 chromosome & eggs have 23 chromosomes
  - the **haploid (n) number is 23….easy peezy…BUT**
- In strawberries they have 56 chromosomes total BUT have 7 in each set with 8 unique sets
  - so their haploid number would be 8 while it has 28 chromosomes in gametes

HAPLOID number is <u>THE NUMBER OF UNIQUE SETS</u> OF CHROMOSMES

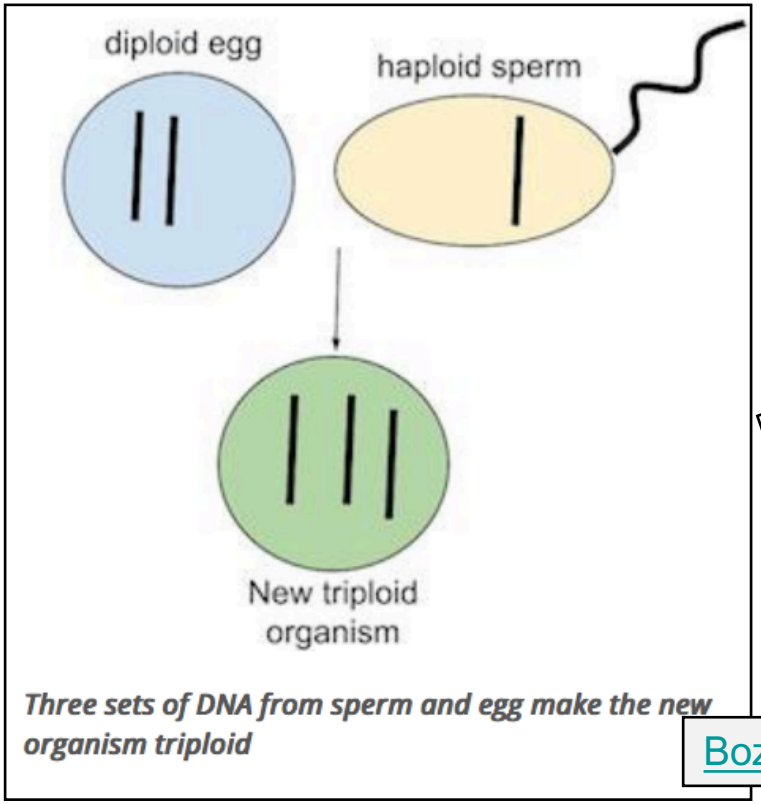
Diploid Numbers Are Unique

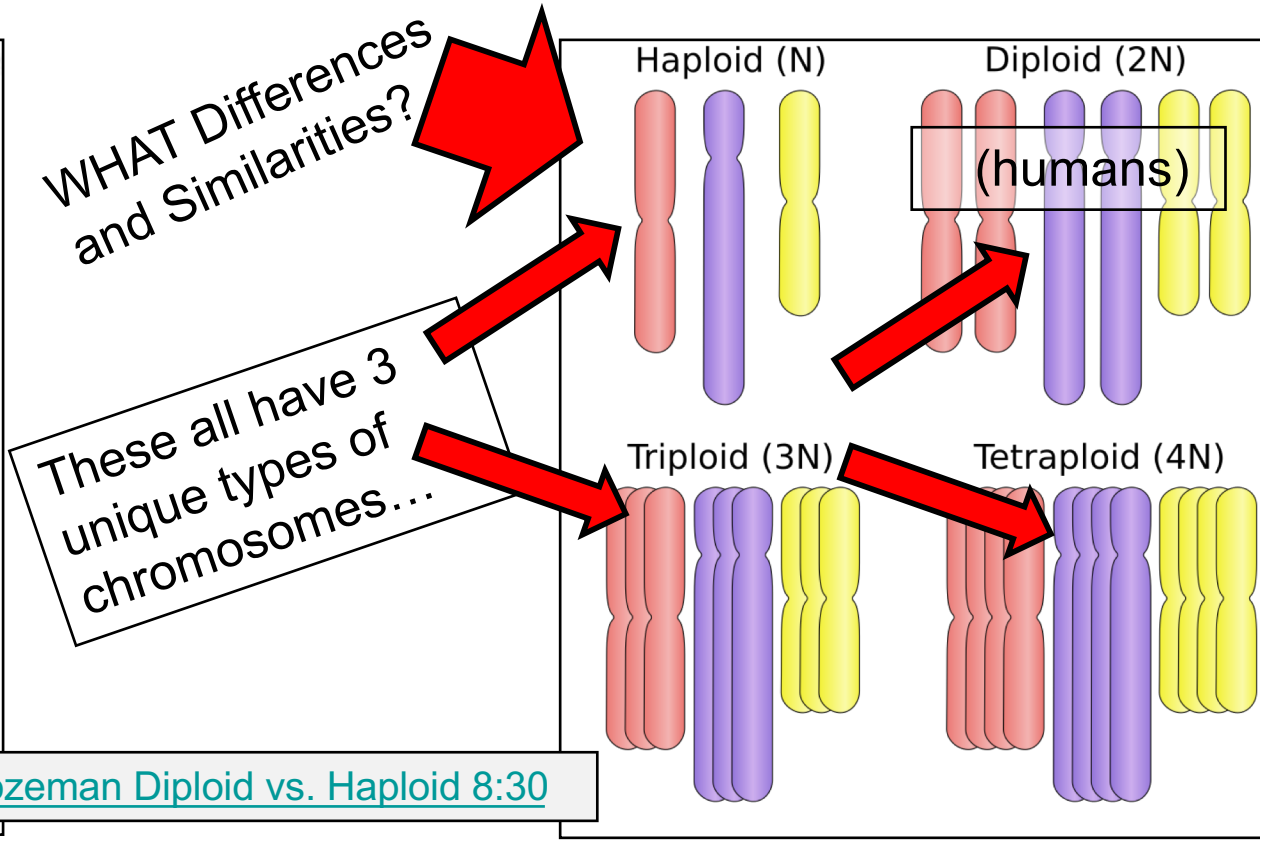
- Just because two organisms may have the same diploid number DOES NOT mean that they are related
- Diploid numbers DO NOT indicate the complexity of an organism!!

Organism	Diploid Number (2N)	Haploid Number (N)
Dog	78	39
Cat	38	
Shrimp		2
Scorpion	256	
Green Ash Tree		23
Human	46	

Polyploidy

- Some organisms are polyploid, meaning that **they have more than 2 chromosomes of a certain "type" of chromosome**
  - Tetraploid = **4n** (4 homologous chromosomes)…4 that are "talking" about the same thing
  - Triploid = **3n** (3 homologous chromosomes)…3 that are "talking" about the same thing
  - Octaploid = **8n** (8 homologous chromosomes)…8 that are "talking" about the same thing



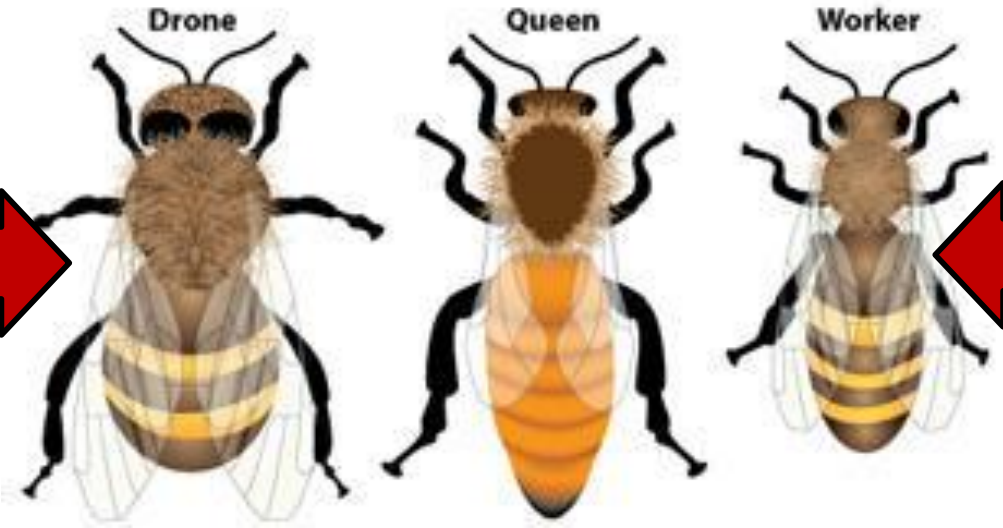


Bozeman Diploid vs. Haploid 8:30

Some interesting numbers:

Haplodiploidy: Having half the chromosomes of the females

(don't need to know this)



Grown from an **unfertilized** egg…

Technically only has a mother!

Grown from a **fertilized** egg…

She can lay eggs but has no sperm to fertilize them with so they would all turn out to be drones.

Ophioglossum reticulatum

Adders Tongue

Highest known chromosome count at

1024

Watch this video on polyploidy…the SCI show

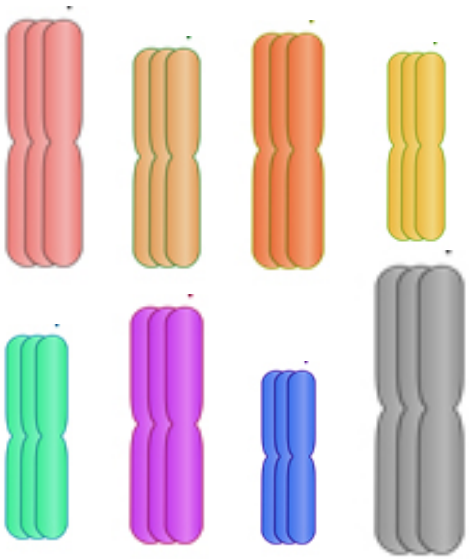
- https://www.youtube.com/watch?v=exA6-wrqOGQ

- Why are mules sterile?

https://www.youtube.com/watch?v=y_zdKJnDXkk

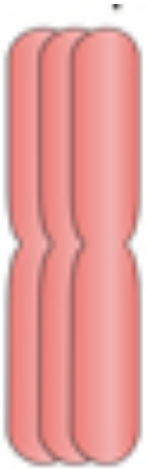
Polyploidy Example

Number of Unique Chromosome Sets (number of sets) (haploid number)



8 SETS

3n = 24



Number of homologous chromosomes in each set (# of similar chromosomes)

Total number of chromosomes per somatic cell

Polyploidy Calculations

- Example 1…

An organism has a ploidy number of 5n,and a haploid number of 3. How many chromosomes does the organism have? we know that n = 3

5 (chromosomes in each set). X 3 (number of sets) = **15** total

5n = 15

Example 2…

An organism has a haploid number of 6 and 30 chromosomes total. What is the ploidy number?

we know that n = 6

we know that total # = 30

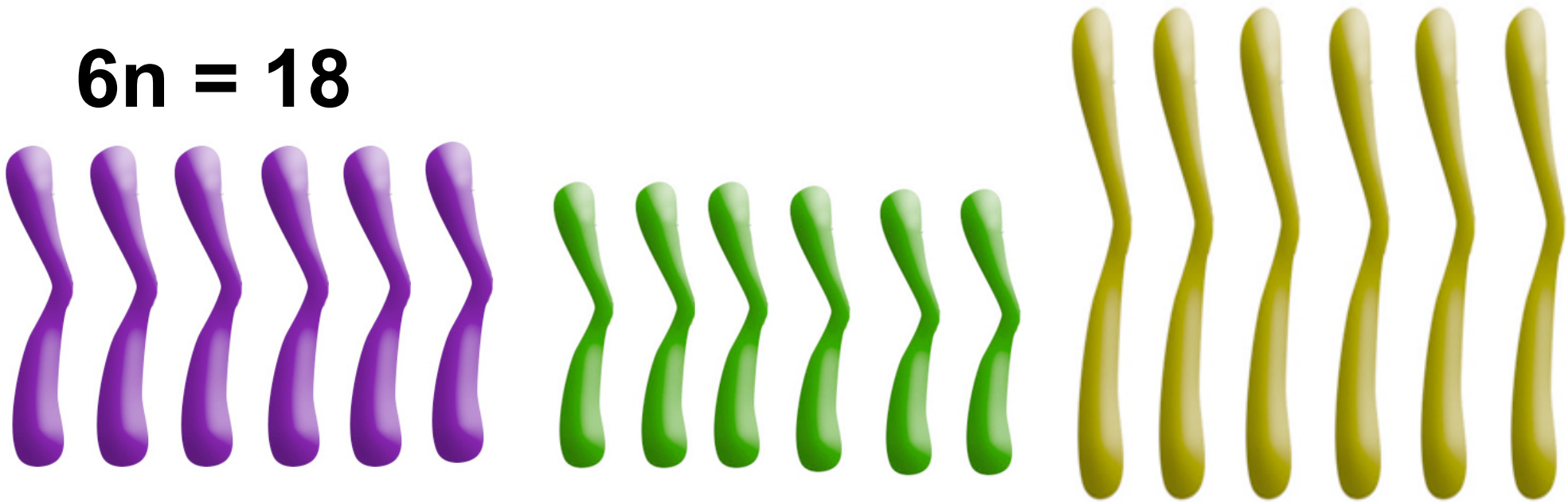
30 (total chromosomes) / 6 (number of sets) = **5n** ploidy number

5n = 30

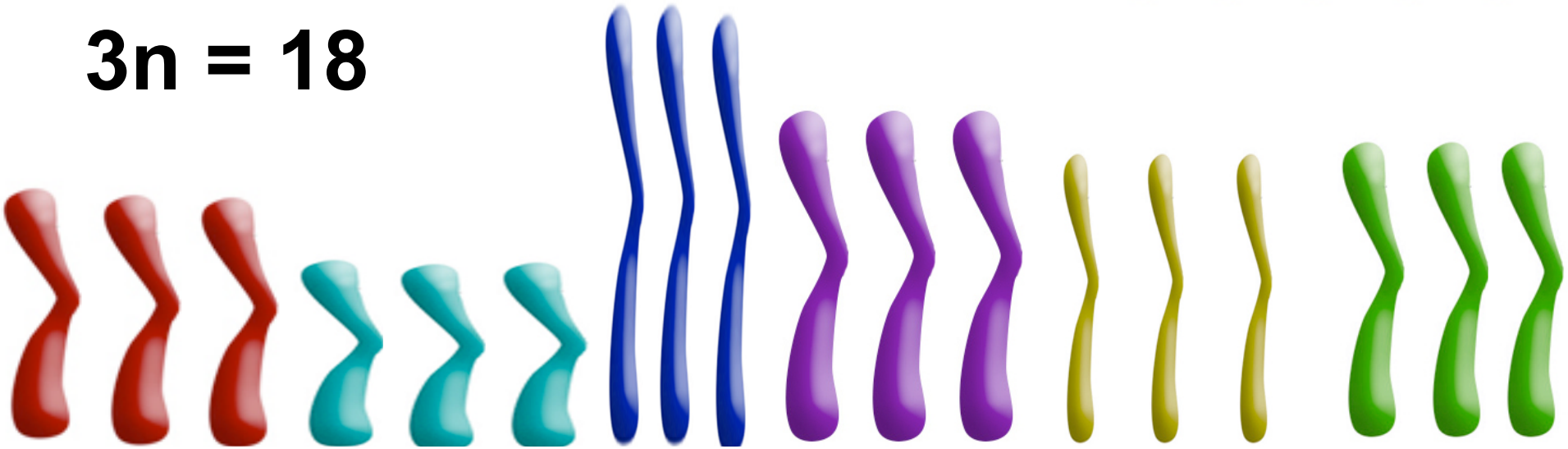
Polyploidy examples

Draw unique chromosomes to represent the following..

6n = 18



3n = 18



Polyploidy examples

PLOIDY = number of a chromosomes in a "set"

(eg) 4n means… 4 similar chromosomes that are "talking" about the same things like hair colour, skin color, etc

Organism	Haploid (n)	Chromosome number	Ploidy
Human	23	46	2n
Oats	7	42	6n
Peanut	10	40	4n
Sugar Cane	10	80	8n
Potato	12	48	4n
Cotton	13	52	4n
Apple	17	51	3n

The case of the banana

- Tetraploid + Diploid = triploid

Organisms with odd number of chromosomes cannot reproduce sexually

-so you get good bananas without seeds

Wild banana
(big seeds but edible)

+

Wild banana
(smaller seeds but not good eating)

=

Polyploidy is all around us

Have you ever wondered why there is such a thing as "seedless watermelons"? https://www.youtube.com/watch?v=yvy1xA2RwxM

Normally

diploid female and Diploid male = diploid offsprig

+

=

diploid **female** 2n=22
(egg will have 11 chromosomes)
(one set or "n")

diploid **male** 2n=22
(pollen will have 11 chromosomes)
(one set or "n")

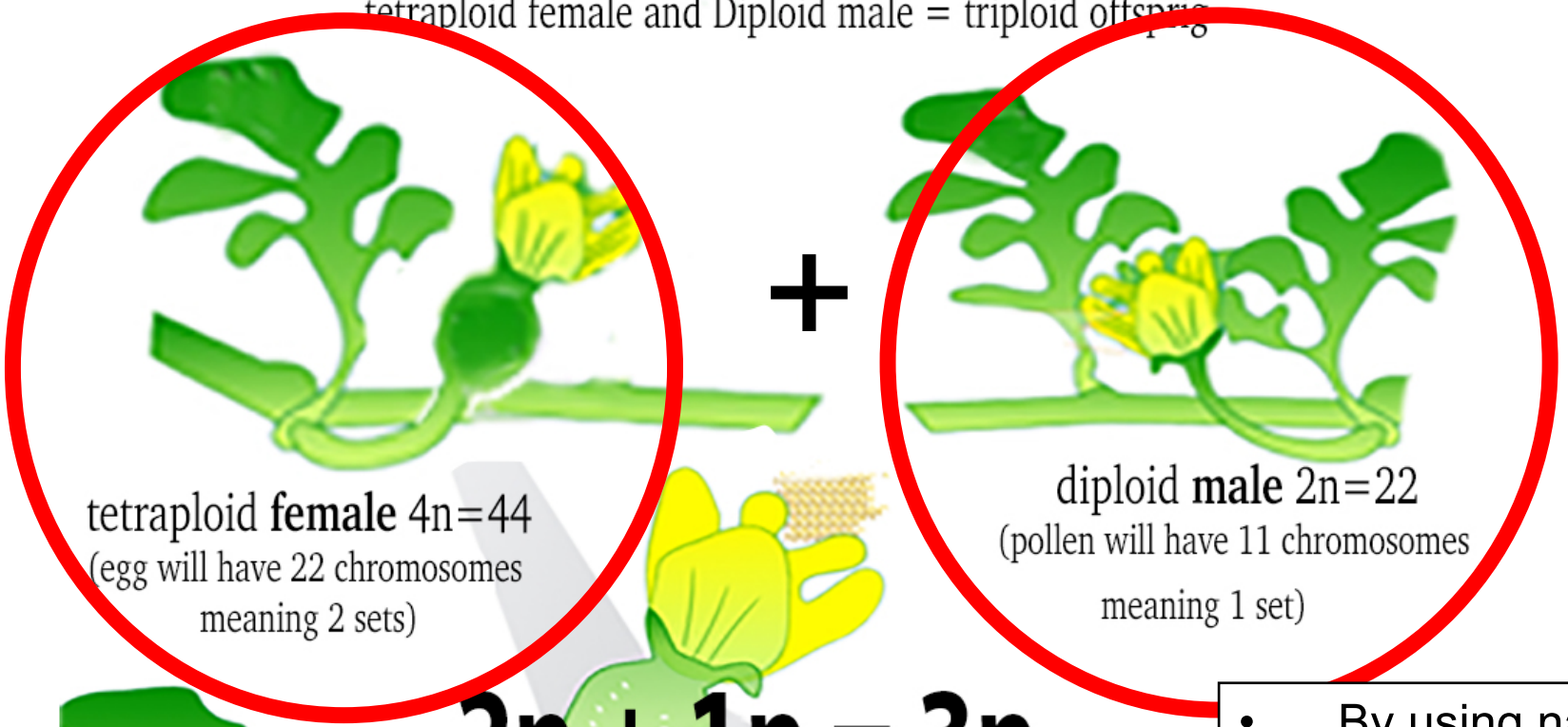
seeded watermelon offspring 2n=22

n + n = 2n

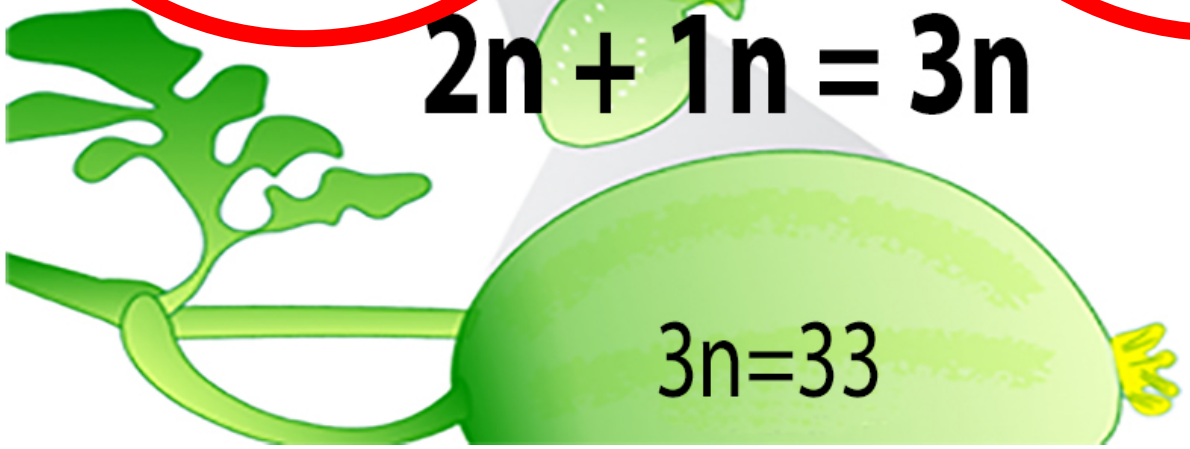
(egg gamete) (sperm gamete) (full # of chromosomes)

Polyploid example created by humans

tetraploid female and Diploid male = triploid offspring



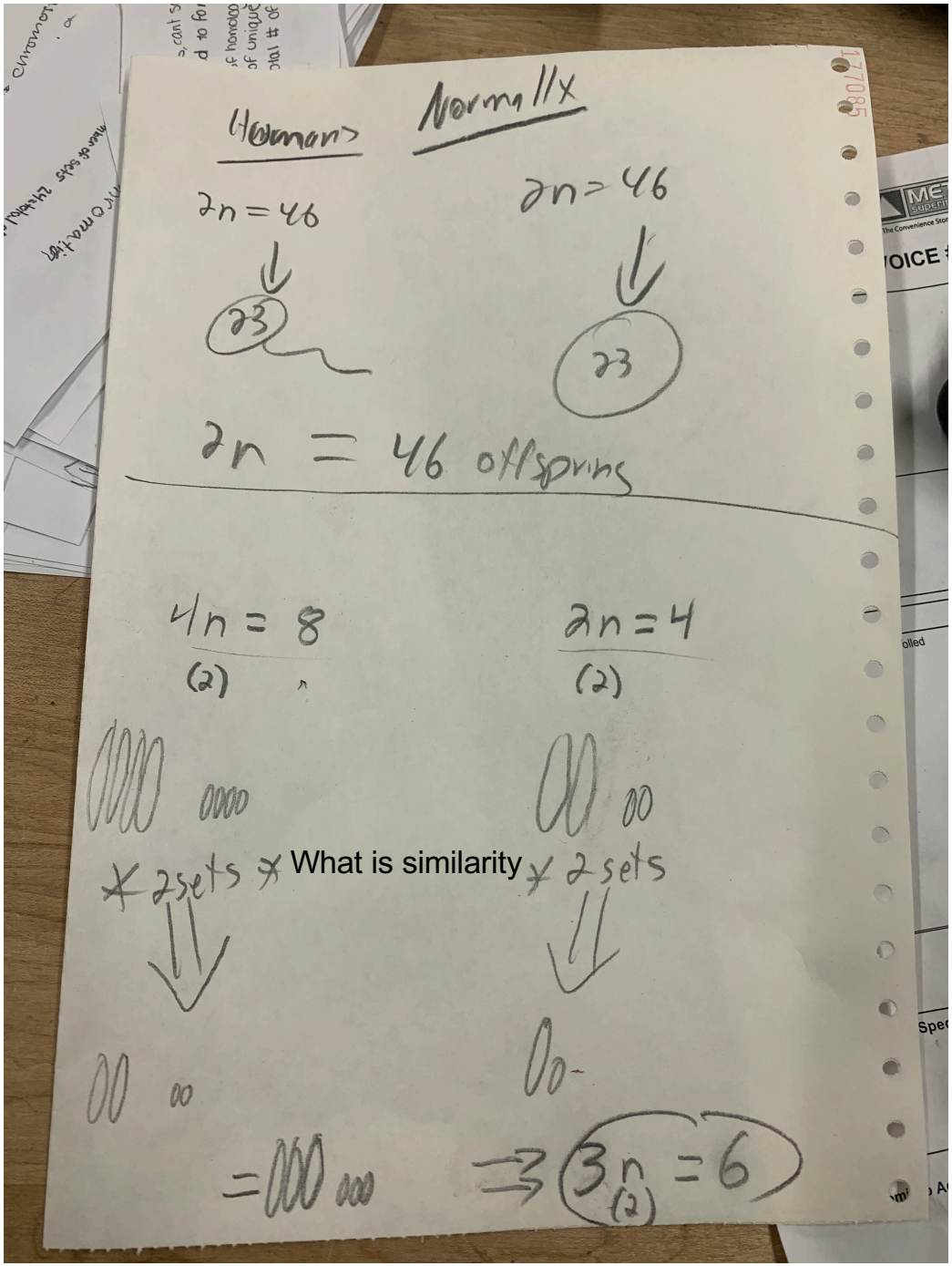
2n + 1n = 3n



These seeds are then planted to create seedless watermelons.

- . By using natural chemicals, plant breeders can double the number of chromosomes in a plant. Then, the **tetraploid** (four sets of chromosomes) watermelons are crossed with a standard diploid watermelon to make **triploid** watermelon seeds.

Do with kids on sheet



Human Example

Male
2n=46

Female
2n=46

Gamete

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Polyploid Example

Male
4n=8

Female
2n=4

draw parent chromosomes

draw parent gamete chromosomes

draw added up Chromosomes in zygote

Polyploid Example 2

a) Lets say an organism after modification is 7n=84.
b) If one of its parents is tetraploid, how many chromosomes does it have?

FIRST: find “n” in the 7n=84

n = 12

SECOND: apply that to the tetraploid…

4n = ?
4(12) = ?
4(12) = 48

So the tetraploid parent has 48 chromosomes

Ploidy REVIEW

Haploid = "n" or number of distinct sets of chromosomes

(eg) as humans we have 23 distinct chromosomes

Diploid = "2n" or we have 2 in every distinct set of chromosomes

(eg) we have 23 sets(distinct sets) of chromosomes. **2 in each set**

Polyploid = "3n, 4n, 5n, etc." or **3 chromosomes** in each distinct set,
4 chromosomes in each distinct set,
5 chromosomes in each distinct set,

QUESTION!! What if you had a octaploid mama and the child turned out be a hexaploid. What is the ploidy of the dad?

8n + **?** = 6n.....4n + **2n** = 6n

…therefore Dad is 4n

QUESTION!!What if you had a hexaploidy mom and a tetraploidy dad, what would your ploidy be?

6n + 4n = ??.....**3n + 2n = 5n**