

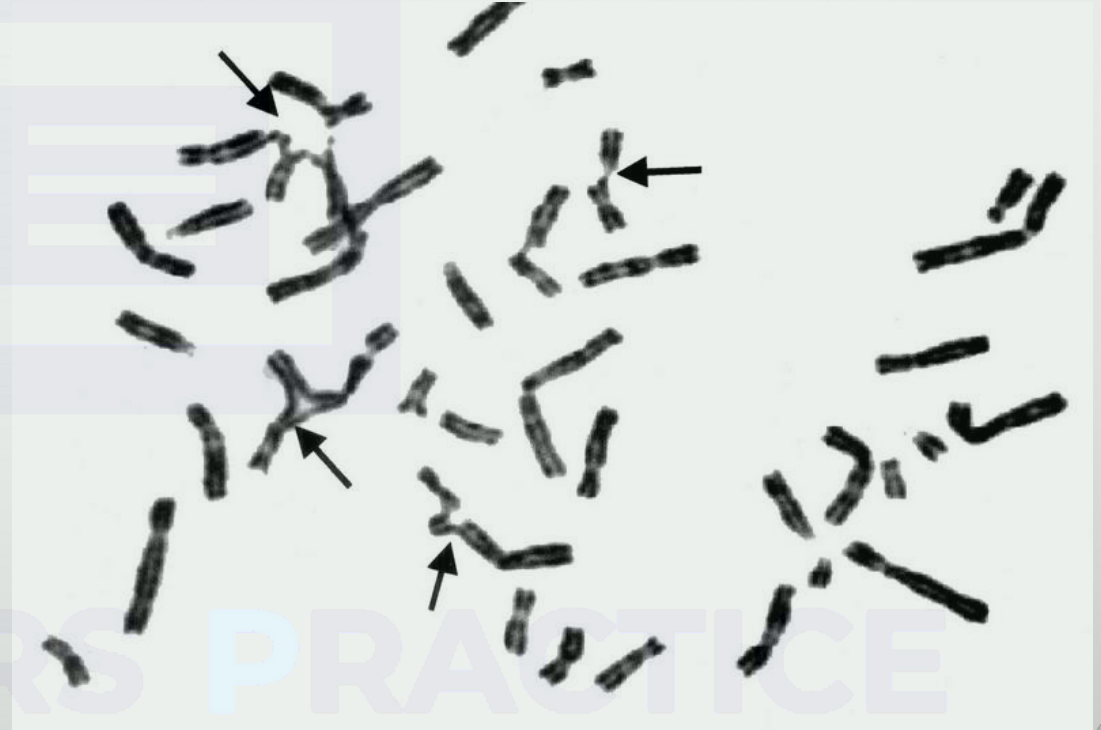
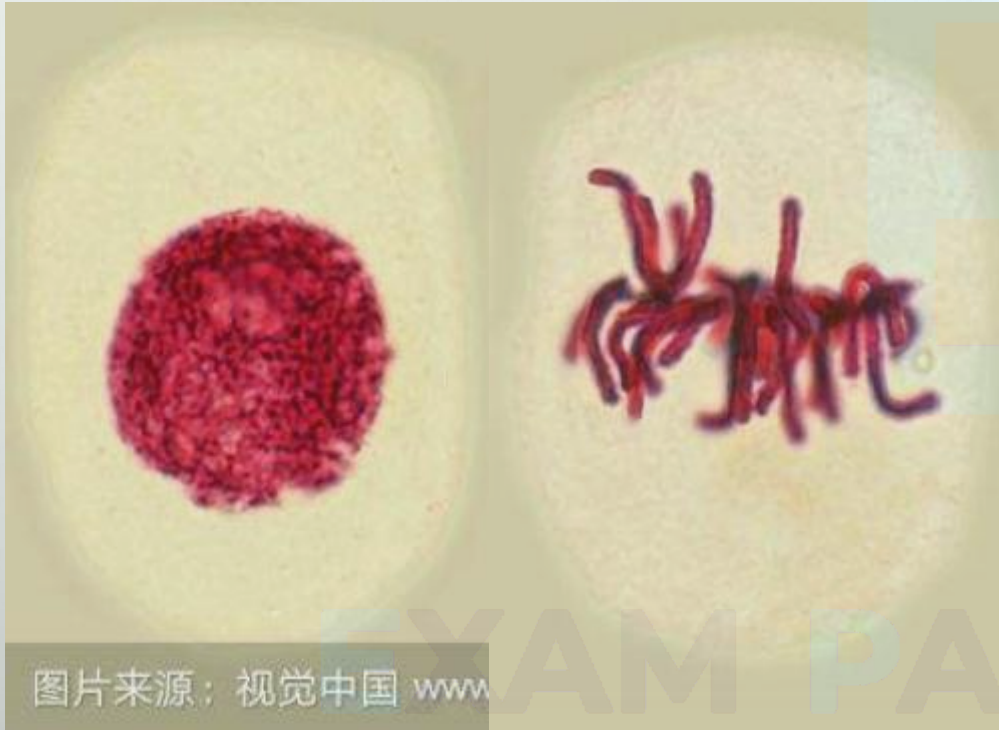
# Inheritance



inheritance 遗传

# Inheritance

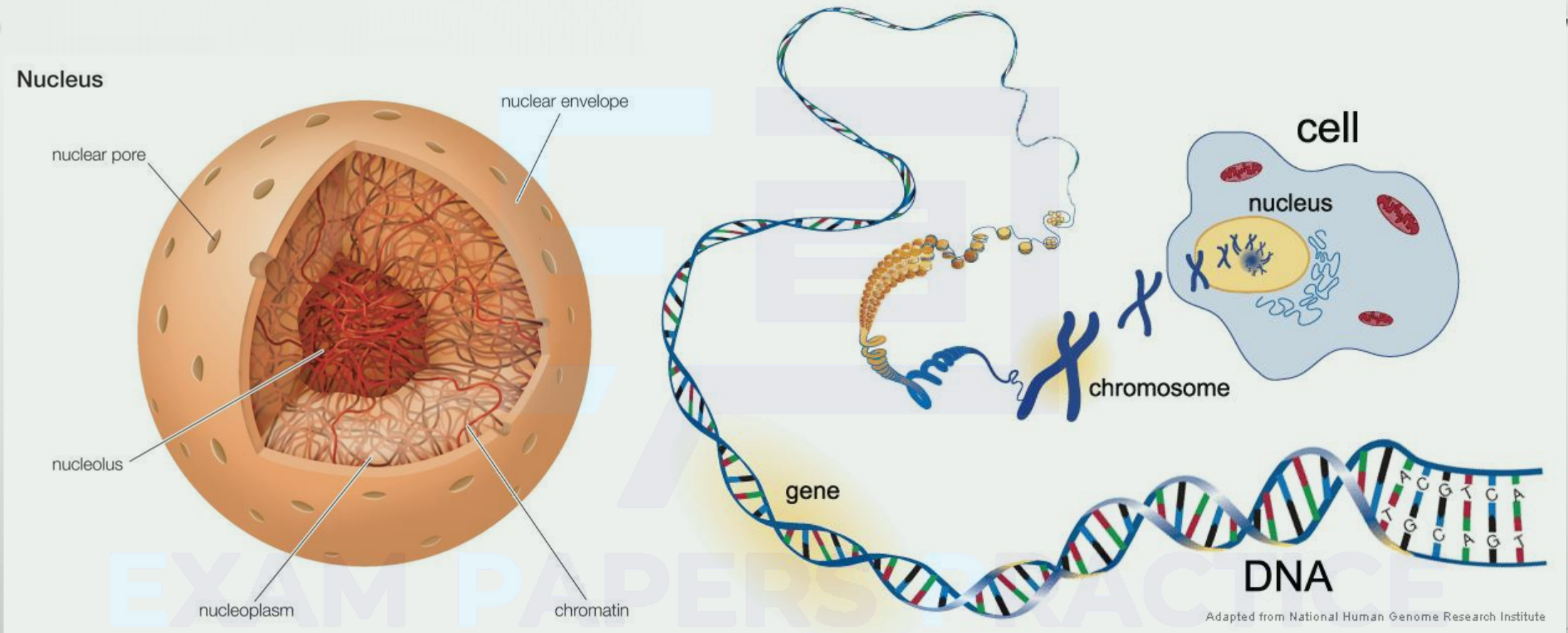
## chromosomes



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# Inheritance

## chromosomes



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### Chromosome

a thread-like structure of DNA, carrying genetic information in the form of genes.

genetic information  
遗传信息

For more help, please visit [www.exampaperspractice.co.uk](http://www.exampaperspractice.co.uk)

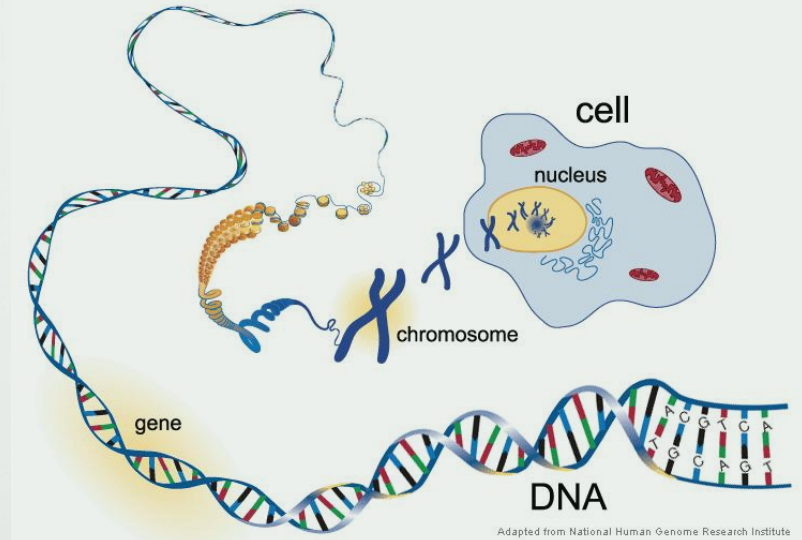
# Inheritance

## chromosomes

### Gene

A length of DNA that codes for a protein

Genes determine all sorts of things about you



| Species         | <i>Escherichia coli</i>                                                                        | <i>Gallus gallus</i>                                                                          | <i>Homo sapiens</i>                                                                           | <i>Daphnia pulex</i>                                                                               | <i>Oryza sativa</i>                                                                          |
|-----------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Number of Genes | ~4,200                                                                                         | ~17,000                                                                                       | ~21,000                                                                                       | ~31,000                                                                                            | ~38,000                                                                                      |
| Common Name     | <br>Bacteria | <br>Chicken | <br>Human | <br>Water flea | <br>Rice |



# Inheritance

Number of chromosomes of humans' body cells  
46

**Diploid nucleus:** a nucleus containing two set of unpaired chromosomes

Sperm, egg  
23

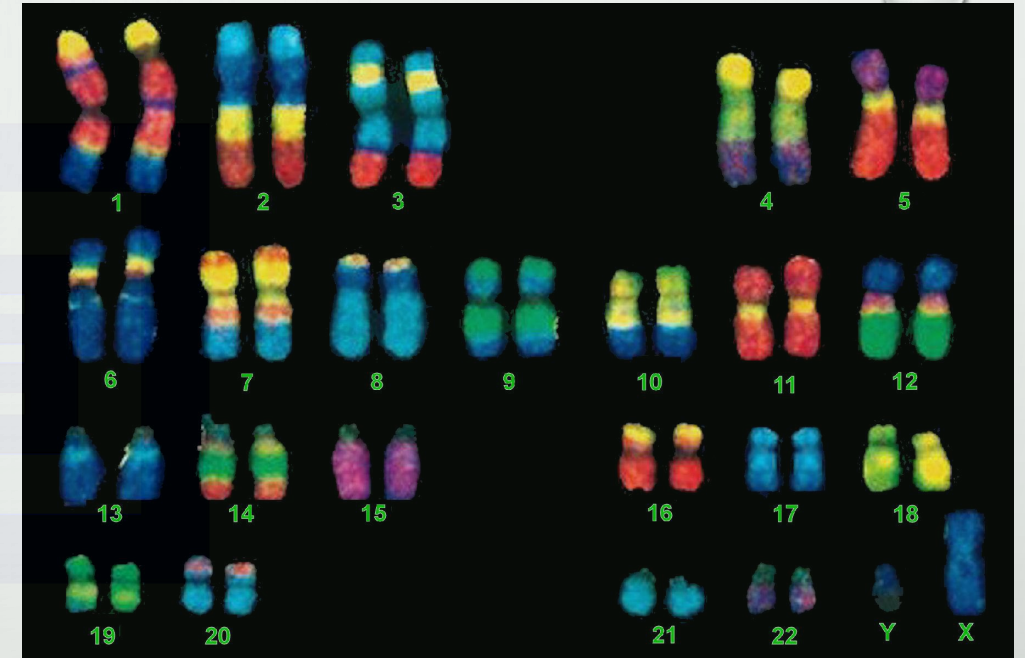
**Haploid nucleus:** a nucleus containing a single set of chromosomes

## Homologous chromosomes

The two chromosomes of a pair,  
One from father, another from mother

**homologous chromosome** 同源染色体  
**nonhomologous chromosome** 非同源染色体

## chromosomes



| Species      | <i>Parascaris equorum</i>                                                                          | <i>Oryza sativa</i>                                                                           | <i>Homo sapiens</i>                                                                            | <i>Pan troglodytes</i>                                                                              | <i>Canis familiaris</i>                                                                      |
|--------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Chromosome # | 4                                                                                                  | 24                                                                                            | 46                                                                                             | 48                                                                                                  | 78                                                                                           |
| Common Name  | <br>Roundworm | <br>Rice | <br>Human | <br>Chimpanzee | <br>Dog |

# Inheritance

## Mitosis

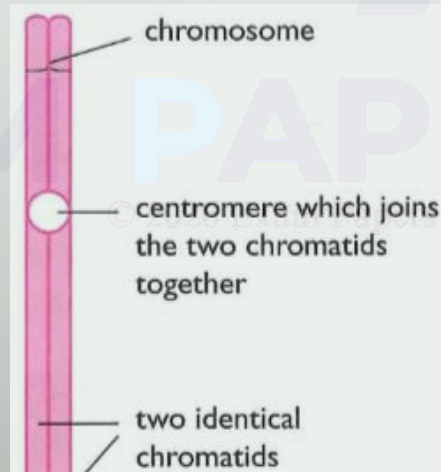
Nuclear division giving rise to cells that are genetically different (DNA duplication)

## chromatid

Two identical threads join together in one chromosome after duplication

## Centromere

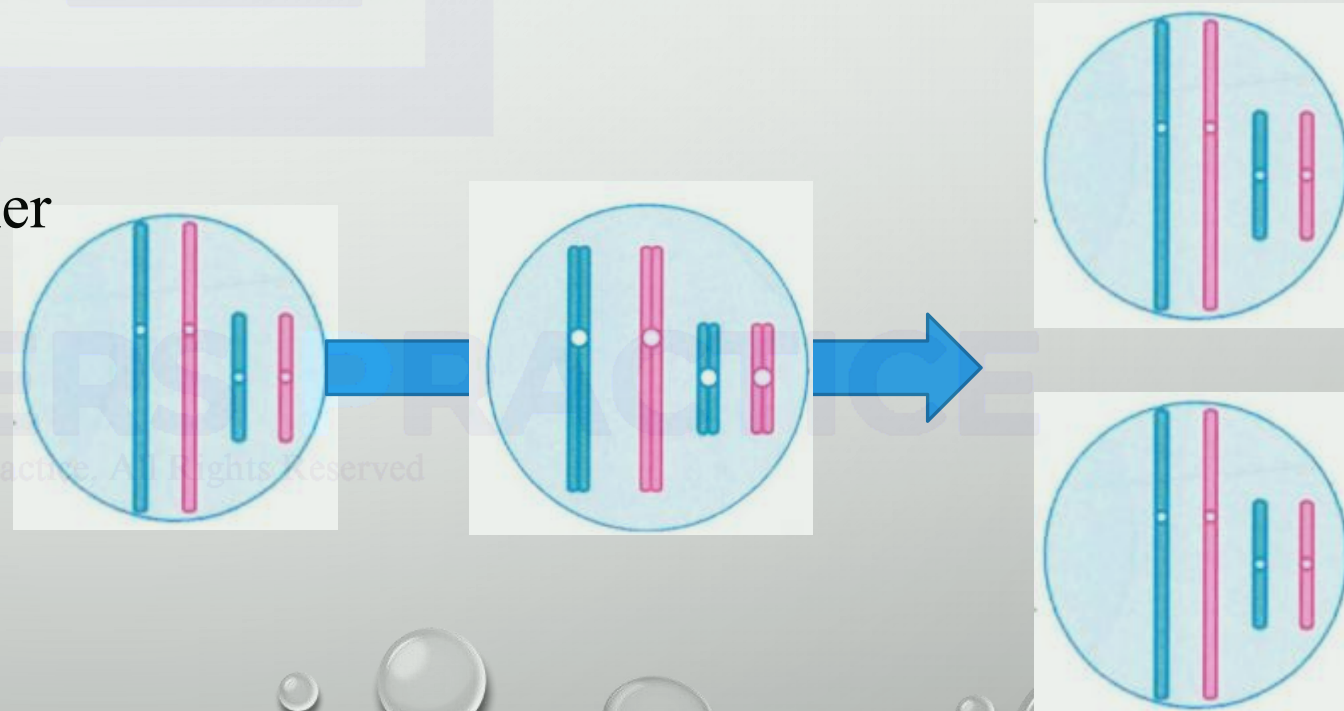
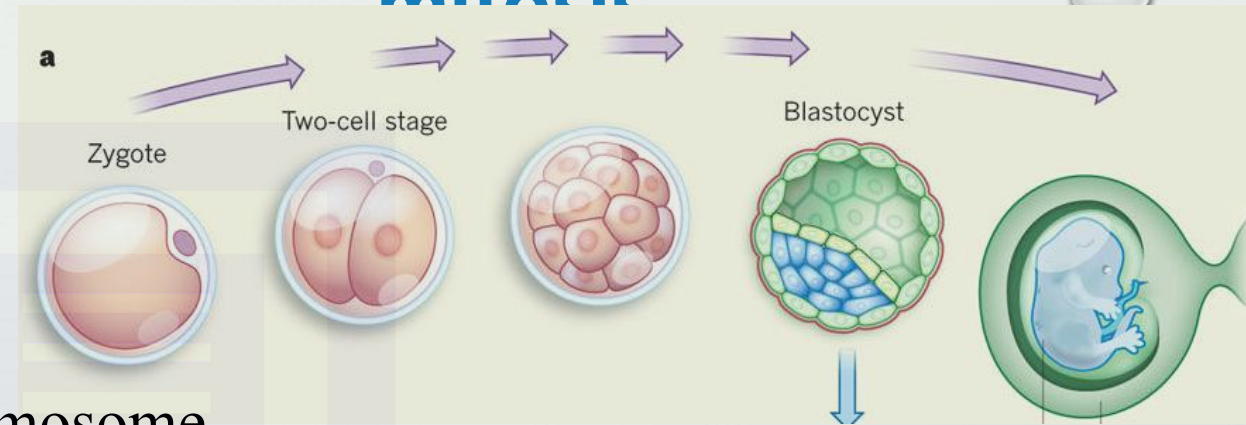
The point where two chromatid held together



chromatid 染色单体  
centromere 中心体  
duplication 复制

# Cell division—

## mitosis



# Inheritance

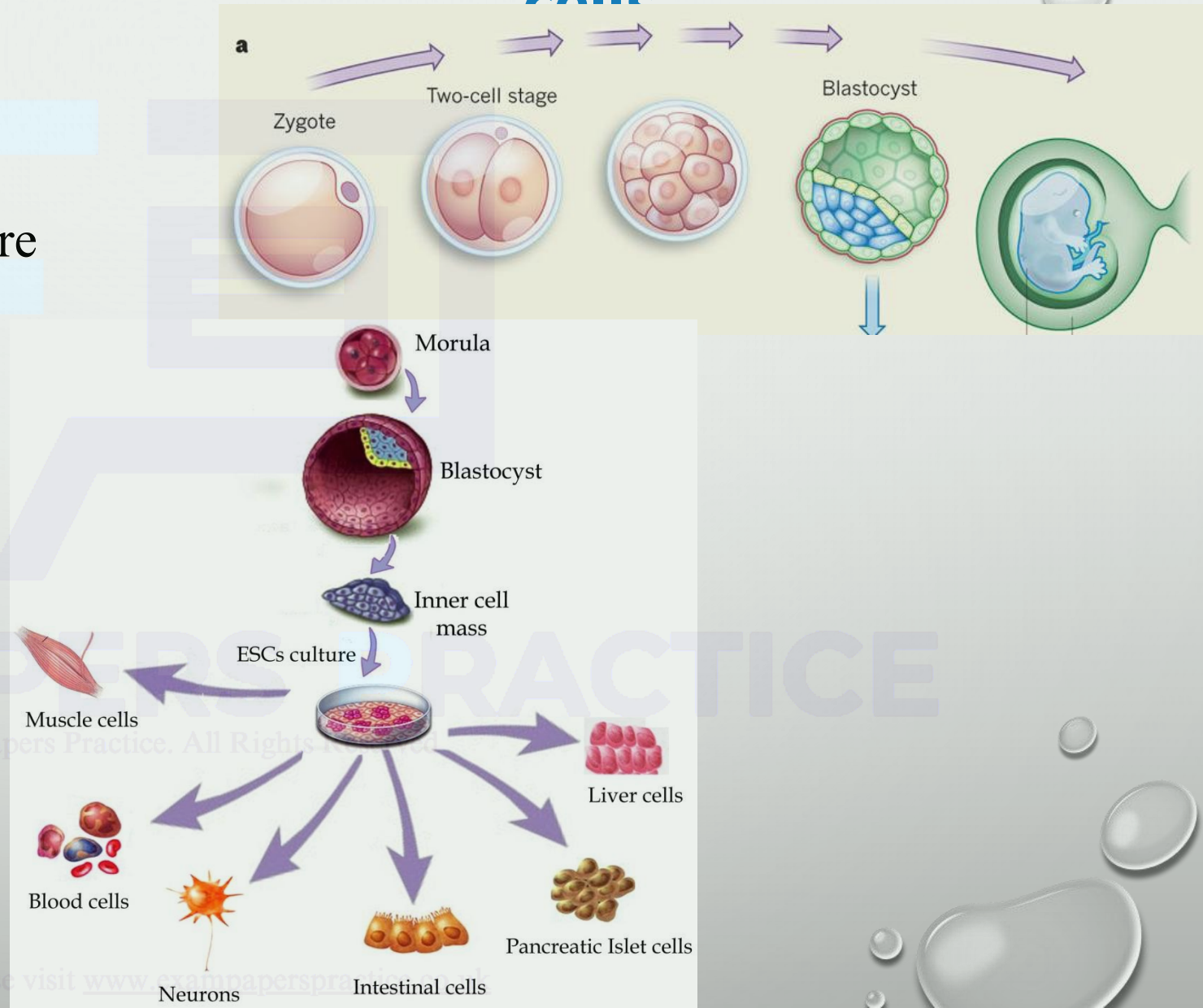
## Cell division—stem cells

### embryonic stem cells

The cells in the **very early embryo**, before they start to become different kinds of cells.

they are able to produce every kind of specialized cell in the body.

embryonic stem cells 胚胎干细胞  
differentiate 分化  
differentiation 分化



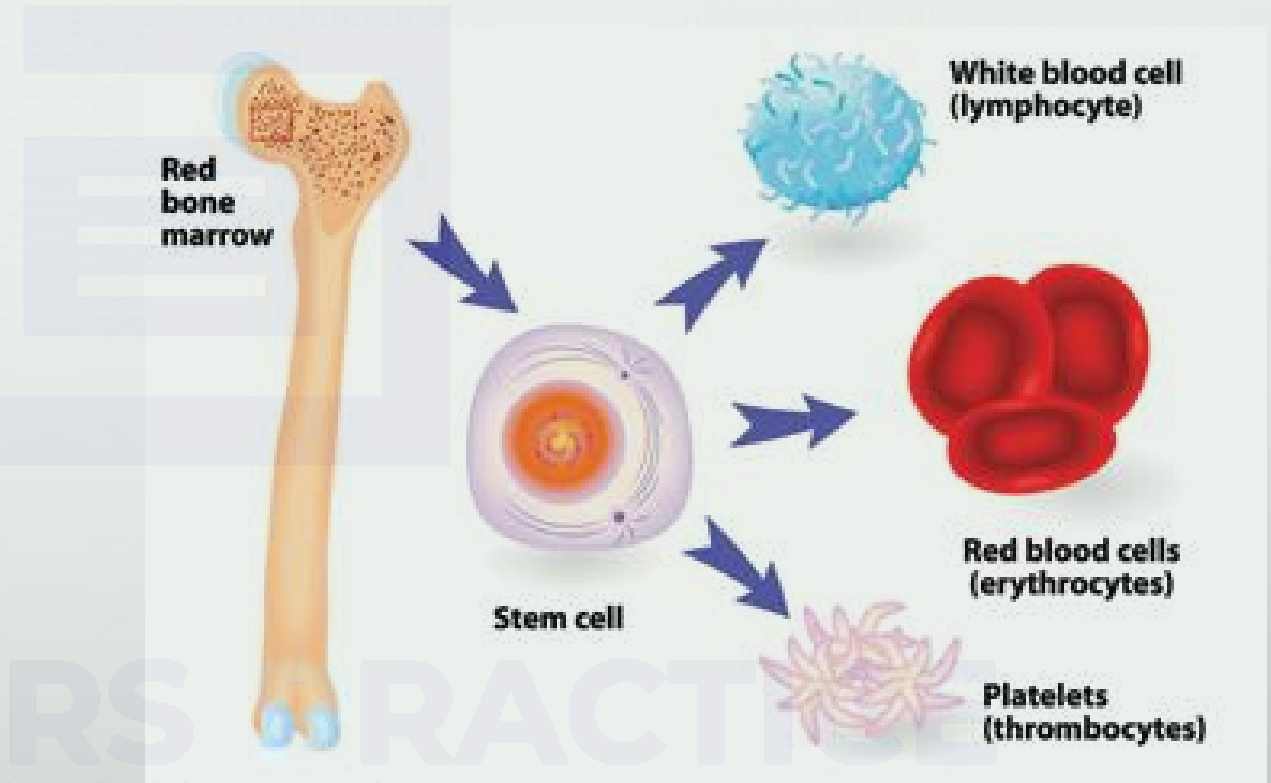
# Inheritance

## Cell division—stem cells

### adult stem cells

In adult body, some cells still can divide to produce different types cells, but the range of different cells they can produced is **limited**.

e.g. **stem cell in bone marrow**



adult stem cells 胚胎干细胞  
bone marrow 骨髓



# Inheritance

## meiosis

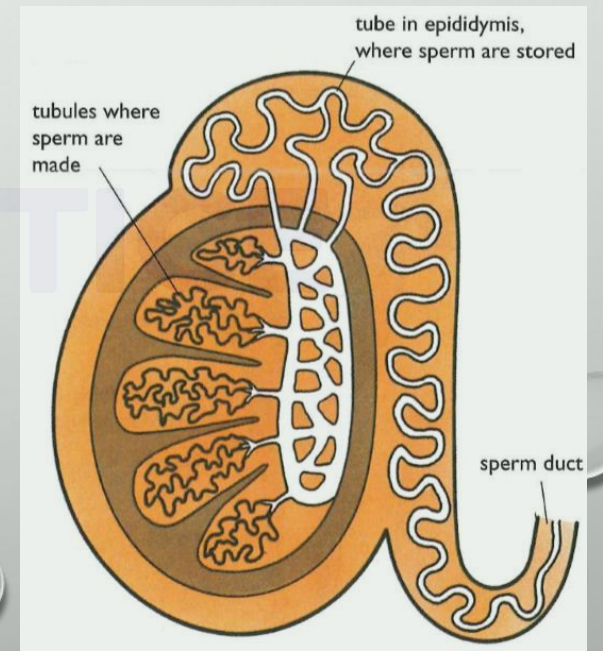
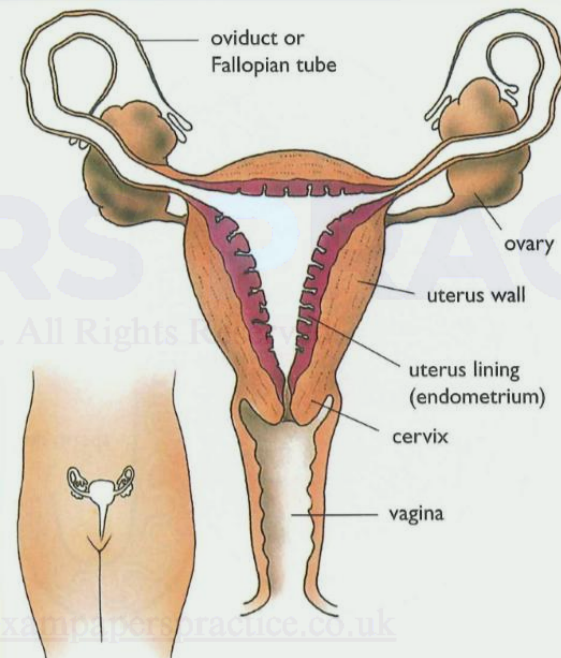
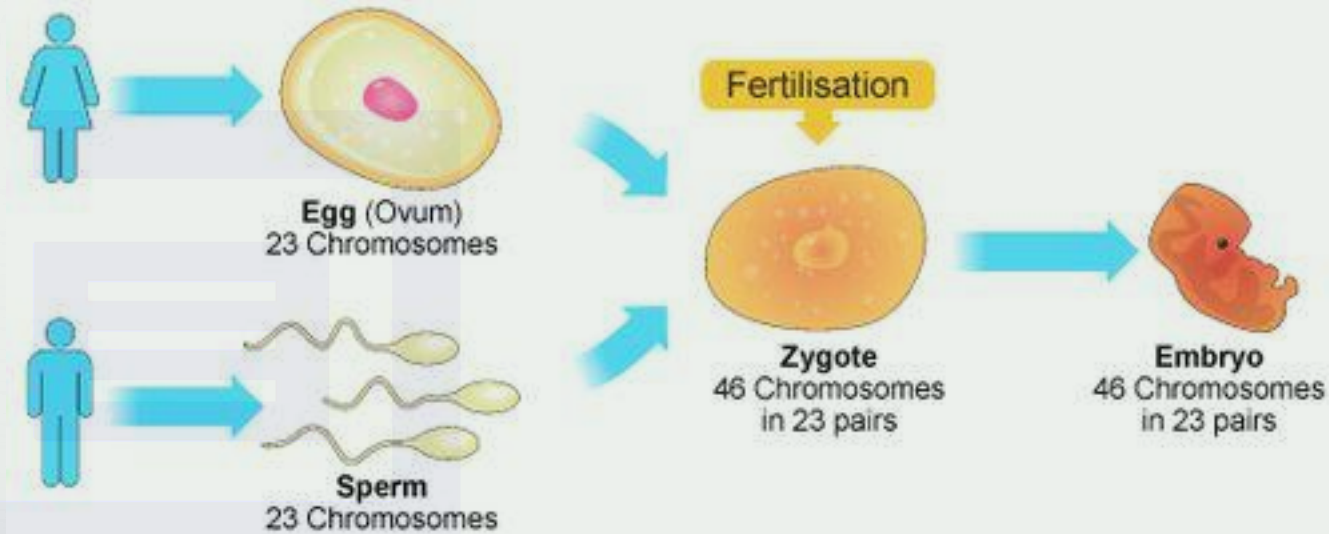
Reduction division in which the chromosome number is halved from diploid to haploid, resulting in genetically different cells

First division

Second division

meiosis 減数分裂

## Cell division— meiosis



Reasons of genetic variation produced by meiosis

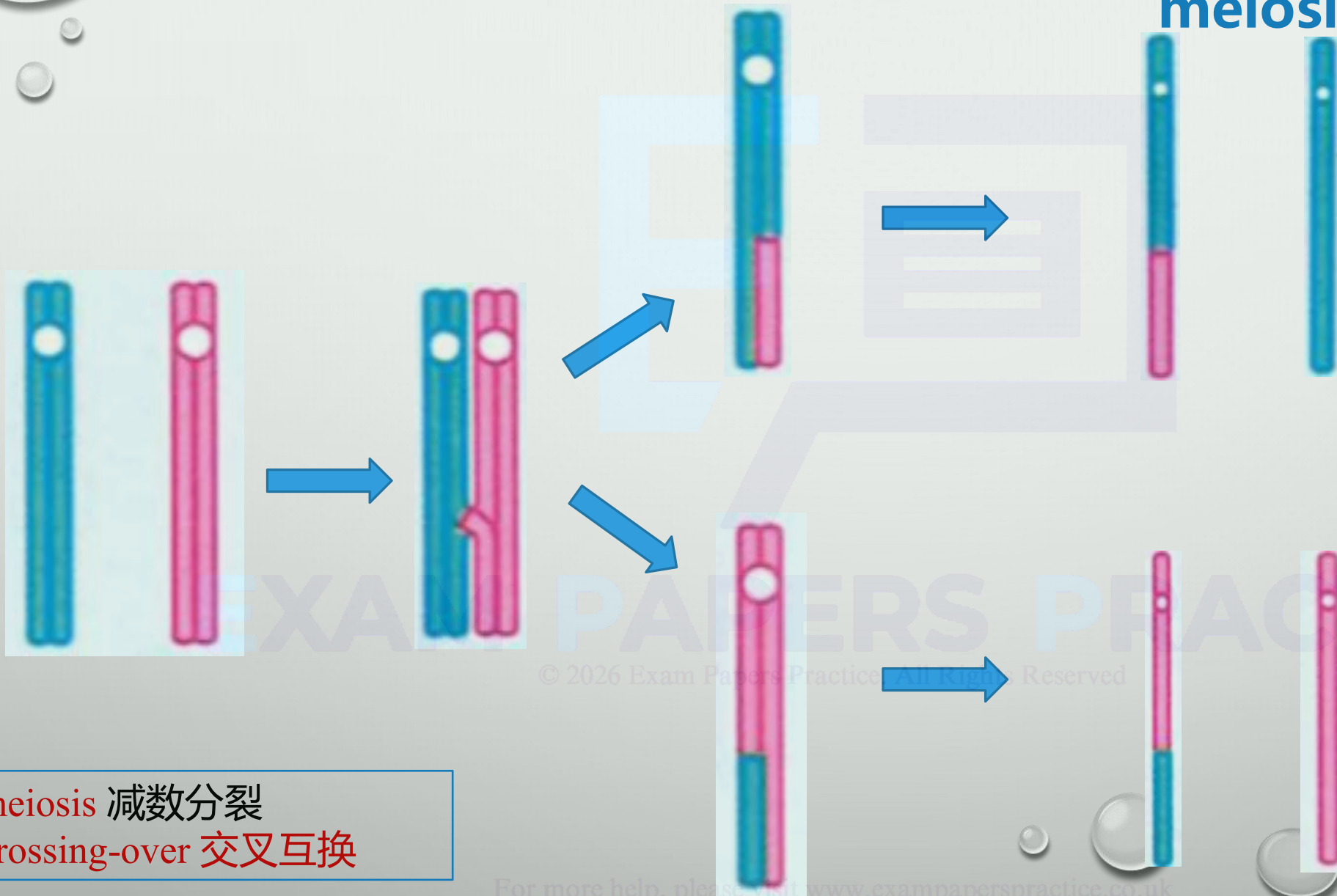
- ♦ different combination of nonhomologous chromosomes

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# Inheritance

## Cell division— meiosis



meiosis 減数分裂  
crossing-over 交叉互换

# Inheritance

## First division – meiosis I

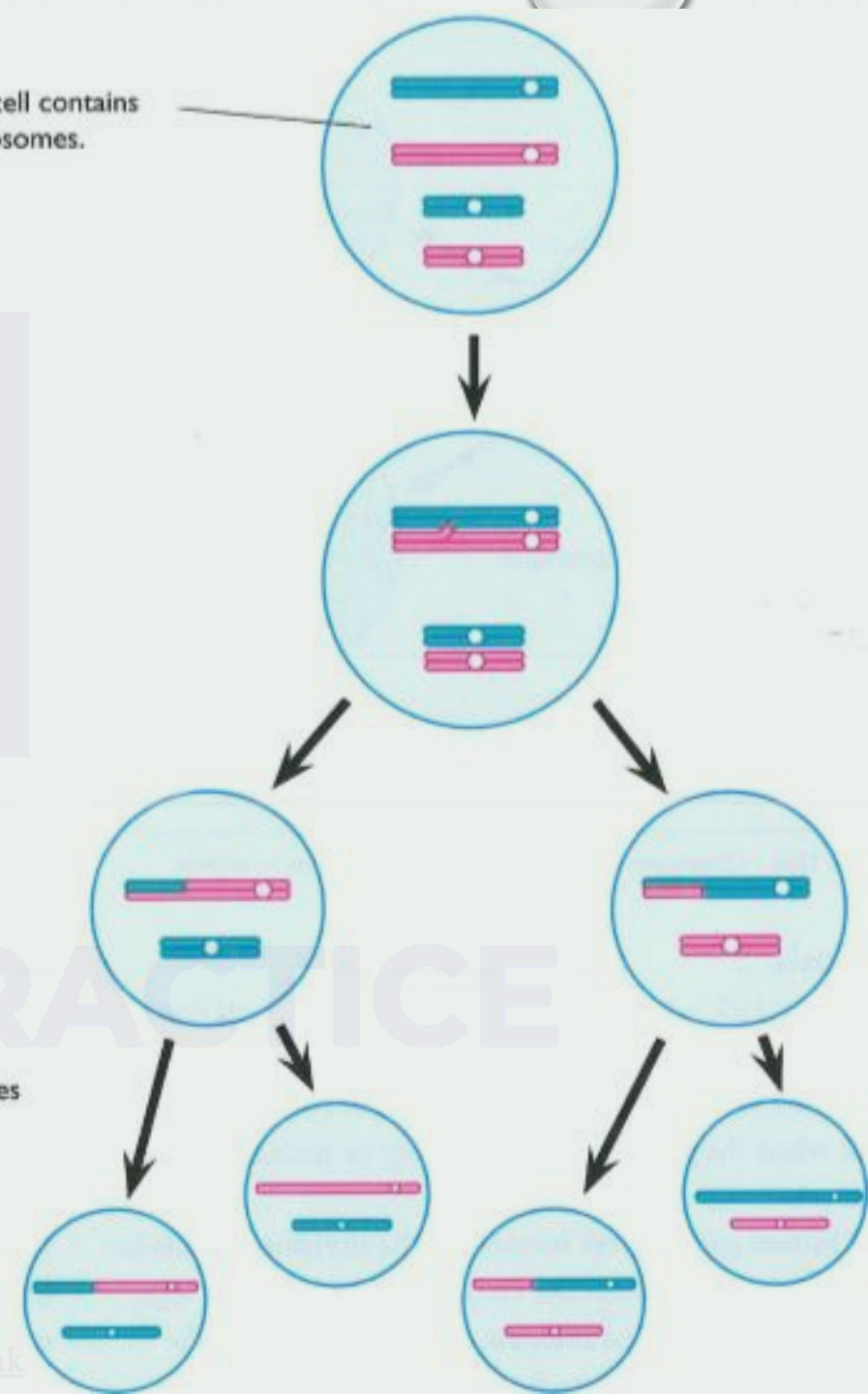
The parent cell contains four chromosomes.

Homologous chromosomes pair together. Crossing over takes place.

Homologous chromosomes separate. One from each pair goes into each daughter cell.

## Second division – meiosis II

Each chromosome separates into two chromatids. One chromatid of each kind goes into each daughter cell.



### Reasons of genetic variation produced by meiosis

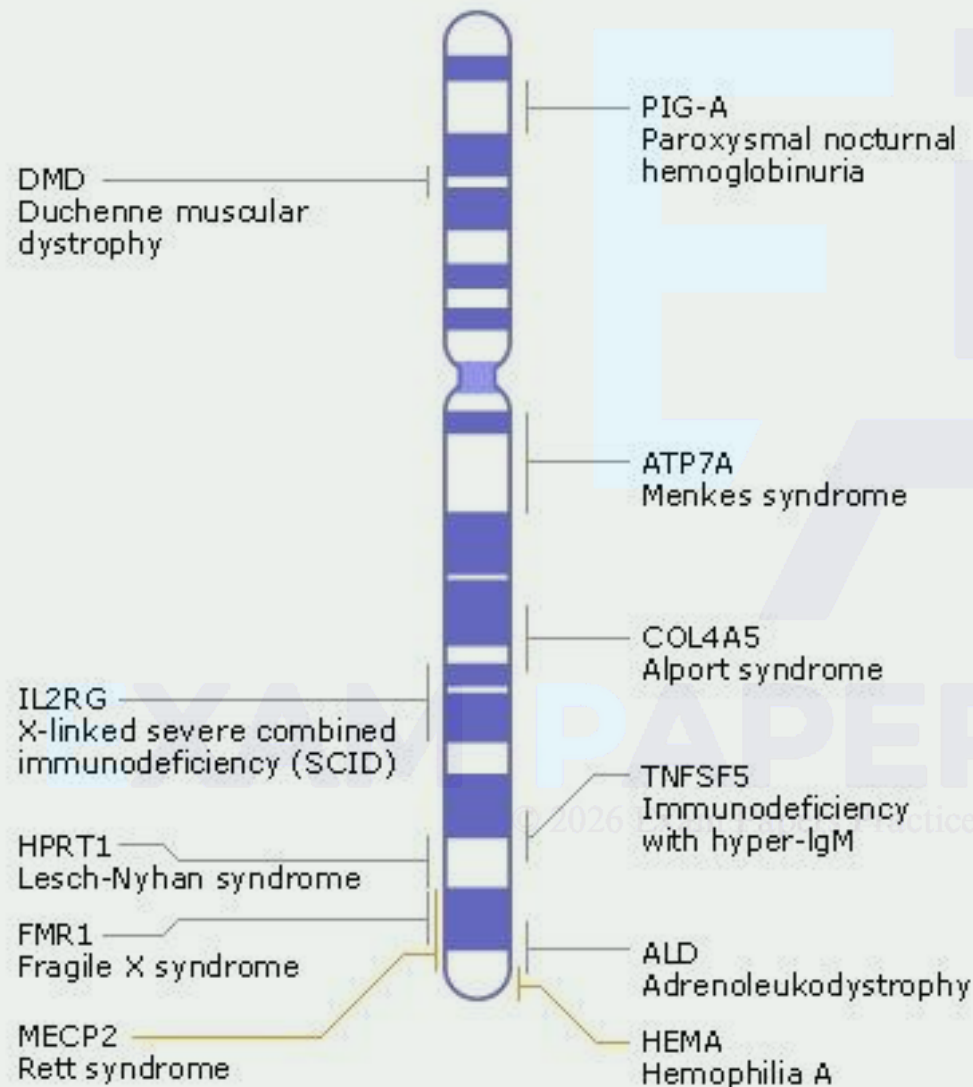
- ◆ different combination of nonhomologous chromosomes
- ◆ crossing-over between homologous chromosomes

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# Inheritance

# Inheritance



| <i>Homo sapiens</i>                                                                  |
|--------------------------------------------------------------------------------------|
| 46                                                                                   |
|  |
| Human                                                                                |

| <i>Homo sapiens</i>                                                                  |
|--------------------------------------------------------------------------------------|
| ~21,000                                                                              |
|  |
| Human                                                                                |

# Inheritance

# Inheritance

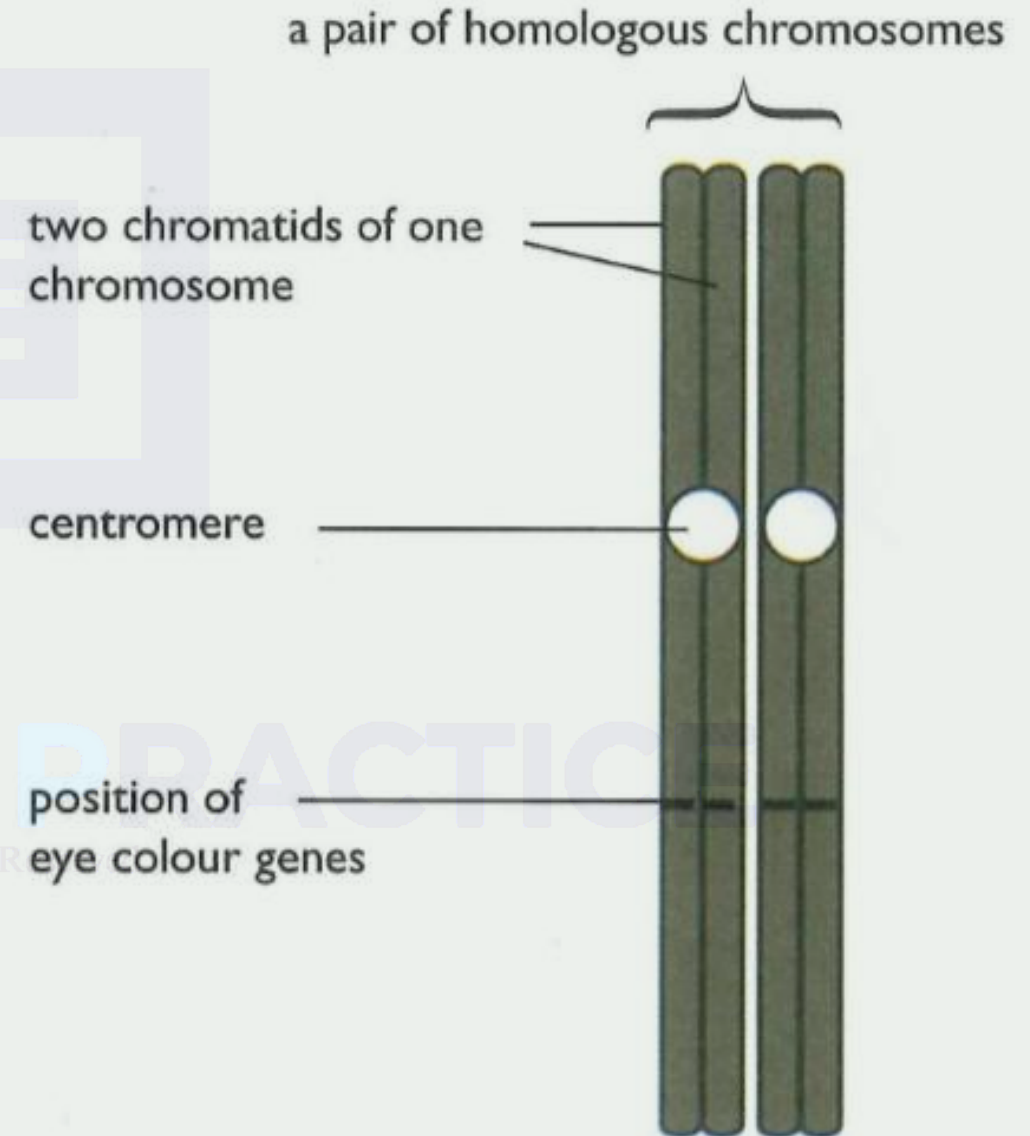
Each chromosome in a **homologous pair** contains genes **for the same characteristic** in the same positions.

## allele

Any of two or more alternative forms of a gene

We refer to these alleles using **letters** as symbols

allele 等位基因  
letter 字母



# Inheritance

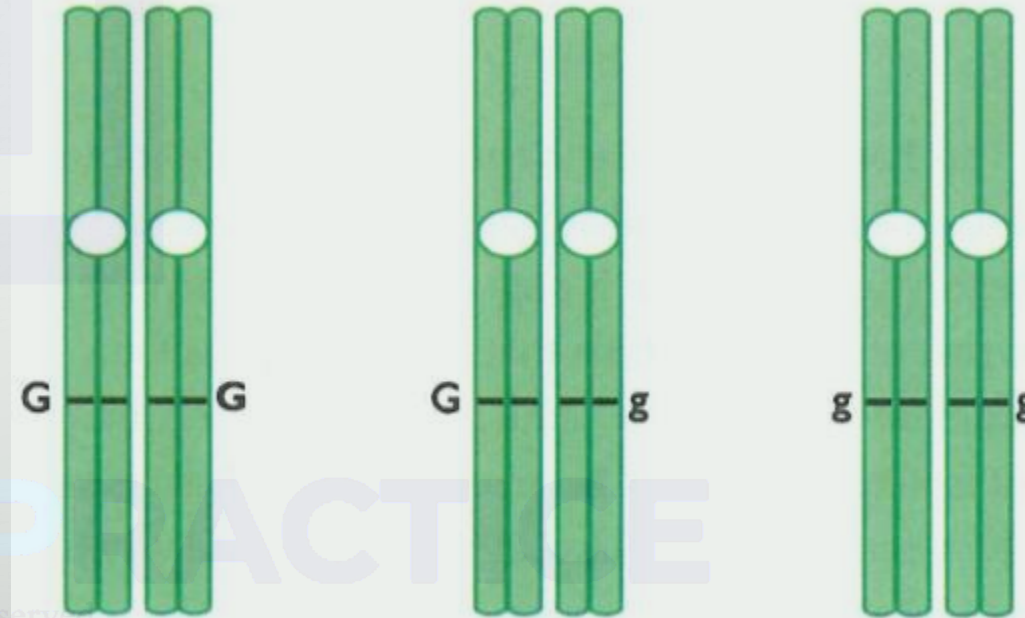
# Inheritance

## homozygous

Have two identical alleles of a particular gene (e.g. GG or gg). Two identical homozygous individuals that breed together will be pure-breeding.

## heterozygous

Having two different alleles of a particular gene (e.g. Gg), not pure-breeding.



homozygous 纯合子的,  
heterozygous 杂合子的

# Inheritance

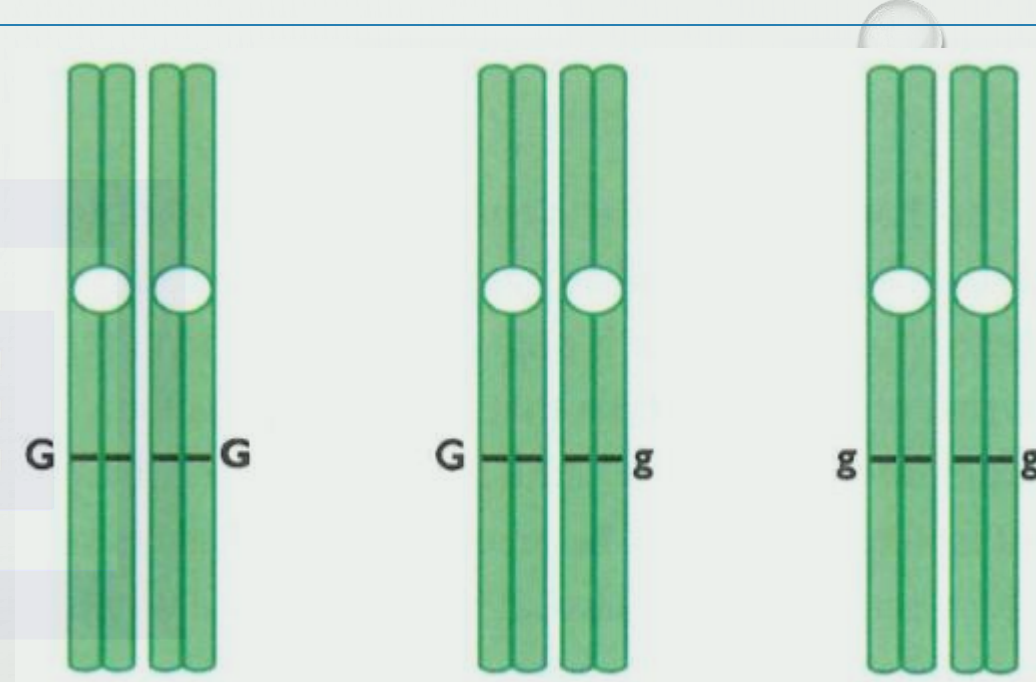
# inheritance

## Genotype

The genetic makeup of an organism in terms of the alleles (e.g. TT or mm).

## phenotype

The features of an organism.



genotype 基因型  
phenotype 表现型

# Inheritance

# inheritance

## Dominant alleles

An allele that is expressed if it is present (e.g. G)

## recessive alleles

An allele that is only expressed when there is no dominant allele of the gene present (e.g. g)



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dominant 显性的  
recessive 隐性的

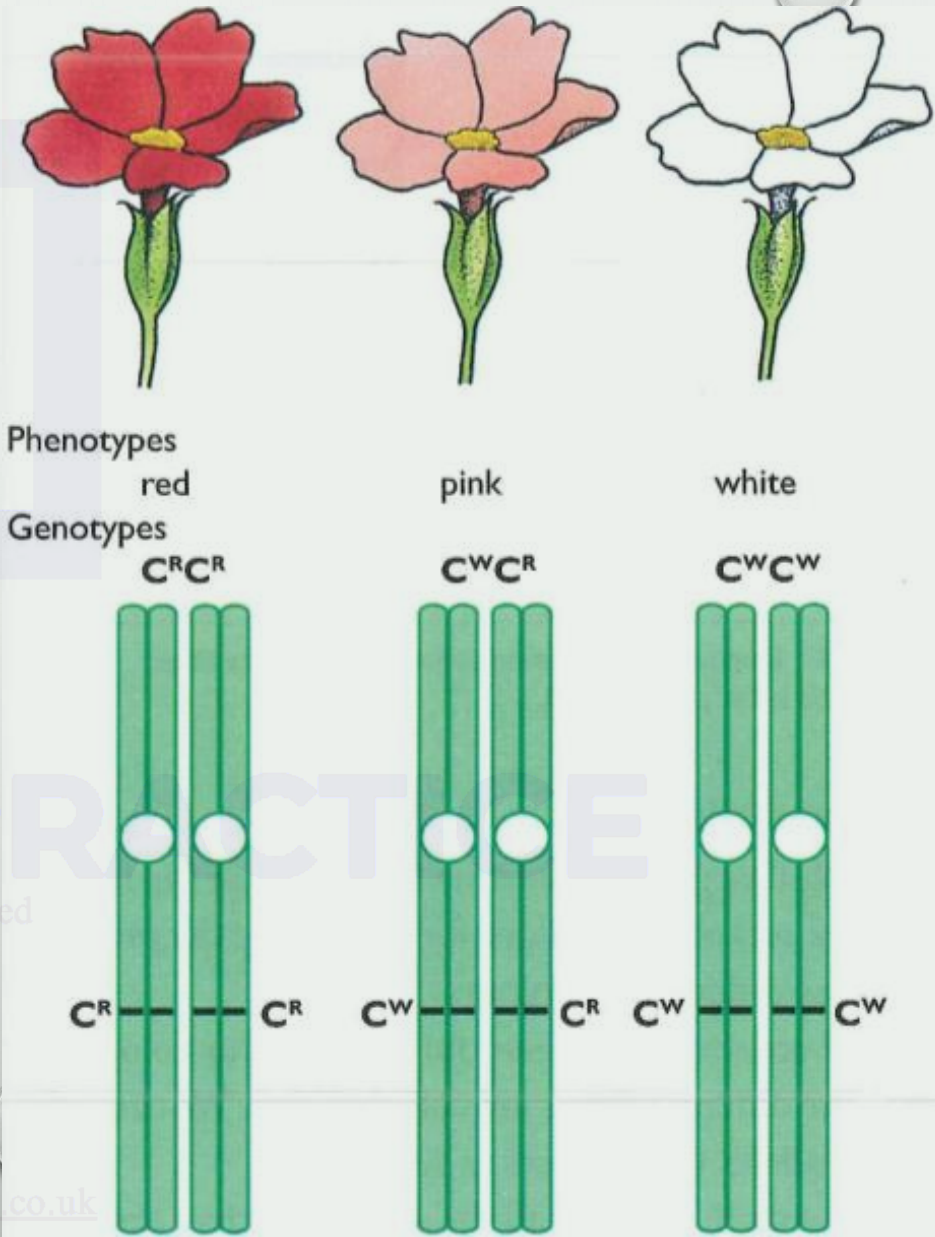
# Inheritance

## inheritance

### codominance alleles

Sometimes, neither of a pair of alleles is completely dominant or completely recessive. They both have an effect on the phenotype.

codominant 共显的  
codominance 共显性



# Inheritance

# inheritance

## codominance alleles

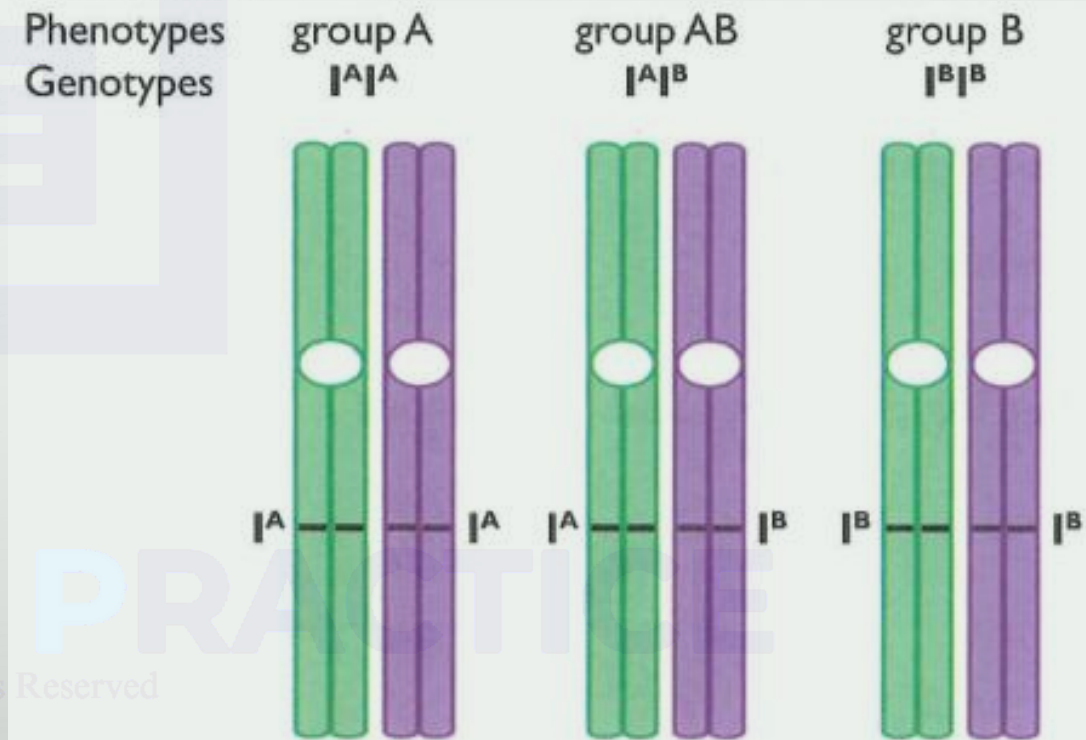
Sometimes, neither of a pair of alleles is completely dominant or completely recessive. They both have an effect on the phenotype.

## ABO blood group antigen

$I^A$   $I^B$   $I^O$

Alleles  $I^A$  and  $I^B$  are codominant, but both are dominant to  $I^O$ .

blood group 血型  
antigen 抗原



The allele for brown eyes is dominant to the allele for blue eyes. Write down suitable symbols for these alleles

What is the phenotype of a person who is heterozygous for this characteristics?

What is codominance?

Alleles of the gene for the ABO blood group antigens in humans show two unusual characteristics. What are these?

Write down all the possible genotypes and phenotypes fro blood goup?

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# Inheritance

## Alleles in gametes

Each gametes has only one of each kind of chromosome instead of two, as in the body cells.

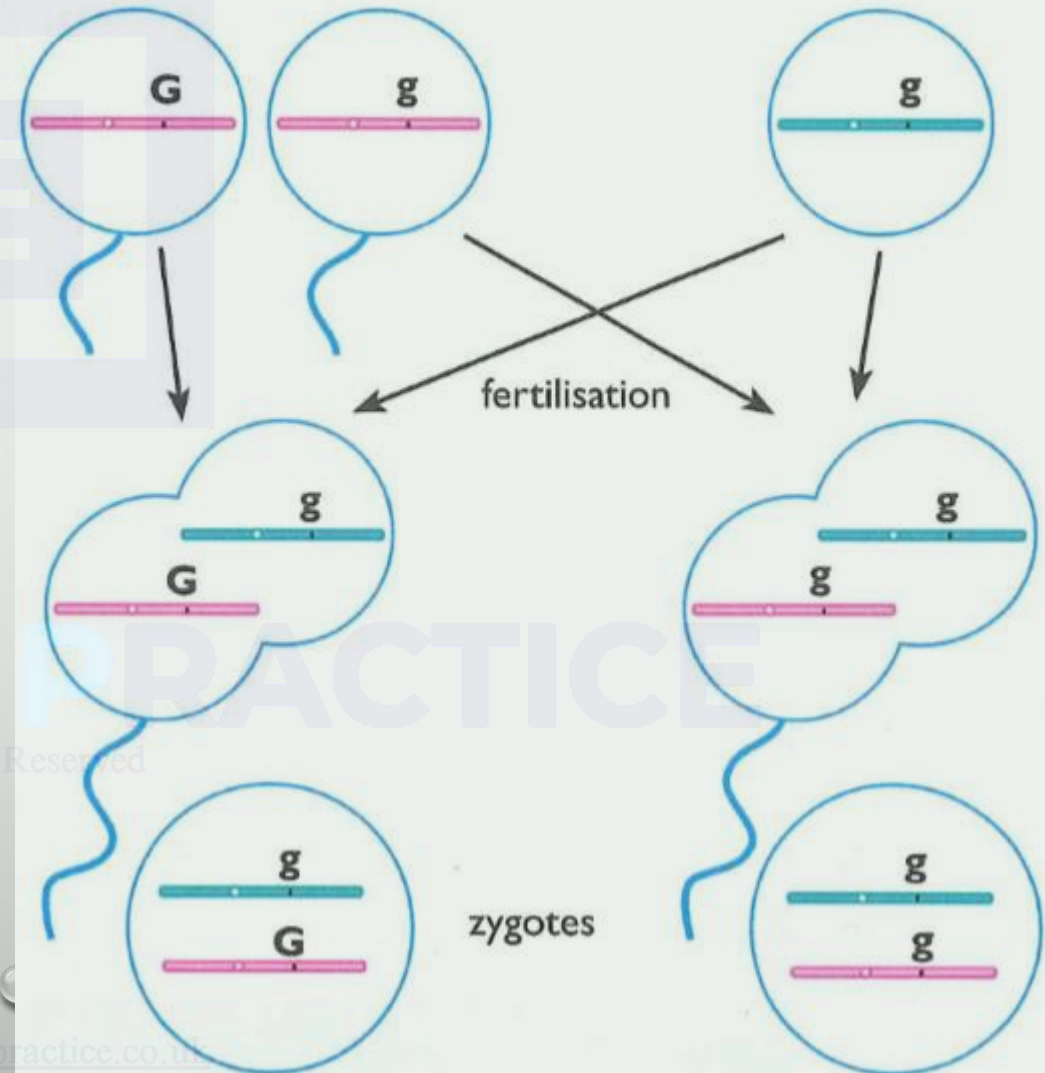
## Genes and fertilization

The chances of diffusion by each kinds of sperms with different eggs are equal.

# inheritance

A male of genotype **Gg** produces equal numbers of **G** and **g** sperm.

A female of genotype **gg** produces eggs of genotype **g**.



# Inheritance

## Genetic diagrams

Genetic diagram

|                     |            |          |
|---------------------|------------|----------|
| Parents' phenotypes | grey       | charcoal |
| Parents' genotypes  | Gg         | gg       |
| Gametes             | (G) or (g) | (g)      |

Offspring genotypes and phenotypes

|       |                    |
|-------|--------------------|
| egg   |                    |
| (G)   |                    |
| sperm | (G) Gg<br>grey     |
|       | (g) gg<br>charcoal |

1/2

1/2

genetic diagram 遗传图解

# Inheritance

## Genetic diagrams

### Genetic diagram

|                     |            |            |
|---------------------|------------|------------|
| Parents' phenotypes | grey       | grey       |
| Parents' genotypes  | Gg         | Gg         |
| Gametes             | (G) or (g) | (G) or (g) |

### Offspring genotypes and phenotypes

|       |     | eggs       |                |
|-------|-----|------------|----------------|
|       |     | (G)        | (g)            |
| sperm | (G) | GG<br>grey | Gg<br>grey     |
|       | (g) | Gg<br>grey | gg<br>charcoal |

|                     |      |      |
|---------------------|------|------|
| Parents' phenotypes | grey | grey |
| Parents' genotypes  | Gg   | Gg   |

If they have borne four offspring, must they have one charcoal fur ?

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An organism that shows a dominant characteristic, what is it possible genotypes?

### Test cross

Cross an individual with the dominant phenotype for a particular gene with one known to have the homozygous recessive genotype for the same gene.

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Pure breeding  
homozygous

F1 generation (first filial generation)

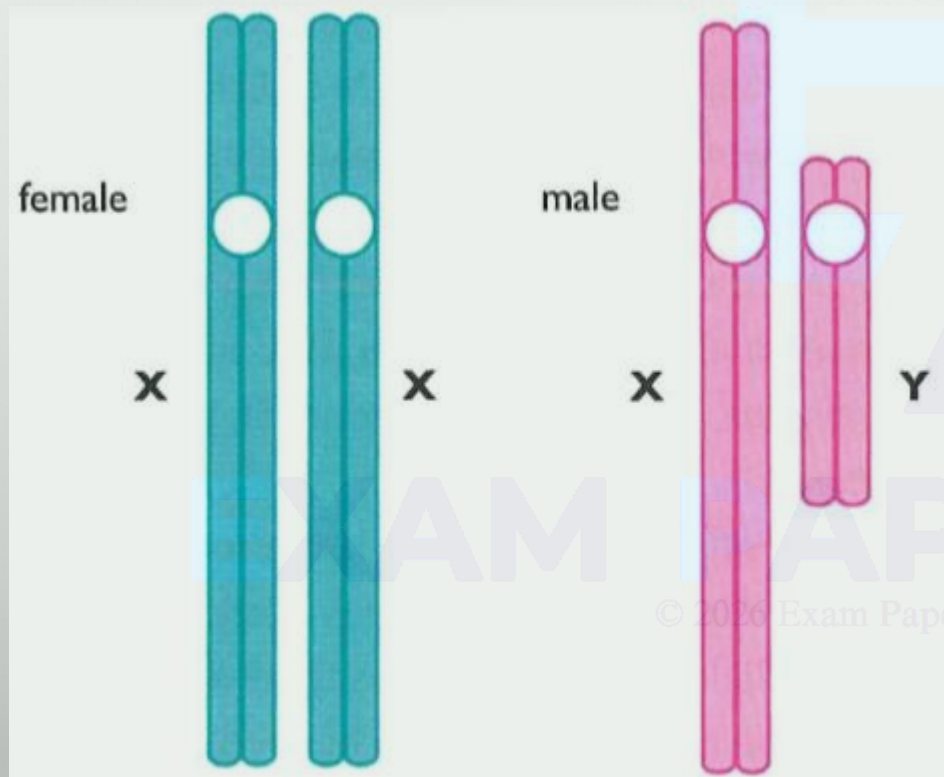
The offspring of two different pure-breeding strains are sometimes called the **first filial generation**.

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first filial generation 子一代

### Sex determination



Parents' phenotypes

male

female

Parents' genotypes

XY

XX

Gametes

(X) or (Y)

(X)

Offspring genotypes and phenotypes

egg

(X)

XX  
female

sperm

(X)

(Y)

XY  
male

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# Inheritance

## Sex linkage

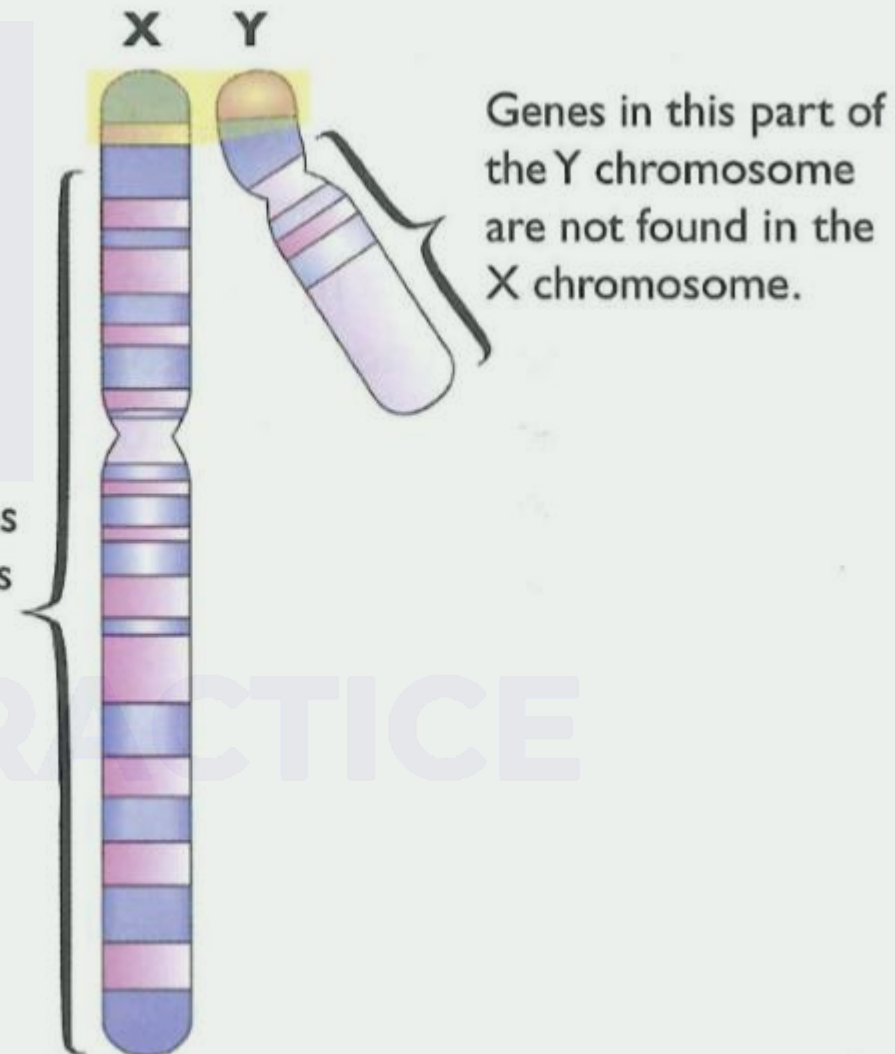
### Sex linkage

Genes that are found only on the non-homologous parts of the X or Y chromosomes are called **sex-linked genes**.

### Sex-linked characteristic

A characteristic in which the gene responsible is located on a sex chromosome, which makes it more common in one sex than in the other.

sex lineage 伴性遗传



# Inheritance

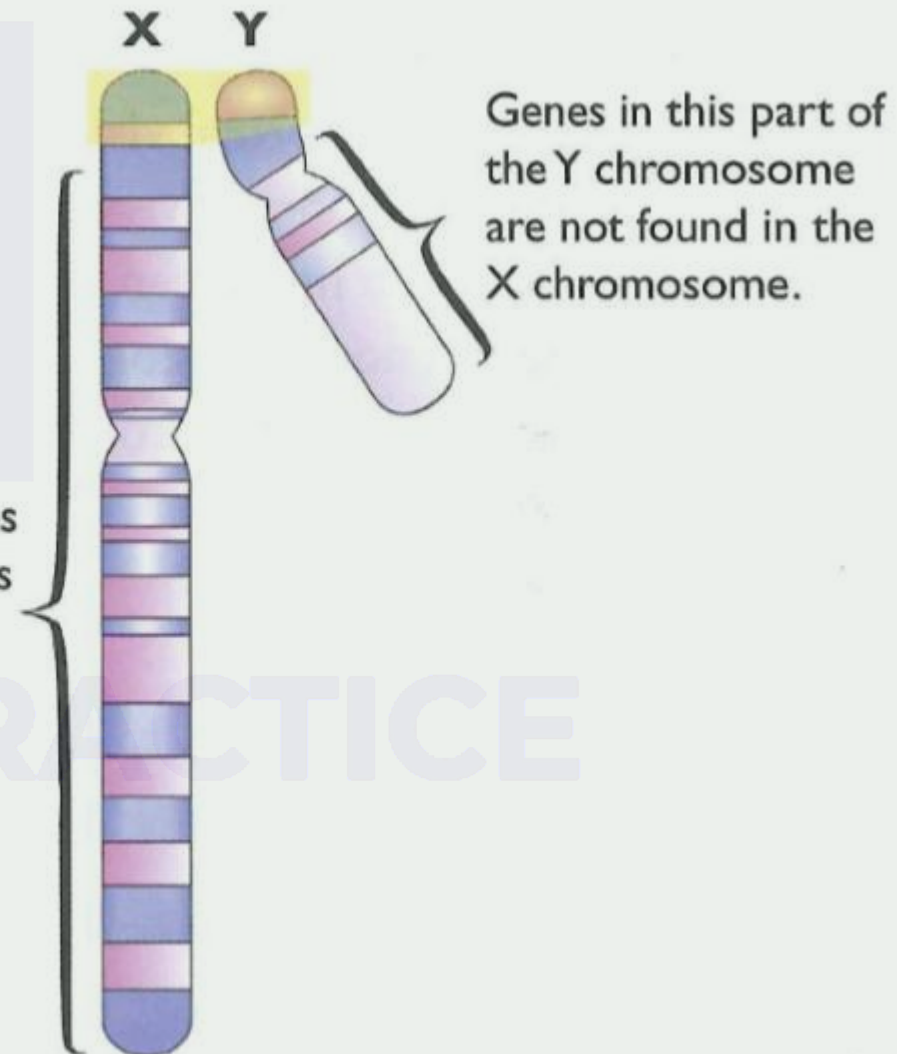
## Sex linkage

### red-green colour-blind

One of these sex-linked genes controls the production of the three different kinds of cone cells in the retina.

A recessive allele of this gene, **b**, results in only two types of cone cell being made.

red-green colour-blind 红绿色盲

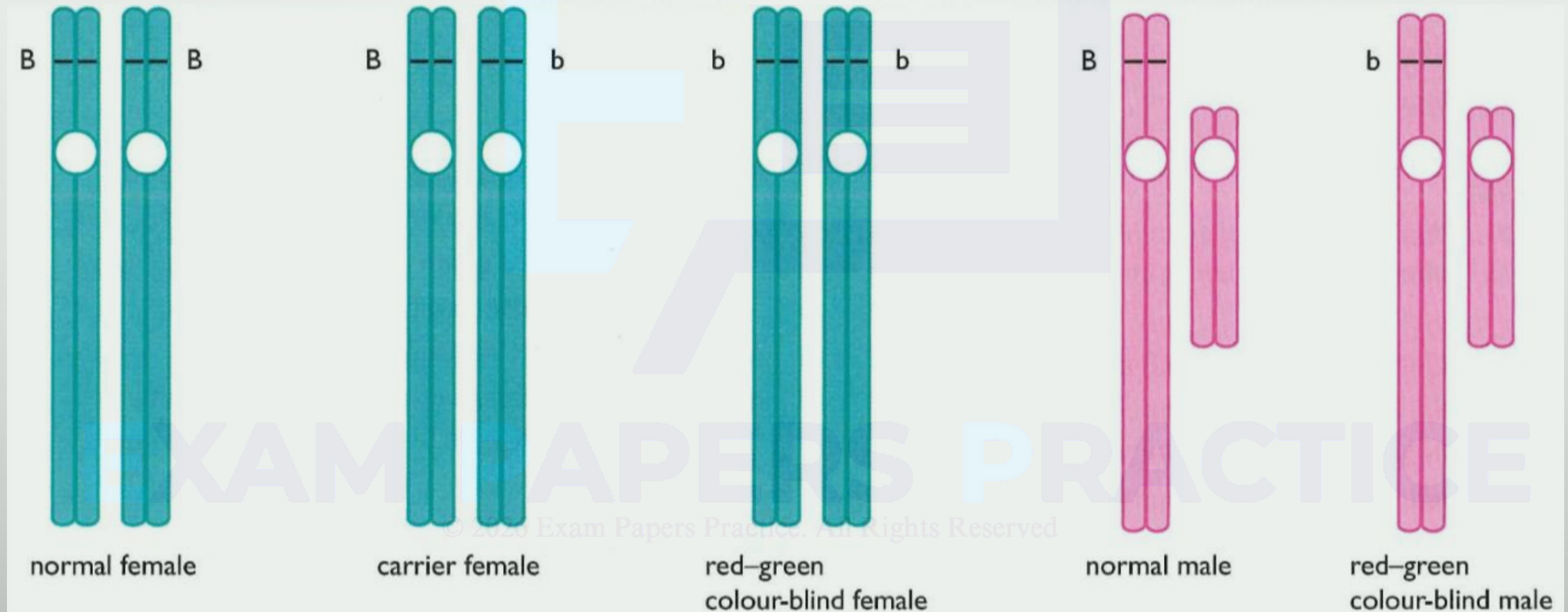


# Inheritance

## Sex linkage

red-green colour-blind

Red-green colour-blind is much more common in men than in women.



$X^B X^B$

$X^B X^b$

$X^b X^b$

$X^B Y$

$X^b Y$

# Inheritance

## Sex linkage

red-green colour-blind

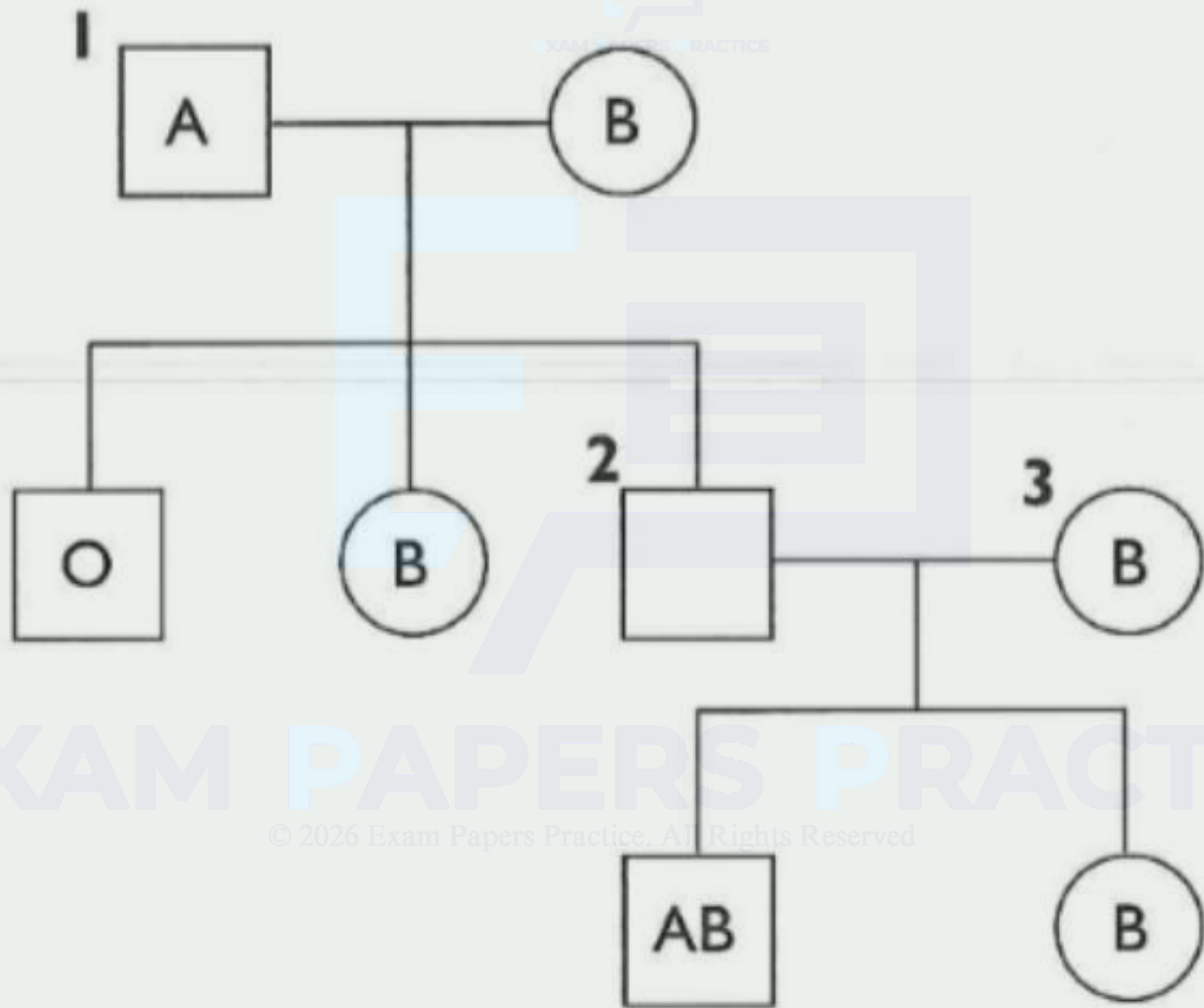
Parents' phenotypes normal man carrier woman

Parents' genotypes  $X^B Y$   $X^B X^b$

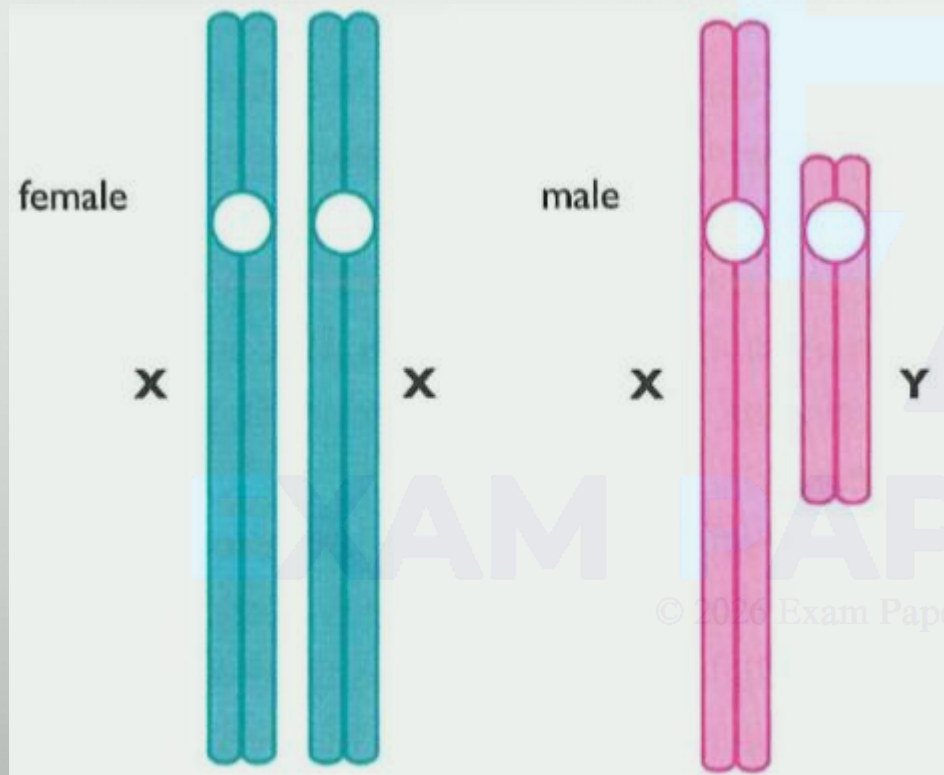
Gametes  $(X^B)$  or  $(Y)$   $(X^B)$  or  $(X^b)$

Offspring genotypes and phenotypes:

|       |         | eggs                       |                                           |
|-------|---------|----------------------------|-------------------------------------------|
|       |         | $(X^B)$                    | $(X^b)$                                   |
| sperm | $(X^B)$ | $X^B X^B$<br>normal female | $X^B X^b$<br>normal female<br>(carrier)   |
|       | $(Y)$   | $X^B Y$<br>normal male     | $X^b Y$<br>red-green<br>colour-blind male |



### Sex determination



Parents' phenotypes

male

female

Parents' genotypes

XY

XX

Gametes

(X) or (Y)

(X)

Offspring genotypes and phenotypes

egg

(X)

XX  
female

sperm

(X)

(Y)

XY  
male

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# Inheritance

## Sex linkage

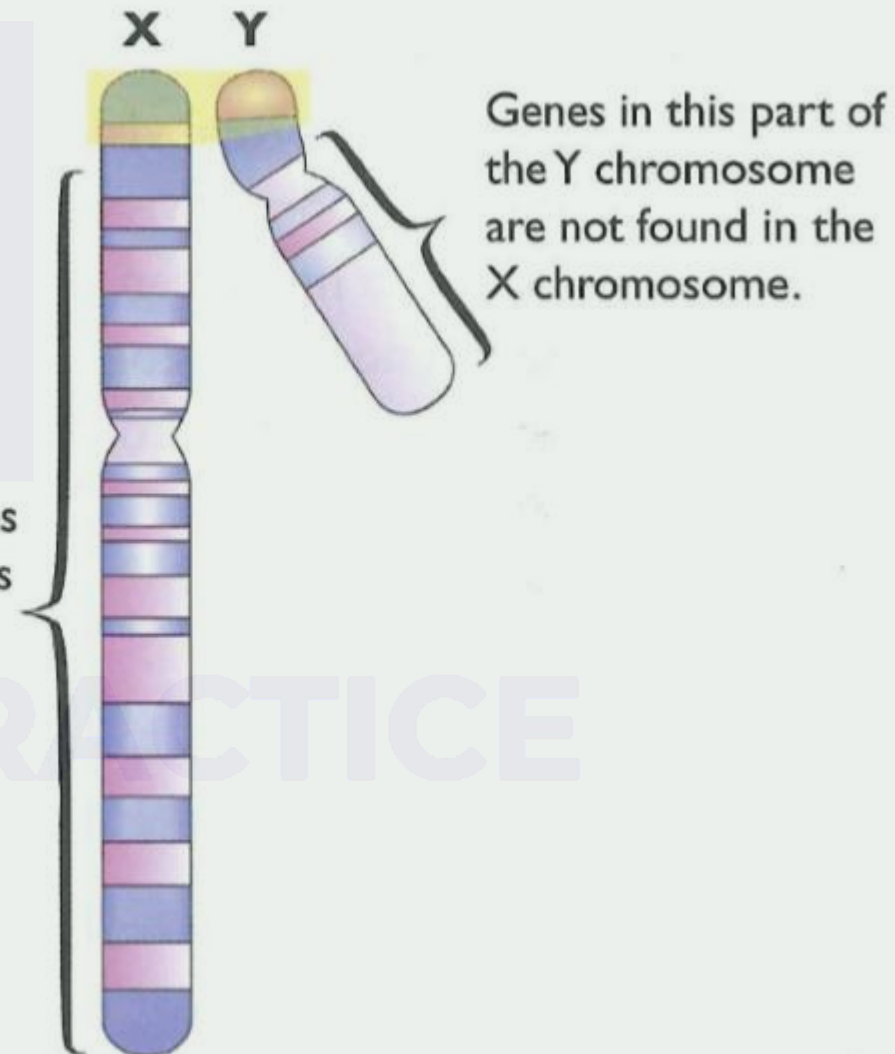
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sex lineage 伴性遗传



# Inheritance

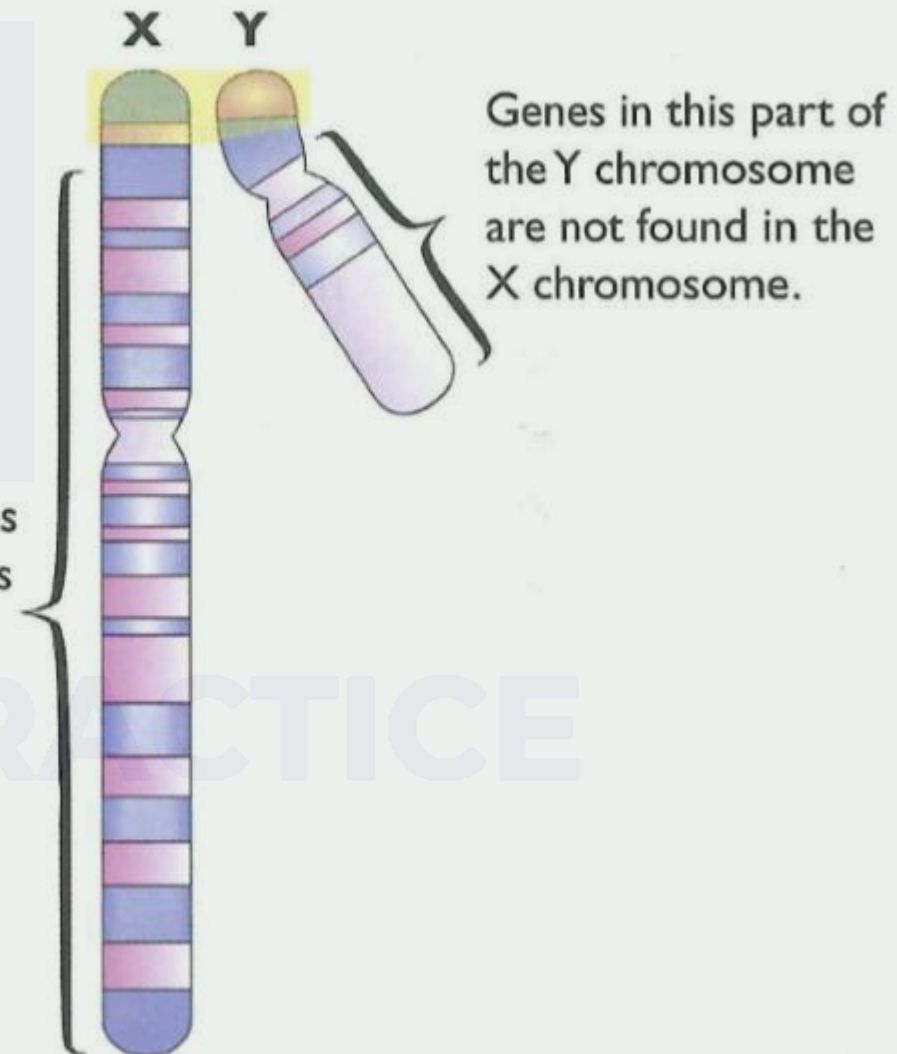
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red-green colour-blind 红绿色盲

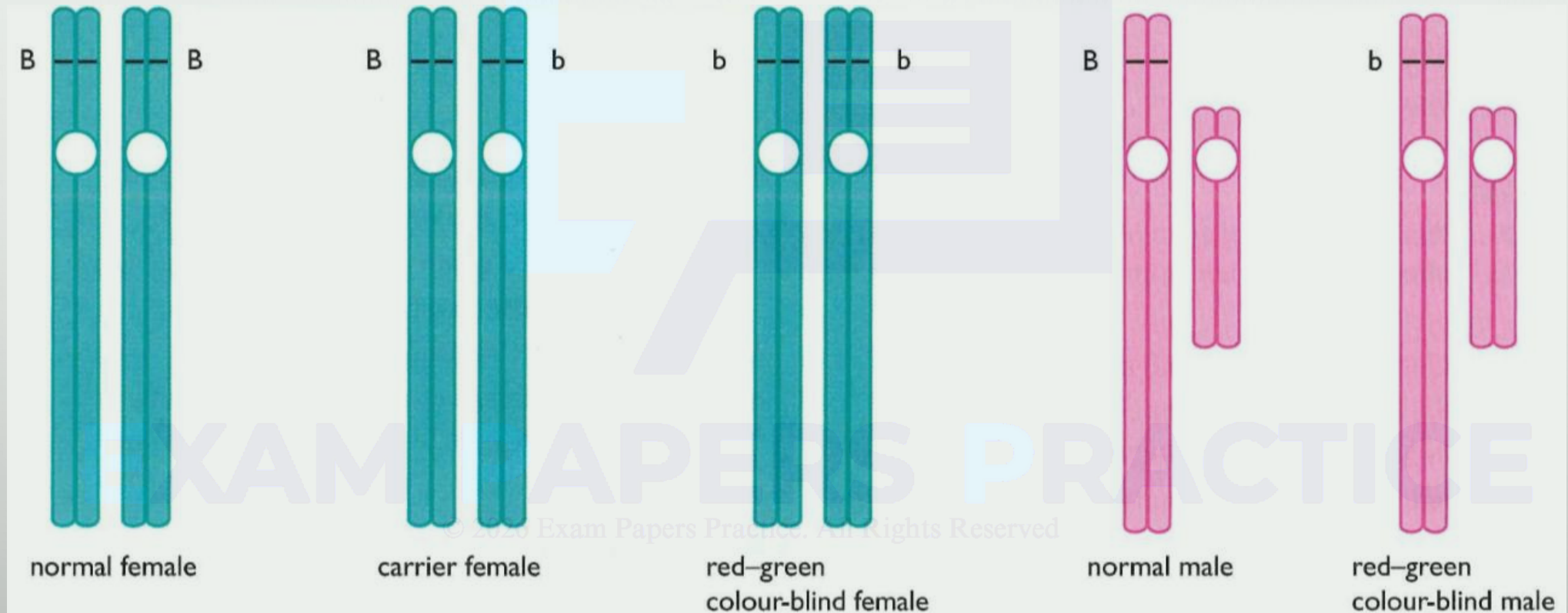


# Inheritance

## Sex linkage

red-green colour-blind

Red-green colour-blind is much more common in men than in women.



$X^B X^B$

$X^B X^b$

$X^b X^b$

$X^B Y$

$X^b Y$

# Inheritance

## Sex linkage

red-green colour-blind

Parents' phenotypes normal man carrier woman

Parents' genotypes  $X^B Y$   $X^B X^b$

Gametes  $(X^B)$  or  $(Y)$   $(X^B)$  or  $(X^b)$

Offspring genotypes and phenotypes:

|       |         | eggs                       |                                           |
|-------|---------|----------------------------|-------------------------------------------|
|       |         | $(X^B)$                    | $(X^b)$                                   |
| sperm | $(X^B)$ | $X^B X^B$<br>normal female | $X^B X^b$<br>normal female<br>(carrier)   |
|       | $(Y)$   | $X^B Y$<br>normal male     | $X^b Y$<br>red-green<br>colour-blind male |

A man who is red-green colour-blind marries a woman with normal vision. What is the chance that the couple's next child will be a colour-blind boy?

# Inheritance

## DNA and protein synthesis

enzyme → metabolic reactions

Antibodies

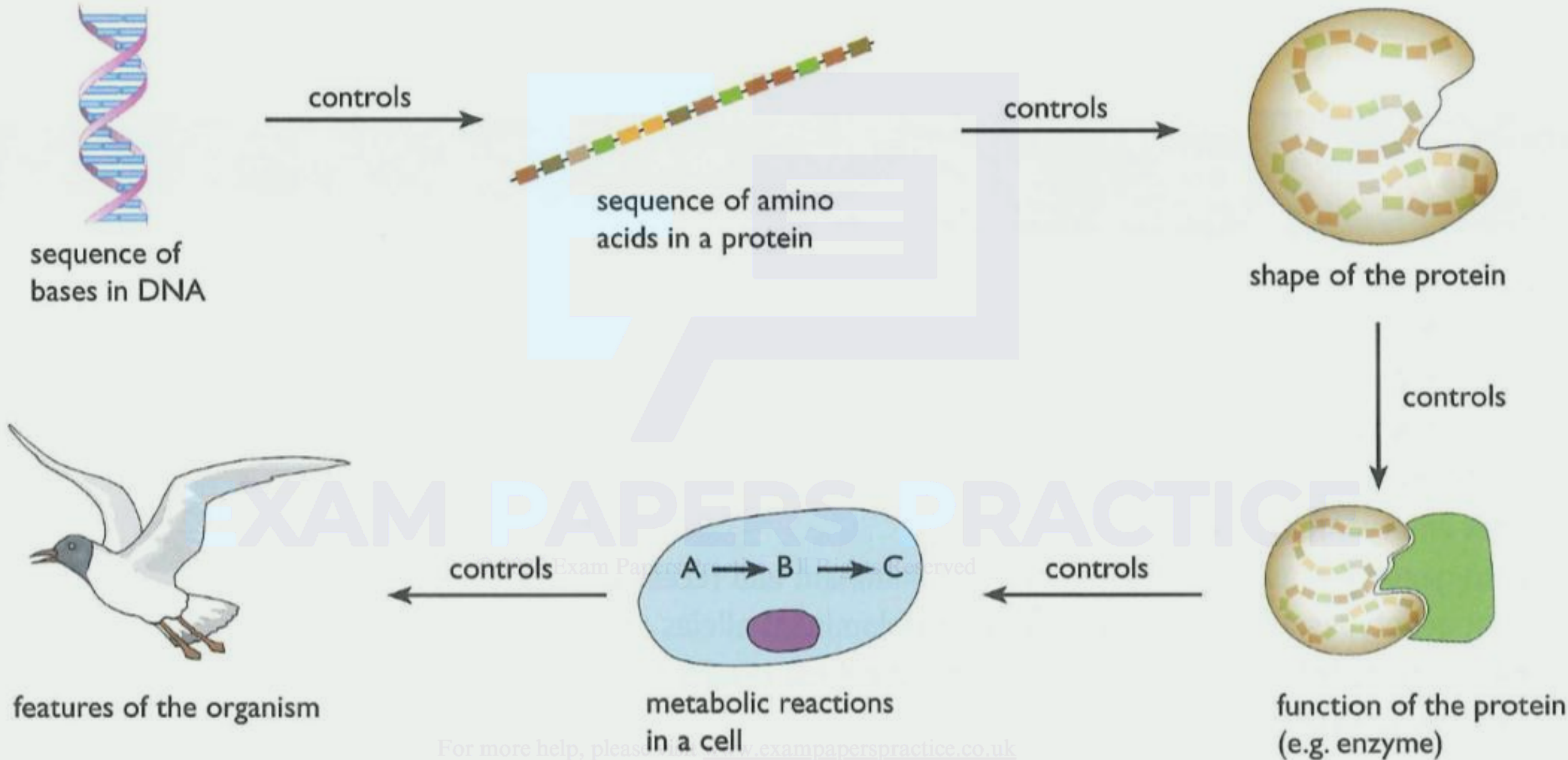
Receptors for neurotransmitters



neurotransmitter 神经递质

# Inheritance

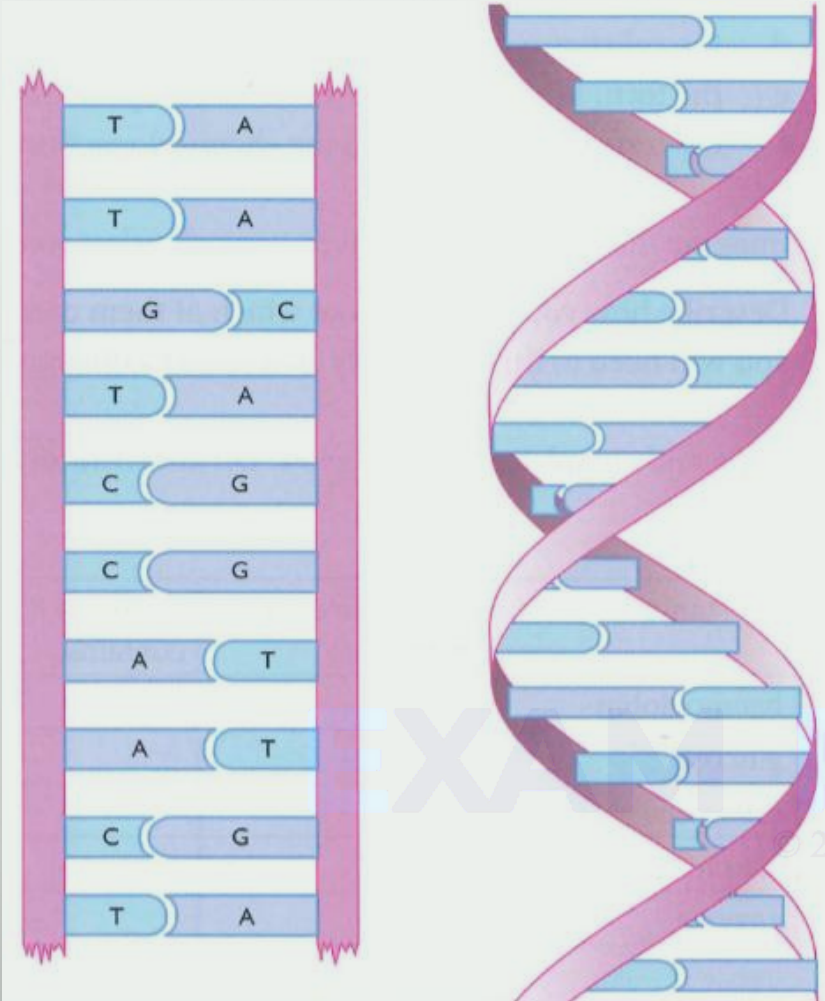
## DNA and protein



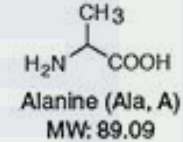
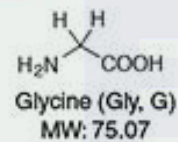
# Inheritance

## DNA and protein synthesis

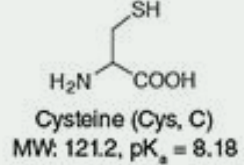
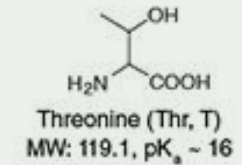
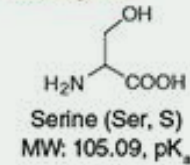
4 bases : A G C T  $\longrightarrow$  20 different amino acids



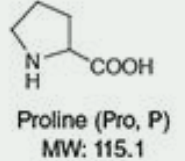
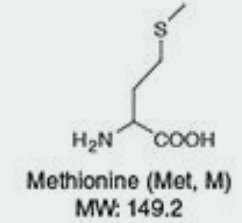
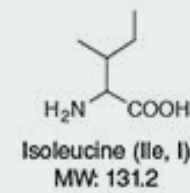
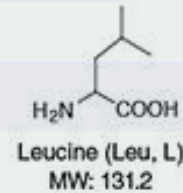
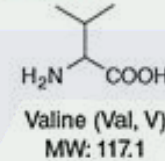
### Small



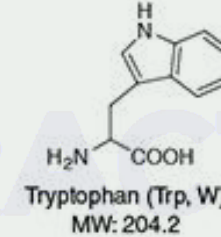
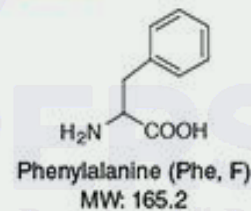
### Nucleophilic



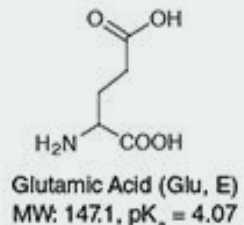
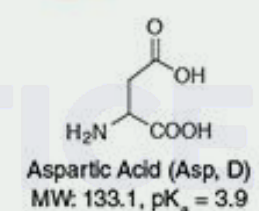
### Hydrophobic



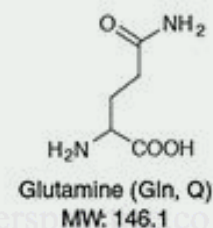
### Aromatic



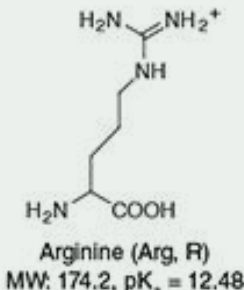
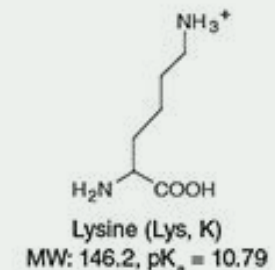
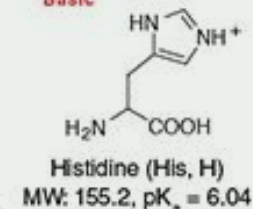
### Acidic



### Amide



### Basic

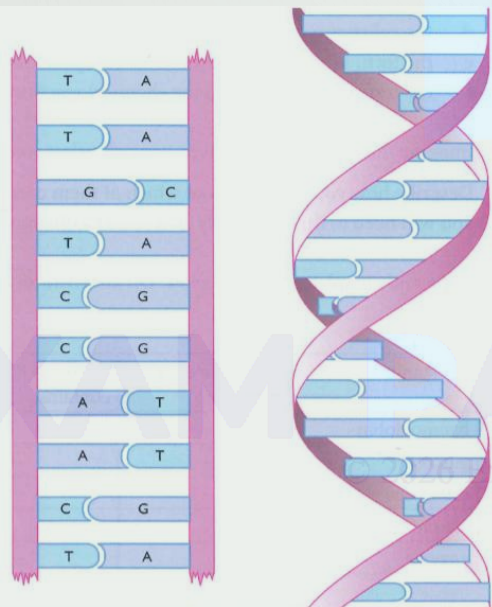


# Inheritance

## DNA and protein synthesis

### The genetic code

The DNA bases are 'read' in sets of three, called **triplets**.



genetic code 遗传密码  
triplet 三个一组

|                |   | Second Position |         |     |         |     |         |     |         |   |
|----------------|---|-----------------|---------|-----|---------|-----|---------|-----|---------|---|
|                |   | U               |         | C   |         | A   |         | G   |         |   |
| First Position | U | UUU             | Phe / F | UCU | Ser / S | UAU | Tyr / Y | UGU | Cys / C | U |
|                |   | UUC             |         | UCC |         | UAC |         | UGC |         | C |
|                |   | UUA             | Leu / L | UCA |         | UAA | STOP    | UGA | STOP    | A |
|                |   | UUG             |         | UCG |         | UAG | STOP    | UGG | Trp / W | G |
|                | C | CUU             | Leu / L | CCU | Pro / P | CAU | His / H | CGU | Arg / R | U |
|                |   | CUC             |         | CCC |         | CAC |         | CGC |         | C |
|                |   | CUA             |         | CCA |         | CAA | Gln / Q | CGA |         | A |
|                |   | CUG             |         | CCG |         | CAG |         | CGG |         | G |
|                | A | AUU             | Ile / I | ACU | Thr / T | AAU | Asn / N | AGU | Ser / S | U |
|                |   | AUC             |         | ACC |         | AAC |         | AGC |         | C |
|                |   | AUA             |         | ACA |         | AAA | Lys / K | AGA | Arg / R | A |
|                |   | AUG             | Met / M | ACG |         | AAG |         | AGG |         | G |
|                | G | GUU             | Val / V | GCU | Ala / A | GAU | Asp / D | GGU | Gly / G | U |
|                |   | GUC             |         | GCC |         | GAC |         | GGC |         | C |
|                |   | GUA             |         | GCA |         | GAA | Glu / E | GGA |         | A |
|                |   | GUG             |         | GCG |         | GAG |         | GGG |         | G |

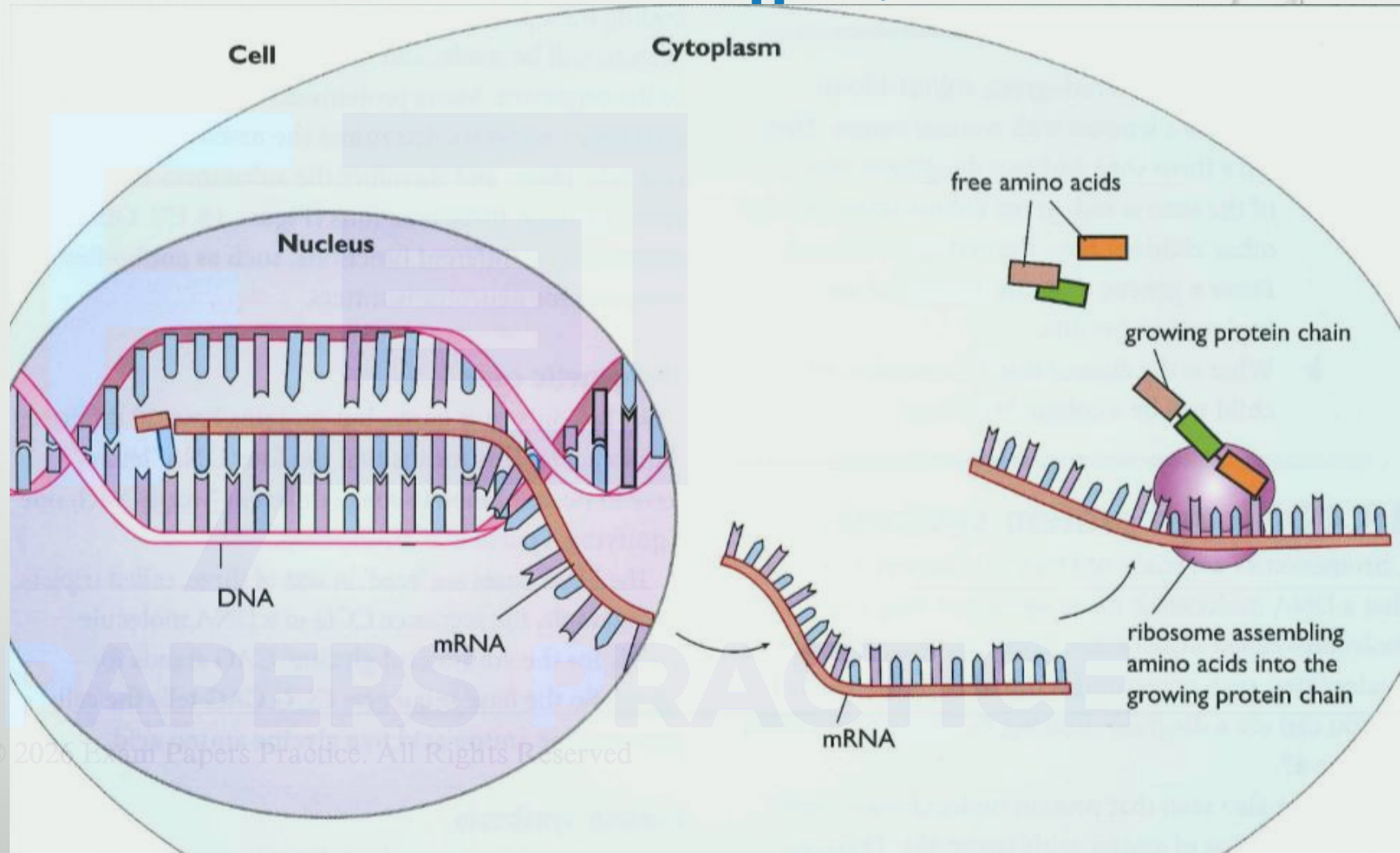
# Inheritance

## DNA and protein

**Protein synthesis**  
happen on the ribosome  
(in cytoplasm)

DNA  
↓  
mRNA  
( copy the base sequence  
from DNA)  
↓  
protein(amino acids)

**Protein synthesis** 蛋白质合成  
**mRNA (messenger RNA)** 信使RNA





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