Blood containing red cells with type A antigen on their surface has in its serum (fluid) antibodies against type B red cells. If, in transfusion, type B blood is injected into persons with type A blood, the red cells in the injected blood will be destroyed by the antibodies in the recipient's blood. In the same way, type A red cells will be destroyed by anti-A antibodies in type B blood. Type O blood can be injected into persons with type A, B, or O blood unless there is incompatibility with respect to some other blood

individuals could result in clumping,
or agglutination, of red blood cells,
the underlying mechanism of this
phenomenon was not understood.
Landsteiner discovered the cause of
agglutination to be an
mmunological reaction that occurs
when antibodies are produced by the
ost against donated blood cells. This
nmune response is elicited because
lood from different individuals may
ary with respect to certain antigens
cated on the surface of red blood

blood from an individual of a different blood type, such as B, the host's immune system will not recognize the B antigens on the donor blood cells and thus will consider them to be foreign and dangerous, as it would regard an infectious microorganism. To defend the body from this perceived threat, the host's immune system will produce antibodies against the B antigens, and agglutination will occur as the antibodies bind to the B antigens. Landsteiner's work made it possible to determine blood type and

After receiving his M.D. in 1891 from the University of Vienna, Landsteiner studied organic chemistry with many notable scientists in Europe, including the German chemist Emil Fischer. In 1897 he returned to the University of Vienna, where he pursued his interest in the emerging field of immunology and in 1901 published his discovery of the human ABO blood group system. At that time, although it was known that the mixing of blood from two

ABO blood group system, the classification of human blood based on the inherited properties of red blood cells (erythrocytes) as determined by the presence or absence of the antigens A and B, which are carried on the surface of the red cells. Persons may thus have type A, type B, type O, or type AB blood. The A, B, and O blood groups were first identified by Austrian immunologist Karl Landsteiner in 1901. *See* blood group.

Blood group O is the most common blood type throughout the world, particularly among peoples of South and Central America. Type B is prevalent in Asia, especially in northern India. Type A also is common all over the world; the highest frequency is among Australian Aboriginal peoples, the Blackfoot Indians of Montana, and the Sami people of northern Scandinavia.

The ABO antigens
before birth and r
life. Children acqu
passively from the
birth, but by three
infants are making
believed that the st
antibody formation
with ABO-like antig
in nature. ABO incc
which the antigens
her fetus are differe
cause an immune re
a small number of r

Haemophilia

Haemophilia is a genetic disorder whereby the body's ability to control blood clotting (and hence stop bleeding) is impaired

- The formation of a blood clot is controlled by a cascade of coagulation factors whose genes are located on the X chromosome
- When one of these factors becomes defective, fibrin formation is prevented - meaning bleeding continues for a long time
- Different forms of haemophilia can occur, based on which specific coagulation factor is mutated (e.g. haemophilia A = factor VIII)

Red-Green Colour Blindness

Red-green colour blindness is a genetic disorder whereby an individual fails to discriminate between red and green hues

- This condition is caused by a mutation to the red or green retinal photoreceptors, which are located on the X chromosome
- Red-green colour blindness can be diagnosed using the Ishihara colour test

the sex chromosomes). The rules of inheritance considered so far, with the u
Mendel's analysis as an example, are the rules of autosomes. Most of the
chromosomes in a genome are autosomes. The sex chromosomes are fewer
number, and, generally in diploid organisms, there is just one pair.

Let us look at the human situation as an example. Human body cells have 4
chromosomes: 22 homologous pairs of autosomes plus 2 sex chromosomes.
females, there is a pair of identical sex chromosomes called the **X chromos**
In males, there is a nonidentical pair, consisting of one X and one Y. The **Y**
chromosome is considerably shorter than the X. At meiosis in females, the
chromosomes pair and segregate like autosomes so that each egg receives o
chromosome. Hence the female is said to be the homogametic sex. At meiosi
males, the X and the Y pair over a short region, which ensures that the X an
separate so that half the sperm cells receive X and the other half receive Y.
Therefore the male is called the heterogametic sex.

The fruit fly *Drosophila melanogaster* has been one of the most important
research organisms in genetics; its short, simple life cycle contributes to its
usefulness in this regard (Figure 2-11). Fruit flies also have XX females and
males. However, the mechanism of sex determination in *Drosophila* differs
that in mammals. In *Drosophila*, the number of X chromosomes determines
two X's result in a female and one X results in a male. In mammals, the pres
of the Y determines maleness and the absence of a Y determines femaleness
difference is demonstrated by the sexes of the abnormal chromosome types
and XO, as shown in Table 2-3 . However, we postpone a full discussion of th
topic until Chapter 23 .

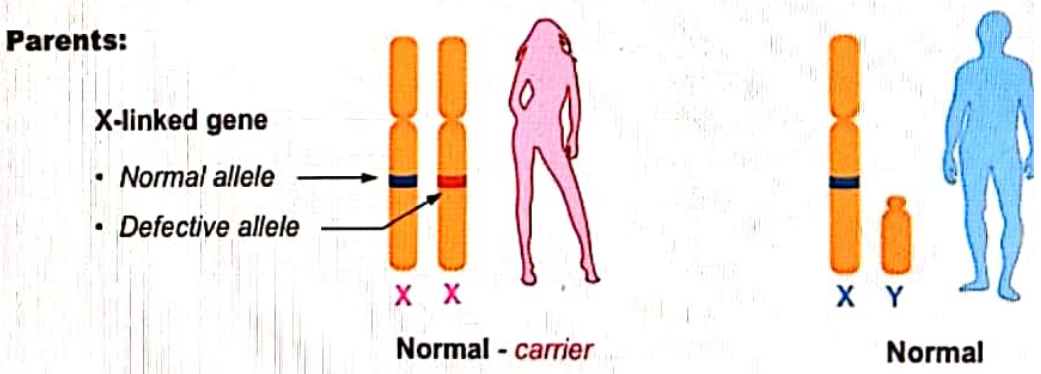
Figure 2-11

Life cycle of *Drosophila melanogaster*, the common fruit fly.

The following ... linked conditions:

- Only females can be carriers (a heterozygote for a recessive disease condition), males cannot be heterozygous carriers
- Males will <u>always</u> inherit an X-linked trait from their mother (they inherit a Y chromosome from their father)
- Females cannot inherit an X-linked recessive condition from an unaffected father (must receive his dominant allele)

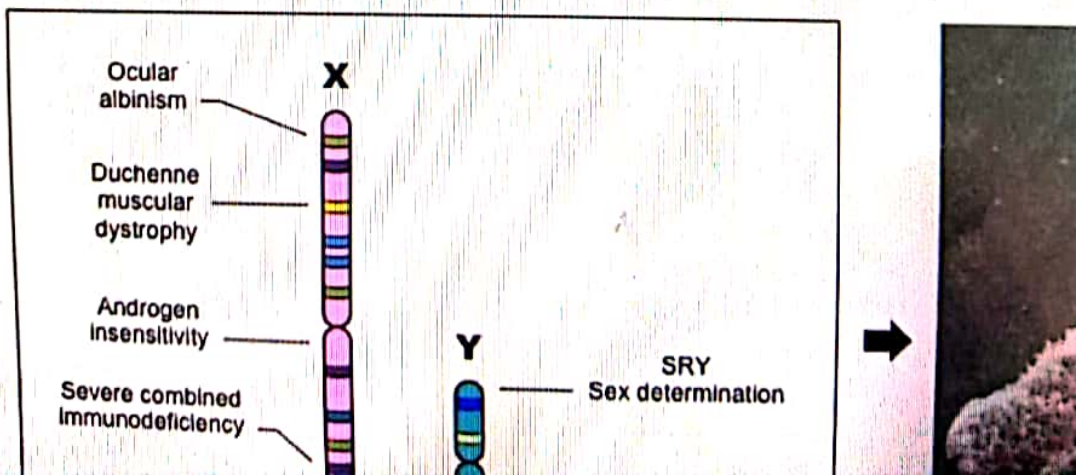
Inheritance of an X-linked Recessive Disease Condition



Sex linkage refers to when a gene controlling a characteristic is located on a sex chromosome (X or Y)

- The Y chromosome is much shorter than the X chromosome and contains only a few genes (50 million bp; 78 genes)
- The X chromosome is longer and contains many genes not present on the Y chromosomes (153 million bp ; ~ 2,000 genes)
- Hence, sex-linked conditions are usually X-linked - as very few genes exist on the shorter Y chromosome

X and Y chromosomes



Understanding:

- The pattern of inheritance is different with sex-linked genes due to the

Sex-linked inheritance patterns differ from autosomal patterns due to the fact that the chromosomes aren't paired in males (XY)

- This leads to the expression of sex-linked traits being predominantly associated with a particularly gender

As human females have **two** X chromosomes (and therefore two alleles), they can be either homozygous or heterozygous

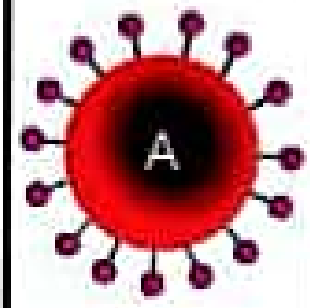
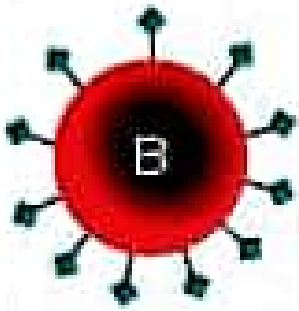
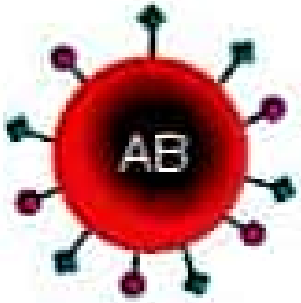
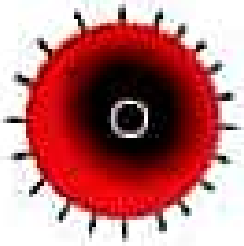
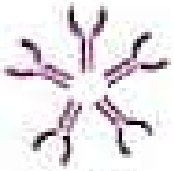
- Hence, X-linked dominant traits are more common in <u>females</u> (as either allele may be dominant and cause disease)

Human males have only **one** X chromosome (and therefore only one allele) and are *hemizygous* for X-linked traits

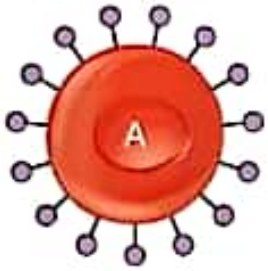
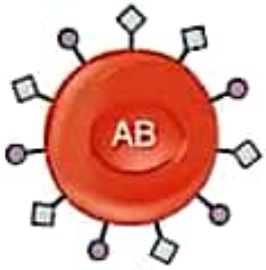
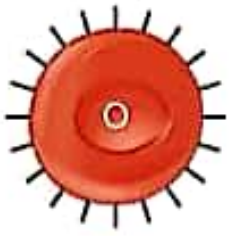
MEDICAL NEWS TODAY

Blood Type Compatibility

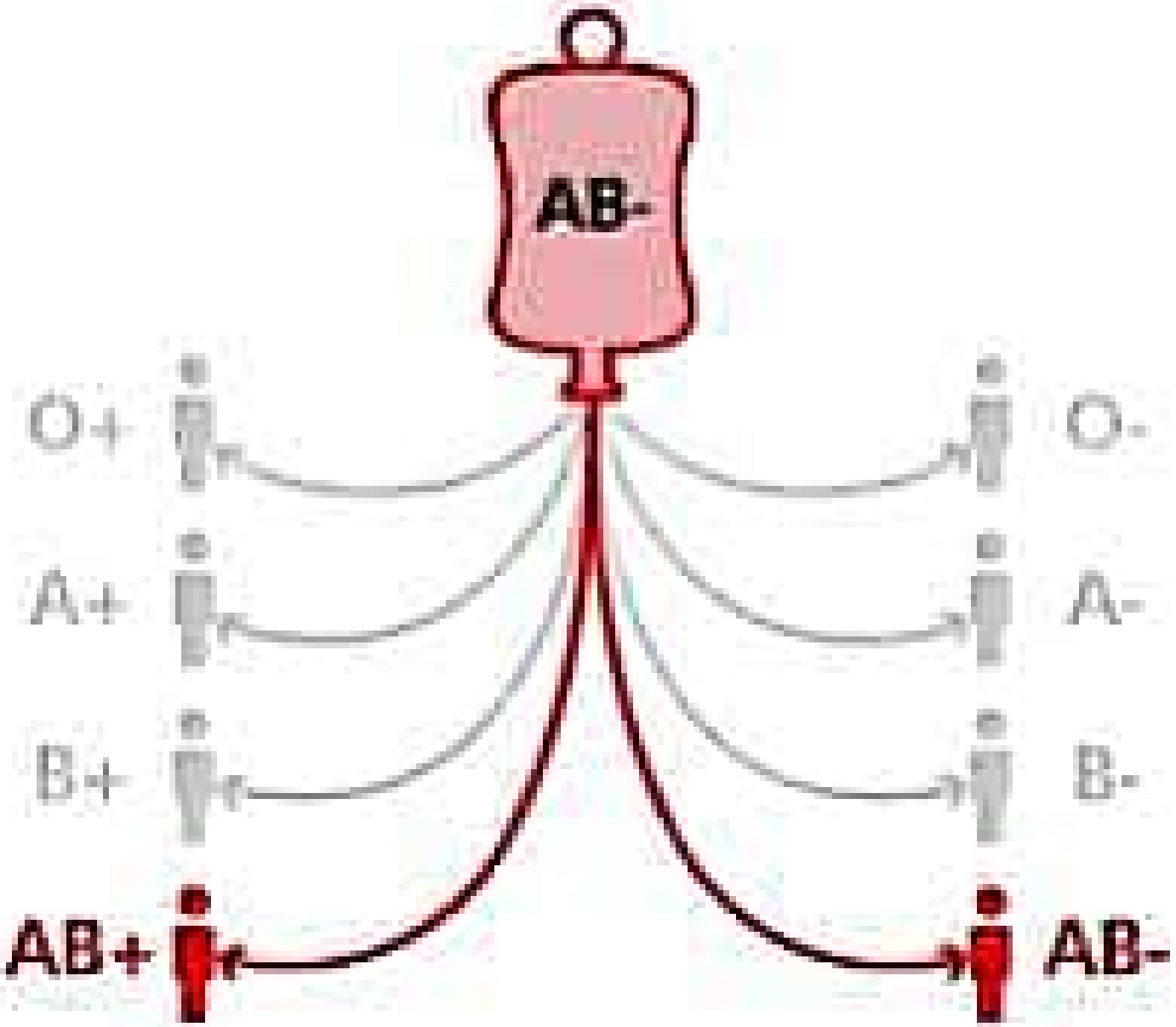
Blood Type	Gives	Receives
A+	A+, AB+	A+, A-, O+, O-
O+	O+, A+, B+, AB+	O+, O-
B+	B+, AB+	B+, B-, O+, O-
AB+	AB+	Everyone
A-	A+, A-, AB+, AB-	A-, O-
O-	Everyone	O-
B-	B+, B-, AB+, AB-	B-, O-
AB-	AB+, AB-	AB-, A-, B-, O-

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

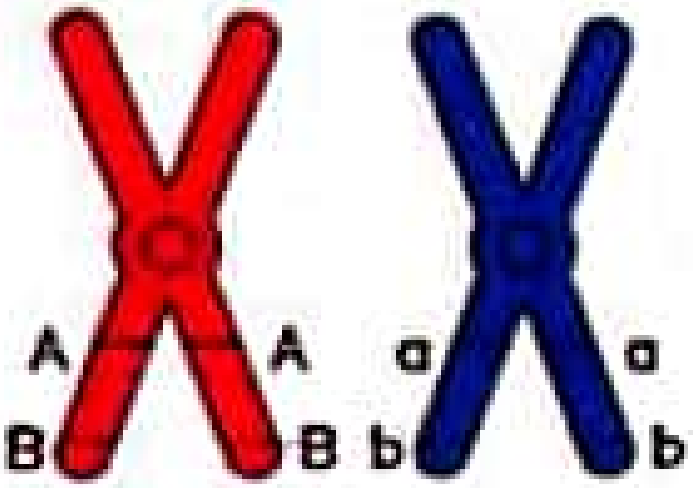
A	B	AB	O
A or O	A, B, AB, or O	A, B, or AB	A or O
A, B, AB, or O	B or O	A, B, or AB	B or O
A, B, or AB	A, B, or AB	A, B, or AB	A or B

Red Blood Cell Type				

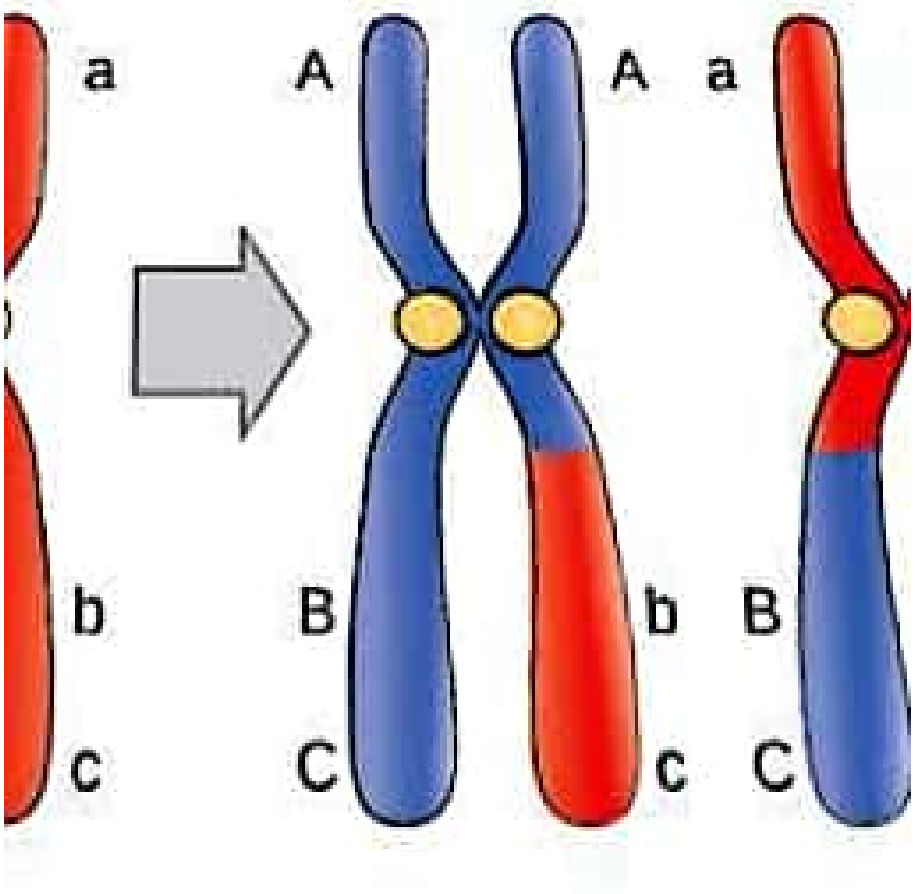
YOU'RE SOMEBODY'S TYPE

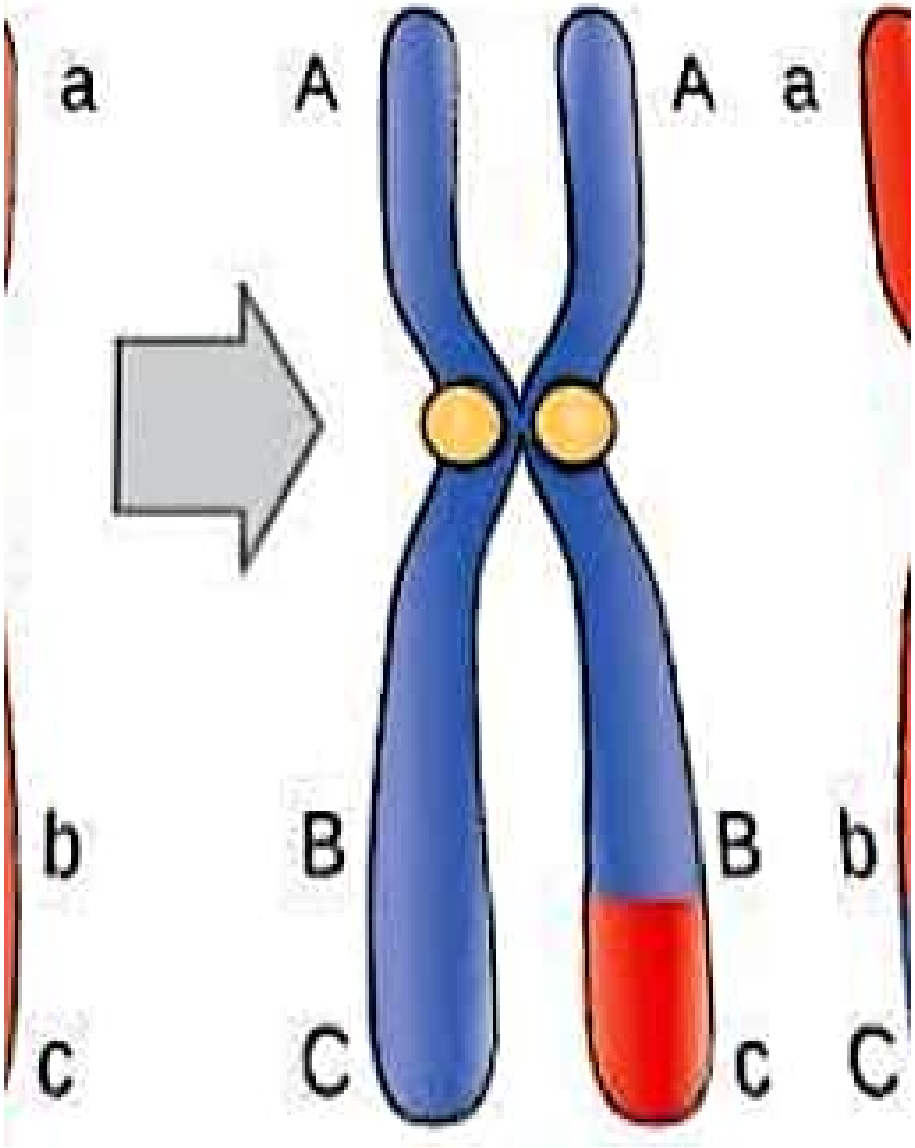


[illegible] takes place at the beginning of meiosis:

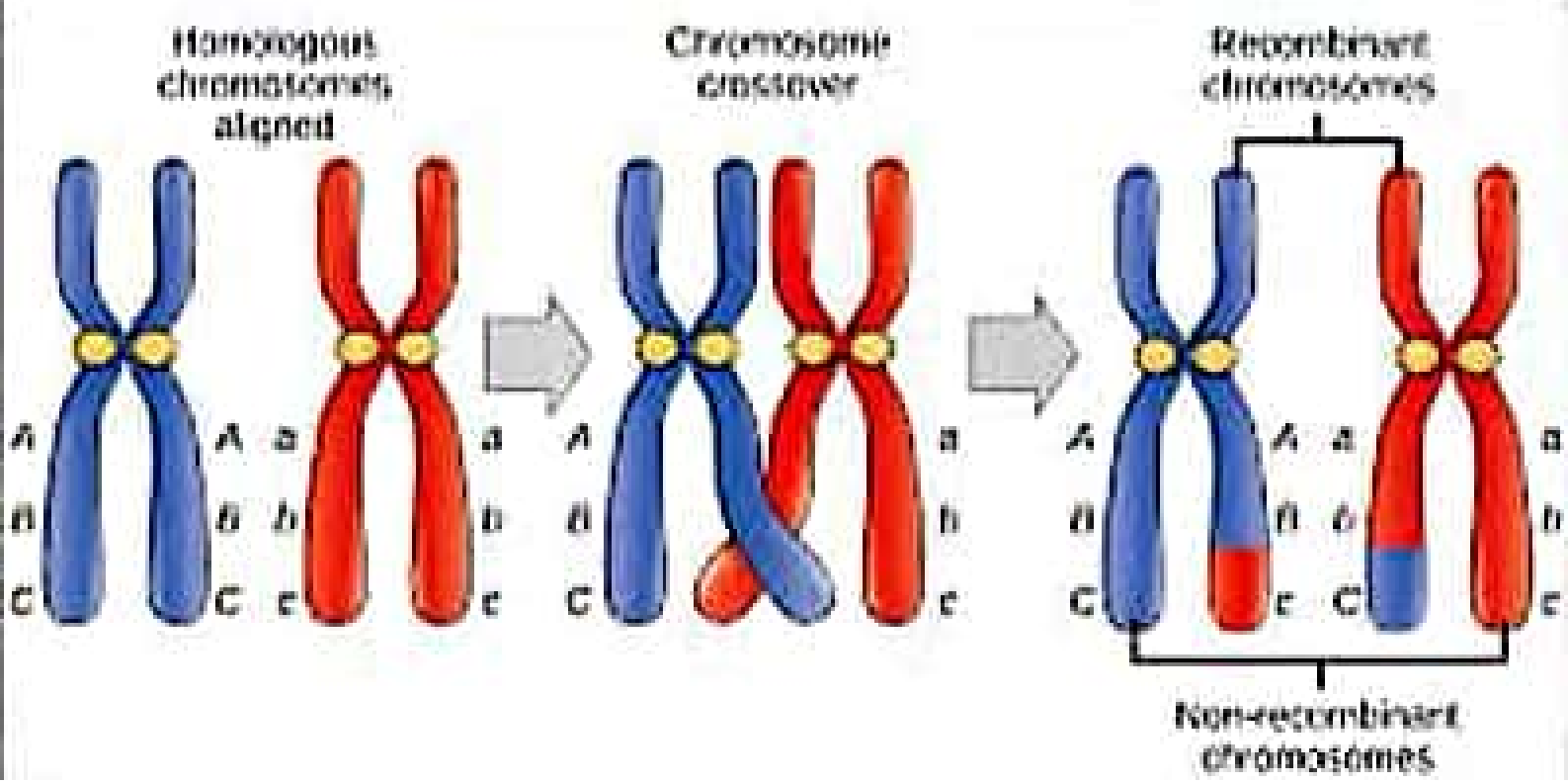


The homologous chromosomes undergo synapsis





Crossover



Life can be defined as *a physicochemical entity which exhibits reproduction, irritability, adaptation and locomotion.*

The problem of origin of life is still shrouded in mystery. However, there are a few speculations explaining the probable origin of life. They are as follows :

1. Abiogenesis (Spontaneous Generation)

The formation of life from non-living substances is called ***abiogenesis*** or ***spontaneous generation***. The belief in abiogenesis started from 300 BC and continued until 17th century.

Aristotle (384-322 BC) believed that fishes originated from mud. Insects (maggots) originated from decaying meat.

Epicurus (342-271 BC) wrote that

Man descended from monkey.

Origin of Life and Organic Evolution

Origin of life and organic evolution are separate problems. The problem of origin of life deals with the formation of simple life in the remote past from chemical substances. On the other hand, organic evolution deals with the derivation of new species of plants and animals from the first formed life by descent with modification. The origin of life and organic evolution may be illustrated as shown below:

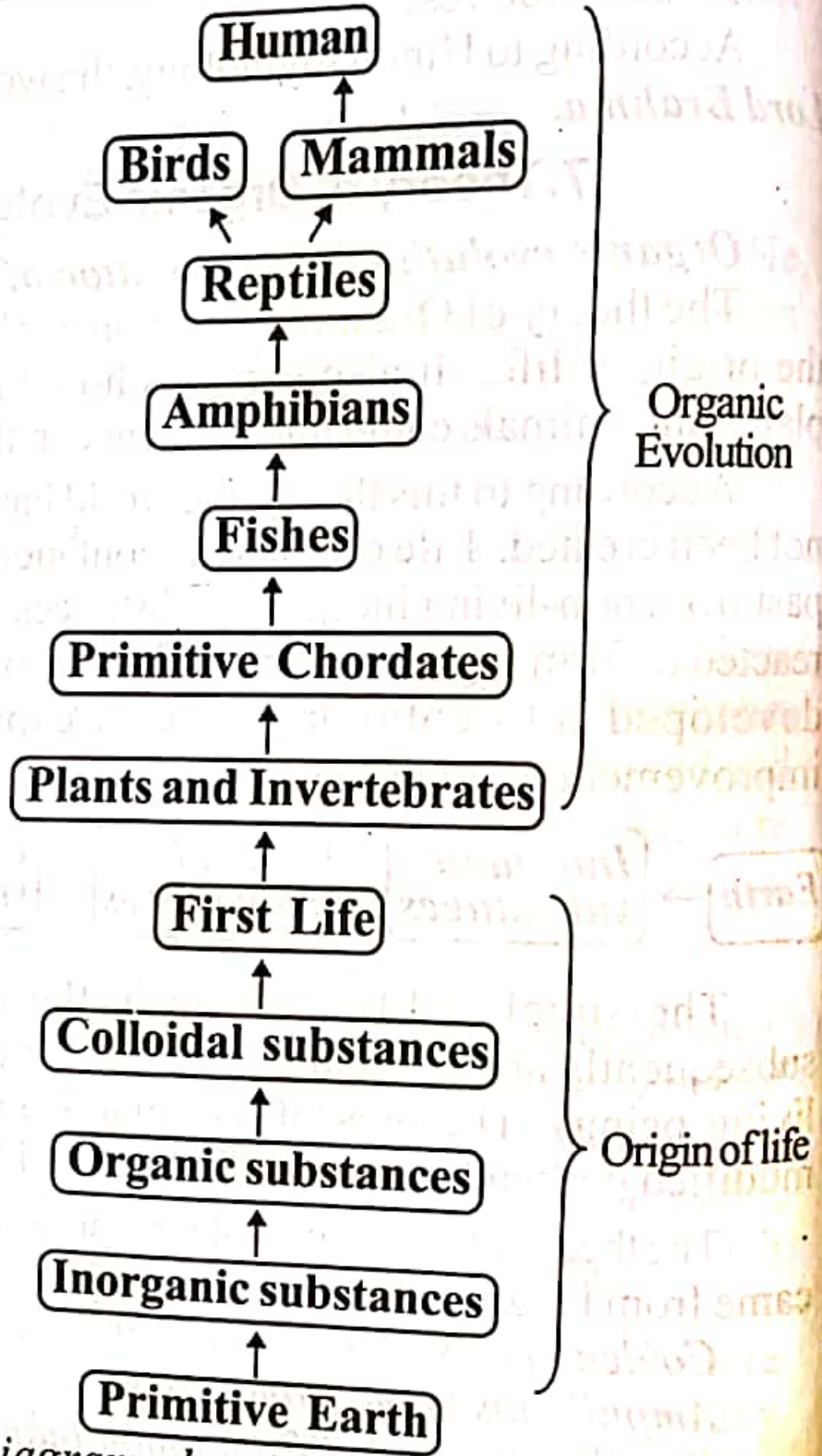


Fig.2.3: Diagram showing the origin of life and

existence by the combination of chemical compounds by constant chemical reactions over long periods of time. This is is the modern concept regarding the origin of life and is known as the '***chemical evolution of life***' or '***self assembly theory of origin of life***'.

Biochemical Origin of Life

Biologists of the present day strongly believe that life originated in the remote past from chemical substances. This theory is called ***biochemical origin of life*** or ***molecular evolution***. This theory was formulated by ***Haeckel,*** but developed by ***Oparin*** (1922) and ***Haldane*** (1929).

This theory is a new version of ***abiogenesis.*** This theory suggests that life originated from simple inorganic substances. These substances are transformed into organic substances which are transformed into a colloidal system to produce life. The origin of life involves the following steps:

1. Origin of Earth
2. Formation of Water, Ammonia and Methane
3. Formation of Micromolecules
4. Formation of Macromolecules
5. Formation of Nucleic acids
6. Formation of Nucleoproteins
7. Coacervation
8. Precell or Protocell and
9. Precell to cell.

1. Origin of Earth

The origin of life on our planet earth is closely related to the origin of earth itself. It is believed that earth was formed from the sun some 5000 million years ago.

The earth, as a piece, was broken from the sun and the piece gradually moved away from the sun. When it was broken

4. Lamarckism

Lamarckism is the theory of ***Organic Evolution.*** It was proposed by ***Lamarck.*** It is also called ***inheritance of acquired characters.*** It explains ***the origin of new species.***

Lamarckism has the following salient features:

1. Complex living organisms are formed from simple living organisms.

2. The environment does not remain constant. It changes.

3. The change in the environment influences the plants and animals.

4. The changes in the environment provide new needs for the organisms.

5. In response to the new needs, organisms develop new structures.

6. Variations in organisms arise through the effects of *use* and ***disuse.***

7. The continuous use makes a structure greatly developed and disuse makes the structure atrophied.

8. *The new structures developed by the organisms in response to the environment* are called ***acquired characters.*** These acquired characters are transmitted generation after generation and by this way a new species is produced.

Principles of Lamarckism

Lamarckism consists of two ... follows:

use their wings. This happened generation after generation resulting in the degeneration of wings and loss of flight.

Fig.4.6: Kiwi, a flightless bird. The flightless condition is the result of disuse of wings.

3. Vestigial Organs

The vestigial organs of man and of other animals are the result of continuous disuse. Eg. *Coccyx, ear muscles* and *plica semilunaris in man, limbs in snakes,* etc.

4. Inheritance of Acquired Characters

The transmission of characters, developed by an organism during its life time, to the young ones is called ***inheritance of acquired characters.***

When the environment changes, animals respond to it. In the response, animals develop new adaptive characters. The characters developed by the animals during their life time in response to the environmental changes are called ***acquired characters.*** According to ***Lamarck,*** these acquired characters are transmitted to the offspring. This is called ***inheritance of acquired characters.***

Examples: 1. The long neck of ***giraffe*** is an acquired character. It is transmitted to the offspring generation after generation.

2. The degenerated wing of ***kiwi*** is an acquired character. It is inherited by its progeny generation after generation.

Tail of Mice: ***August Weismann*** cut the tails of mice continuously for about twenty generations. He did not allow the mice to use their tails for twenty generations. If ***Lamarck's*** principle of inheritance of acquired characters was correct then, in the 21st generation all the mice should have been tailless. But the mice were born with tails with normal length.

Germplasm Theory: The germplasm theory of ***August Weismann*** gives another blow to ***Lamarckism.*** The germplasm theory states that each organism is formed of two types of cells, namely ***somatic cells*** and ***germ cells.***

The somatic cells constitute all the body cells except the germ cells of gonads. They perish with the death of the animal. Any character, acquired by somatic cells, cannot be transmitted to the offspring. That is why the scar of a soldier is not inherited by his son.

The germ cells (gametes of parents) alone are transmitted from parents to offspring. So any change that occurs in the germ cells alone is transmitted to the offspring.

Lamarck could not differentiate between the germplasm and the somatoplasm. He said that all acquired characters are heritable. But, according to germplasm theory, the characters or changes that occur in the germ cells alone are inherited.

August Weismann says that *'acquired characters are not inherited because, environmental factors cannot influence the next generation. This is because the environmental factors do not affect the genes in the sex cells'.*

Lamarck

Lamarck was a ***French Scientist.*** He was the first ***Evolutionist*** to propose a definite theory explaining the ***evolution of living organisms.***

He was born in 1744. As his father wished him to enter priesthood, he was sent to study ***Christianity.*** As soon as his father died he discontinued his course. Then he joined the ***French army.***

One of his comrades caused injury to the glands of his neck by lifting him by the head. This made him unfit for military life and he left the military service.

Then he studied ***Medicine*** in Paris. He could not com-
plete Medical career.

At the age of 50, he became a ***Professor of Invertebrate Zoology.***

Lamarck had a struggling life throughout. He had to fight against poverty. In his last days, he became blind for ten years and he died in a miserable condition in 1829.

Osborn stated that ***Lamarck was the most prominent figure between Aristotle and Darwin.***

Contributions of Lamarck

1. Lamarck was the first man to propose a ***theory for evolution*** called ***Lamarckism*** or ***inheritance of acquired characters.***

2. He coined the term ***Biology.***

3. He believed that plant and animal series were continuous with each other at a remote point.

4. Lamarck was a ***taxonomist. Lamarck's*** work on classification is probably his best. He separated spiders and crustaceans from insects.

He classified the animals into ***vertebrates*** and ***invertebrates.***

5. ***Lamarck*** published many books. The book, ***Philosophic zoologique*** published in 1809, gives the evolutionary ideas of ***Lamarck.***

The modern version of Lamarckism is called ***Neo-Lamarckism.***

It is a theory of ***Organic Evolution.***

It explains the origin of new species by the ***inheritance of acquired characters.***

The Neo-Lamarckism gives experimental evidences for Lamarckism.

1. Inheritance of Bony plates in Stickle-back

The best example that illustrates the inheritance of acquired characters is provided by the fish stickle-back, *Gasterosteus.*

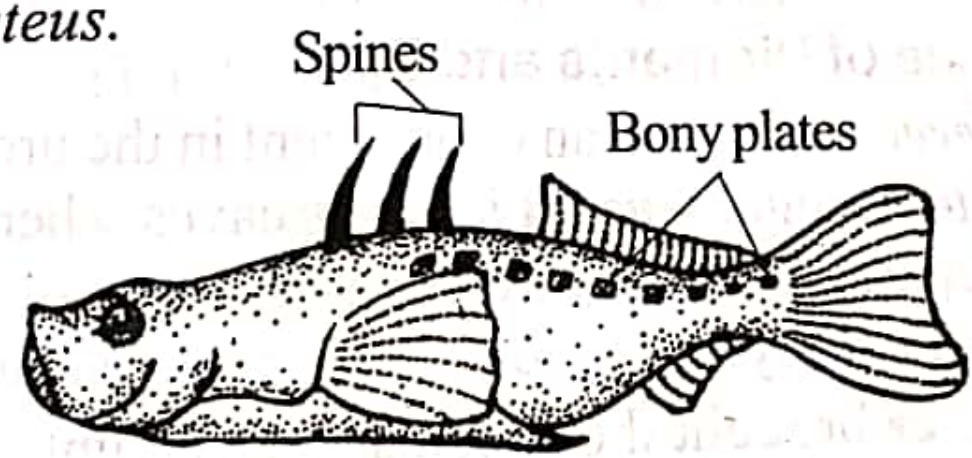


Fig.5.1: Stickle-back showing bony plates.

This fish inhabits freshwater, sea water and brackishwater.

The marine stickle-back has ***20 to 30*** bony plates on the middorsal line of the trunk; these bony plates seem to protect the fish from tides and waves and salt. The brackishwater fish has ***3 to 15*** bony plates; the freshwater fish has no bony plates. When a freshwater stickle-back is brought into the sea water, it gradually develops the bony plates. This is an acquired character and this character is inherited by its offspring. Similarly, when a marine fish is brought into the freshwater, it loses

6. Darwinism

Charles Darwin

Charles Darwin was an eminent ***evolutionist.*** He proposed an evolutionary theory called ***Darwinism*** or ***natural selection theory.***

He was born in England, in 1809. His father admitted him in a medical school at Edinburgh; but ***Darwin*** was not at all interested in medical study. So he discontinued his course. He was then admitted to ***Cambridge*** to become a clergyman. ***Darwin*** took his degree for clergyman in 1831.

When he was studying, he got the friendship of many scientists, the most prominent of them was ***Dr.Henslow.*** From them he learned many things about biology and natural history. He was much attracted by nature. At that time, the British Admiralty planned a voyage of exploration for 5 years on a ship named ***H.M.S. Beagle. Dr. Henslow*** was asked to nominate a young naturalist for the voyage. He gave the opportunity to young ***Darwin.***

The voyage took him to many islands including Galapagos islands. During the voyage, ***Darwin*** took elaborate notes on the nature of the ***land, plants*** and ***animals*** of the regions visited. The voyage started in 1831 and ended in 1836.

After the voyage, ***Darwin*** worked intensively on his observation of nature. He published his observations, views and inferences in journals and books.

He published more than 15 journals and books on various branches like ***Geology, Botany, Zoology*** and so on. Of all these

publications, the most important one and that which brings fame to ***Darwin*** is the ***"Origin of Species"*** published in 1859.

Charles Darwin married his cousin ***Emma wedgwood*** in 1839. He had 2 daughters and 5 sons.

Darwin died on April 19, 1882 and he was buried in ***Westminster Abbey,*** next to ***Sir Issac Newton.***

Darwinism or Natural Selection Theory

The evolutionary idea contributed by ***Darwin*** is called ***Darwinism*** or ***Natural selection theory.*** It explains the mechanism of evolution. Darwinism consists of five principles. They are the following:

1. *Over Production*
2. *Struggle for Existence*
3. *Variations*
4. *Survival of the Fittest*
5. *Origin of new Species.*

1. Over Production or Geometric Ratio of Increase

Animals and ***plants*** produce young ones by reproduction. This is called ***prodigality of production***. This leads to overcrowding.

1. Paramecium

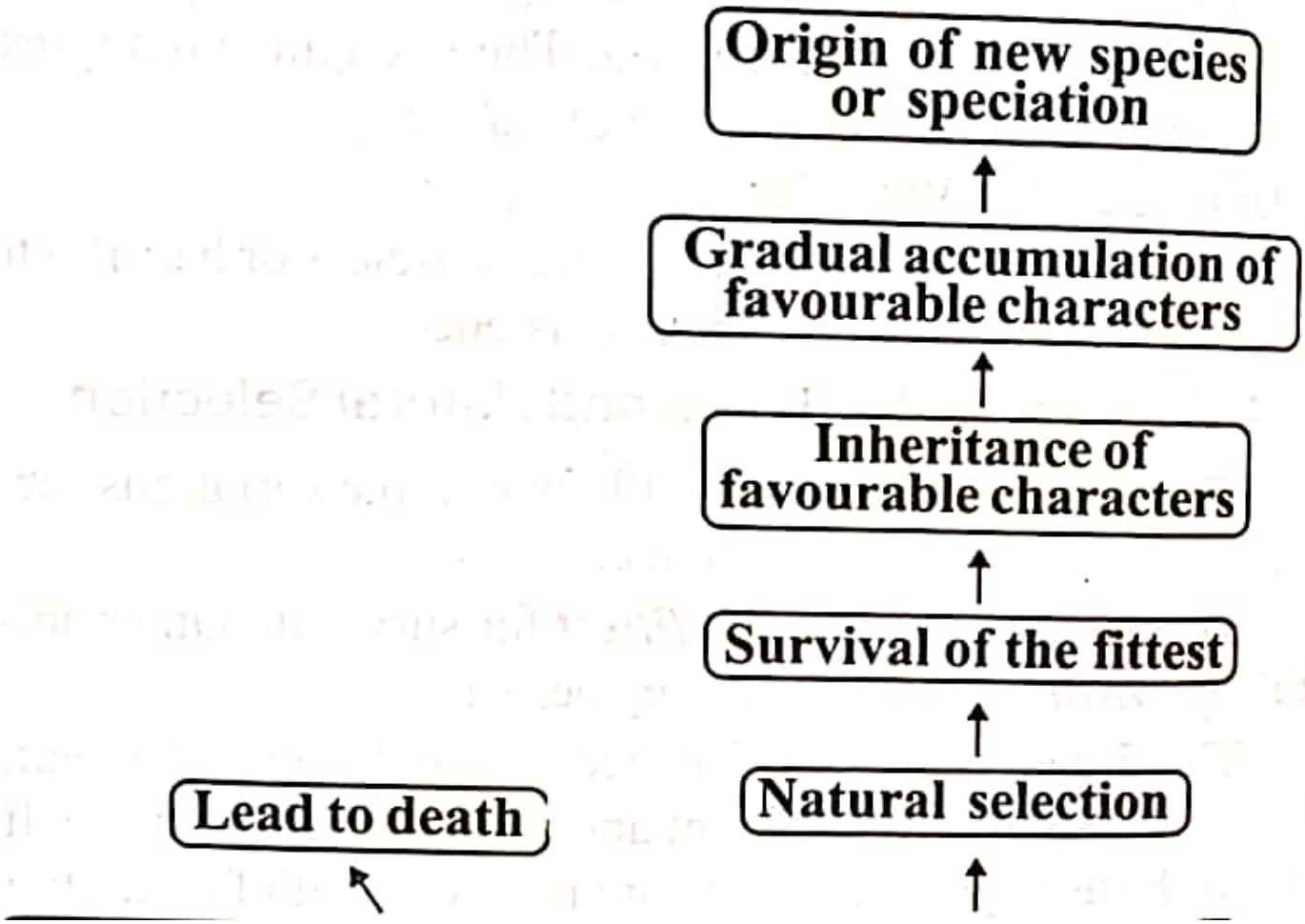
Paramecium undergoes binary fission every 16 hours. If all the daughter ***paramecia*** of a single ***Paramecium*** survive and reproduce at this rate for five years, they will produce a cytoplasmic mass, the volume of which will be equal to 10 thousand times the volume of the earth ***(Woodruff).***

2. Oyster

A single oyster lays about 50 million eggs in a season. If all these eggs hatch out, and if all the young ones reproduce for 5 generations, they will form a volume about eight times the size of the earth.

3. Elephant

ceeding generation, also natural selection operates and hence suc-
in each and every generation there is a slight betterment of the
already developed favourable characters. Thus after many gen-
erations the descendants appear to be different from the origi-
nal animals. Hence these descendants can be classified into a
separate group or unit called ***species.*** Thus, according to Dar-
win, a new species originates by the ***gradual accumulation***
of favourable variations for a number of generations.



7. Neo-Darwinism

Neo-Darwinism is *the modern theory of natural selection.*

The recent supporters of Darwinism modified the theory according to the latest developments in biology.

In Neo-Darwinism, the major defects of Darwinism are rectified. ***Darwin's*** supporters give their experimental evidence of natural selection. Mutations and other contributions of genetics are incorporated in Neo-Darwinism.

The biologists who are extending their helping hand for the construction of Neo-Darwinism are called ***Neo-Darwinians.*** A few Neo-Darwinians are

Romanes	***Haldane***	***Dobzhansky***
Wallace	***Goldschmidt***	***Mendel***
Fisher	***Sewall Wright***	***Kettlewell*** and
Huxley	***Ernst Haeckel***	***Herbert Spencer***
Ford	***August Weismann***	

The Neo-Darwinism has the following ideas:

A. Experimental evidences

B. Explanations to the objections

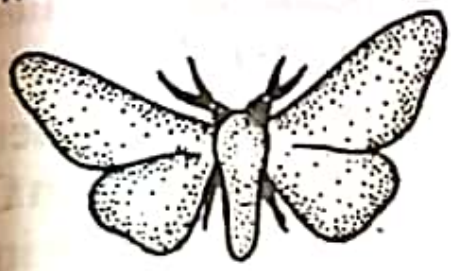
A. Experimental Evidences

The natural selection theory is supported by a number of experiments conducted by biologists. A few are given below:

1. Industrial Melanism

Industrial melanism is *a phenomenon where the moths living in the industrial areas, develop black colour (mela-*

nin pigments) to match the body to soot-covered background, on the bark of trees.



Non-melanic form

Melanic form

87

Fig.7.1: Peppered Moths.

The industrial melanism is observed and worked out by a number of evolutionists like ***Fisher, Ford*** and ***Kettlewell.***

Industrial melanism was observed in a ***peppered moth**** *Biston betularia* living in ***Manchester,*** an industrial city of Great Britain.

The peppered moths exist in two forms, namely ***melanic forms*** and ***non-melanic forms.*** The melanic forms are black in colour because, they contain ***melanin*** pigments. They are also called ***carbonaria.*** The non-melanic forms are light coloured. The light colour is due to the absence of melanin pigments.

In ***Manchester,*** all the moths were non-melanic before 1845. In the year 1845, only one melanic form appeared. There after the number of melanic forms gradually increased. In 1848, it formed about 1% of the population and the remaining 99% was non-melanic forms. In the year 1898, the melanic forms formed up to 99% of the population and the non-melanic form was reduced to 1%.

Year	Melanic forms	Non-melanic forms
Before 1845	-	100%
1848	1%	99%
1898	99%	1%

Fig.7.2: Distribution of peppered moth.

De Vries

- ***Hugo De Vries*** was born in Netherlands in 1848. He worked as a ***Professor of Plant Physiology.***
- ***De Vries*** proposed the ***mutation theory*** of Evolution in 1901. He stated that ***mutation*** is the universal source of origin of species.
- He made extensive experiments on the ornamental plant evening primrose, *Oenothera lamarckiana.* He discovered the sudden appearance of new species of *Oenothera* from seeds collected from normal plants. The new forms bred true

2. Retrogressive Species

In retrogressive species, there is a loss of some parental characters. Eg. *O. laevifolia*, *O.brevistylis* and *O. nannella*.

3. Degressive Species

In degressive species, some of the vital characters are lost and the survival is difficult. For example, *O.albida* is a variety where the chlorophyll system is defective. *O.oblonga* is a weak variety where the leaves are oblong and needle-like.

4. Inconstant Species

Inconstant species, do not breed true; very often they produce new varieties. *O. lata* produces only pistillate flowers; pollen grains are absent; so cross pollination is the rule. *O. scintillans* produces flowers of its own variety as well as of original variety.

Salient Features of Mutation Theory

1. ***De Vries*** believed that new species originate as a result of large ***discontinuous variations*** which appear suddenly and form new species at once.

2. New species are formed by sudden changes at a single stroke. The animals exhibiting mutations are called ***mutants.***

3. There are no intermediate stages because new species are formed in a single generation.

4. Mutation can take place in any direction.

5. Mutations are recurring in nature.

6. A large number of the same type of mutations appear at the same time.

7. Mutations are subjected to natural selection.

Examples of Mutation from Animals

1. **Ancon Sheep**: In 1891, in the flock of ***Seth Wright*** a farmer in England, appeared a male lamb with short, bowed legs. ***Wright*** reared this lamb and bred from it the ***Ancon*** breed of sheep. It was so short that it could not jumb over an ordinary stance fence. This breed become extinct about 80 years ago.

Introduction

The synthetic theory is a modern theory of Evolution ***combining Darwinian Natural Selection and Mendelian Genetics.***

It explains the origin of new species and the process of Evolution.

This theory was proposed by ***Dobzhansky*** in 1937 through his book ***Genetics and the Origin of Species.***

Huxley (1942) proposed the term ***modern synthesis.***

The main architects of the synthetic theory are ***Dobzhansky, Mayr, Huxley, Simpson, Stebbins, Fisher, Haldane, Sewall Wright,*** etc.

Mayr (1978) states that the modern synthetic theory of evolution amplifies ***Darwin's*** theory of ***natural selection*** in the light of ***Mendelism, population genetics, biological concept of species*** and many other concepts of ***biology*** and ***palaeontology.***

The new synthesis is characterized by the complete rejection of the inheritance of acquired characters. It gives an emphasis on the ***gradualness*** of evolution.

Huxley (1942) states that '***modern synthesis' owes much more to Darwin than to any other evolutionists and is built around Darwin's principles.***

Need for Modern Synthesis

The concept of evolution explains the origin of life and the origin of the wide variety of animals and plants existing on

the Earth. There are three theories on evolution. They ar
Lamarckism, Darwinism and ***De Vrism.***

Since Lamarckism has been proved false, it is only of hi
torical interest.

Darwinism does not satisfactorily explain the origin an
inheritance of variation.

De Vries theory of mutation is weak because no sing
mutation or set of mutations has ever been so large and n
merous that it can start a new species in one generation.

Hence the modern evolutionists selected the best aspec
of the older concepts and combined them with their ideas
order to get a new concept. The new concept is called sy
thetic theory of Evolution.

Aim of Modern Synthesis

The modern synthesis explains the mechanism of evo
tion. It explains evolution in terms of genetical change in pop
lations leading to the origin of new species.

Concepts of Modern Synthesis

The modern synthetic theory consists of three main co
cepts. They are the following:

1. Genetic variation
2. Natural selection
3. Isolation.

1. Genetic Variation

The difference in closely related animals is called va
tion. *The change in genes and gene frequencies* is ca
genetic variation. Genetic variation is the *raw material*
evolution.

Futuman (1979) states that ***any change from one g***
eration to the next in the proportion of different gen
called evolution.

Eldredge and ***Guild*** (1977) state that ***evolution is***
modification of genes and gene freauencies.

quired by mutations and it is inherited on the ***Mendelian*** principles. When the resistant strains are cultured in chloramphenicol free medium, they grow much more slowly than the susceptible ones. This experiment shows that populations can be made to respond adaptively to controlled changes in their environment, and these adaptive changes are due to mutations.

B. Explanations to the Objections

Neo-Darwinians tried to give convincing evidences and explanations against the objections and criticisms raised against Darwinism. They are as follows:

1. Germplasm Theory

The important objection levelled against Darwinism is that ***Darwin*** did not distinguish between ***heritable*** and ***non heritable*** variations. This objection is answered by ***'Germplasm theory'*** proposed by ***August Weismann*** in 1904. According to this theory, the characters appearing in the somatoplasm disappear with the death of the possessor; so they are not ***inherited.*** The characters or changes appearing in the germplasm alone are inherited generation after generation.

2. Mendel's Experiments

Another objection raised against Darwinism is that it does not explain the process of inheritance. This objection is solved by ***Mendel's*** discoveries. ***Mendel*** explained the process of inheritance through experiments. He said that characters are determined by factors or determiners (now called genes). The factors are transported through the gametes to the offspring. He did a number of experiments on pea plants to prove his hypothesis. The results of his experiments are formulated in the form of laws, collectively called ***Mendel's laws.*** ***Mendel's*** concept has the following principles:

1. Each animal has a ***bundle of characters.***
2. Each character is controlled by a pair of ***genes.***

Geographical isolation brings about ***allopatric speciation.*** Reproductive isolations brings about ***sympatric speciation.***

Operation of Modern Synthesis

* Populations develop genetic variations through ***mutation, hybridization, recombination***, etc.
* Natural selection allows the favourable genetic variations to spread in the population through differential reproduction in successive generations.
* The populations are ***isolated*** geographically and reproductively and this leads to the failure of interbreeding. When interbreeding does not occur, the isolated populations are grouped into new species.

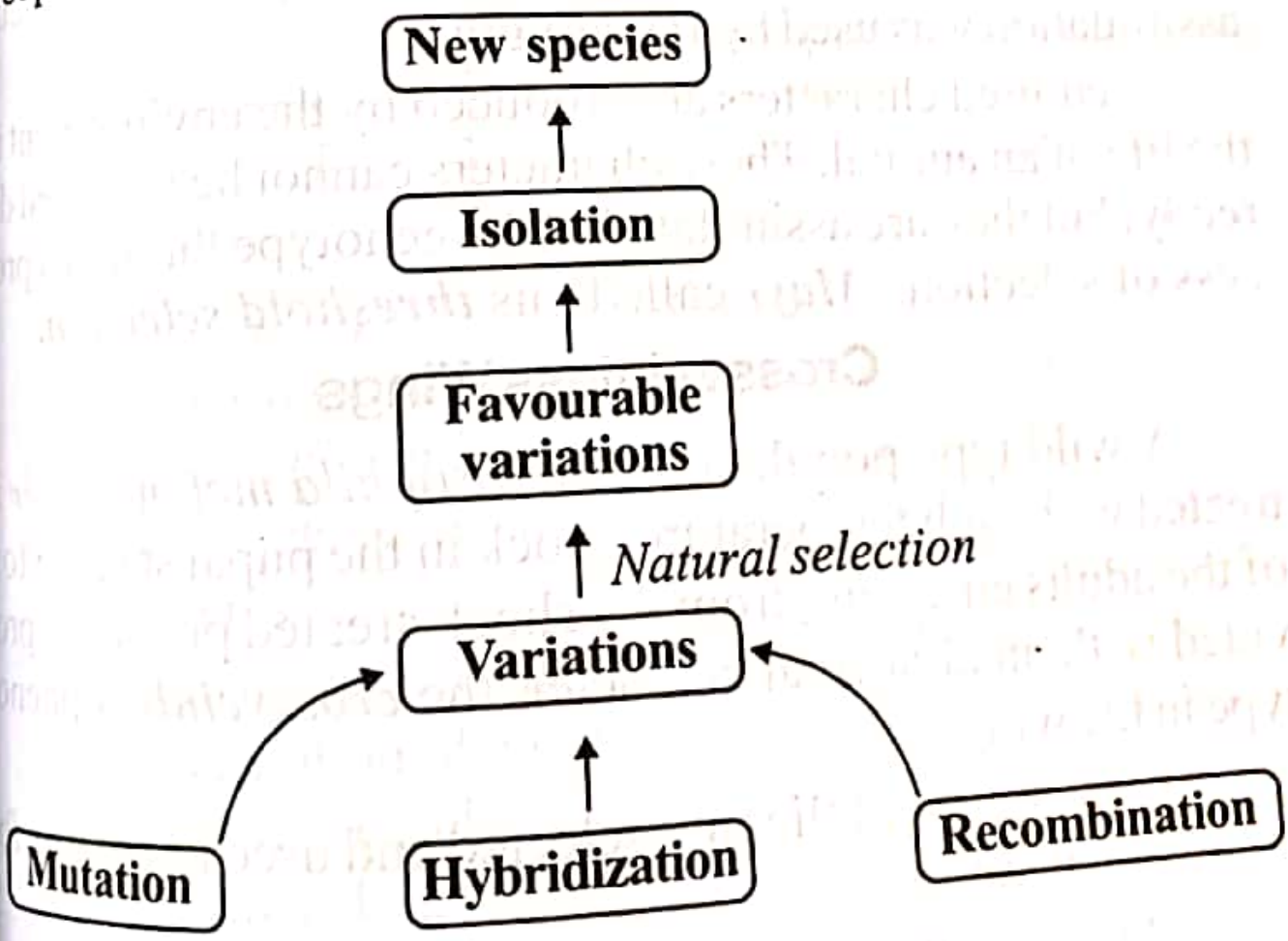


Fig.11.2: Mechanism of modern synthesis.