SUBJECT CODE: 18BBO54C: UNIT - IV

MASS SELECTION

Mass selection can be used in the improvement of self pollinated crops by planting segregating populations in large plots and harvesting in bulks.

Selection may be practiced in each generations by eliminating undesirable plants.

Mass selection permits a large pool of germplasm to be manipulated an carried along.

STEPS IN MASS SELECTION

- FIRST YEAR- A large no. of phenotypically similar plants are selected for their vigour, plant type, disease resistance, etc. The no. may vary from few hundred in few thousands. Seed from selected plants are composited to raise next generation
- SECOND YEAR – The composite seeds are planted in a preliminary yield trial along with standard check variety. The variety from which the selection was made should also be included as a check to determine if there has been an improvement due to the selection.

- THIRD TO SIXTH YEAR – The variety is evaluated in a coordinated yield trials of several locations.

- SEVENTH YEAR – The variety may be released for cultivation if found suitable and if recommended

APPLICATION OF MASS SELECTION

In self pollinated crops mass selection has two basic applications :-

1. Improvement of local varieties
2. Purification of existing varieties

ADVANTAGES OF MASS SELLECTION

- It retains considerable genetic variability.
- Reduction in time and cost because extensive and prolonged yield trials are expensive
- Since a large no. of plants are selected the adaptation of original variety is not changed.

PURELINE BREEDING

- This is the development of new varsities from the old 'land' varieties that have passed down from generation to generation of the farmers.
- Most plants selected from such varieties can be expected to be homozygous and hence the starting point of a new tree breeding variety.

PURE LINE – Pure line is the progeny of single self fertilised homozygous plant.

PROCEDURE

- Select a no. of single plant, compare their progenies in field trials and save the single most valuable progenies as a new variety.
- Many valuable varieties are traced back to a single chance variant noticed and selected by farmers.

CHARACTERISTICS OF PURE LINE SELECTION

1. The phenotypic differences within a pure line is environmental and therefore non heritable.
2. The pure line becomes genetically variable with time due to mechanical mixture, mutation, etc.

❑ USES OF PURE LINE

- Superior line is used as variety.
- It is used as parent in development of new variety by hybridisation.

APPLICATION OF PURE LINE SELLECTION

- It is used for improvement of local varieties, have a considerable genetic variability, e.g., wheat variety NP-4 and NP-52 .
- It is practiced in introduced material to develop suitable varieties, e.g., Shining mung-1 selected from Kulu type-1 .
- It provides an opportunity for selection of new characteristics such as disease resistance, grain type, plant type, etc.
- It provides an opportunity for selection in the segregating generations from crosses.

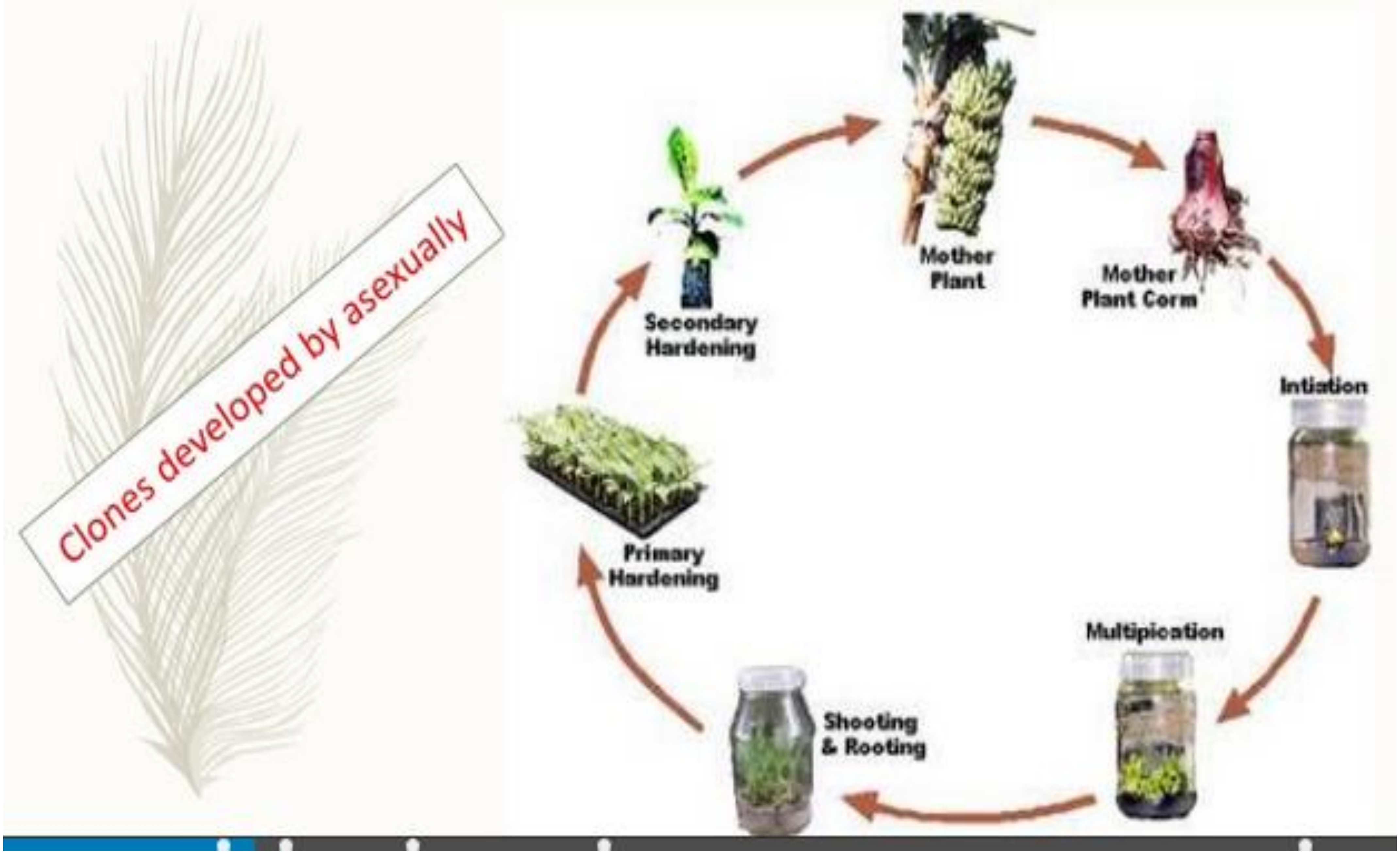
MERITS OF PUE LINE METHOD

1. Pure line selection achieves maximum possible improvement over the original variety.
2. It is easier than hybridisation, required less skill.
3. Used for developing inbreed line and pure line.

Clone

- Progeny of a single plant obtained by asexual reproduction is known as clone.
- Crop which are propagated asexually or by vegetative means clonal crops.

Figure 1. *In vitro* proliferation of guava (*Psidium guajava* L). (A) stock guava plants in the greenhouse; (B) nodal section became browning after sterilization; (C) new shoots break out from healthy nodal sections; (D) shoots proliferated; (E) elongated shoots; (F) rooted shoots by medium method (medium with IBA); (G) rooted shoots by dipping method; (H) guava plantlets acclimatized into the soil for 2 weeks; (I) guava plantlets acclimatized into the soil for 10 weeks.


Clones developed by asexually
Mother Plant
Mother Plant Corm
Intiation
Multipication
Shooting & Rooting
Primary Hardening
Secondary Hardening

Clonal selections

Improvement of asexually propagated crops by selecting superior clones is known as clonal selection.

Superior clones can be isolated from three types of materials

1) Local variety
2) Introduced variety
3) Inter crossed population

Breeding procedure of clonal selection

FIRST YEAR :-

a) From a mixed variable population, few hundred to few thousand desirable plant are selected.

b) A rigid selection can be done for simply inherited characters with high heritability.

c) Plant with obvious weakness are eliminated.

SECOND YEAR:-

Clones from the selected plants grown separately.

a) Desirable clones selected

THIRD YEAR :-

Preliminary yield trials with standard checks.

a) Selection for quality, disease resistance etc. Disease nurseries may be planted.

b) Few outstanding clone selected.

FOURTH-SIXTH YEAR :-

Multilocation yield trials with standard checks.

a) Best clone identified for release as a new variety.

SEVENTH YEAR :-

The best clone release as a new variety.

a) Seed multiplication for distribution begins.

Schematic representation of clonal selection

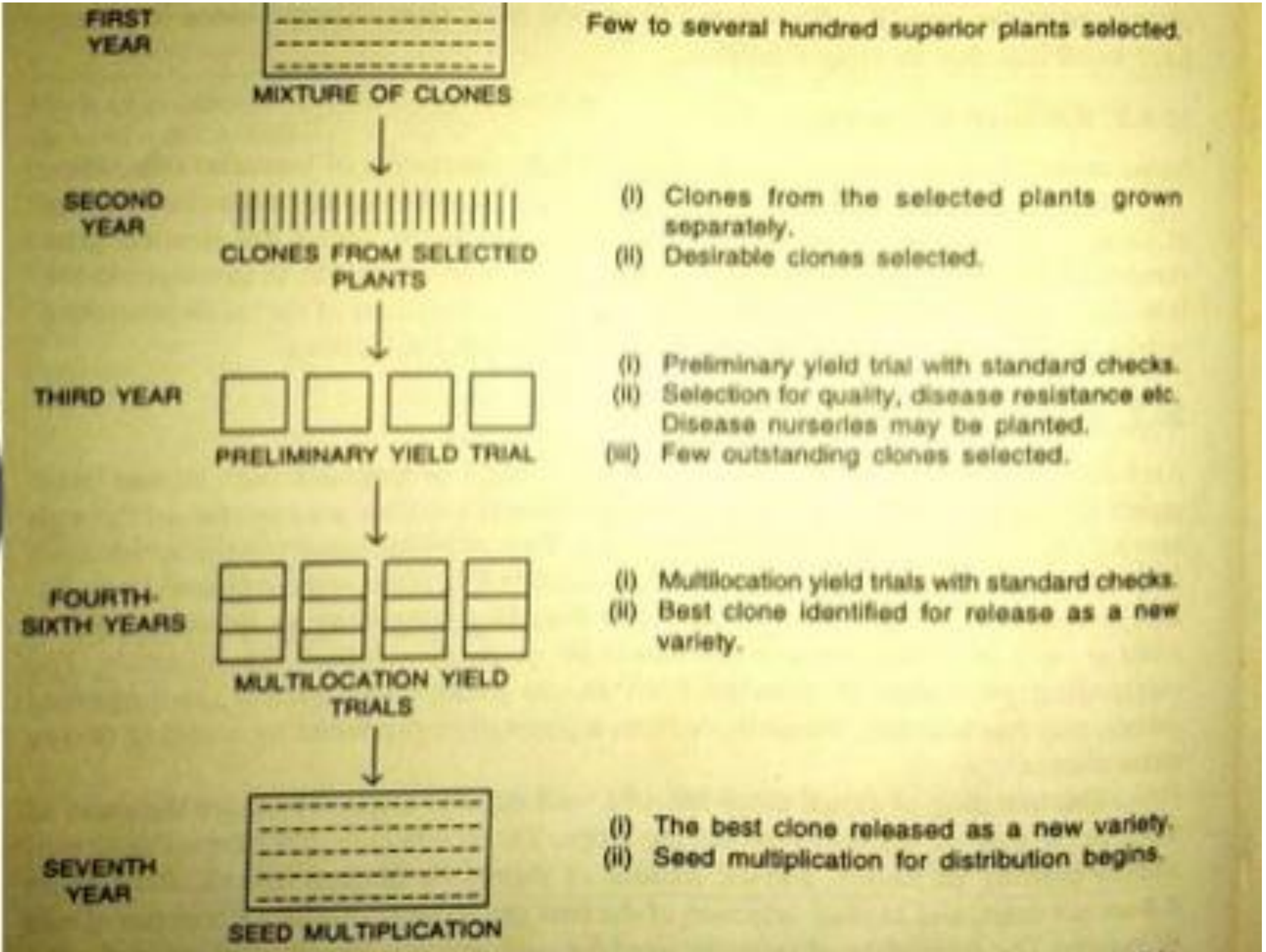


Fig. 20.1. A generalised scheme for clonal selection in asexually propagated species. This figure applies to a crop in which one generation does not take more than one year.

Merits

1) Useful in conserving heterosis for several generations i.e. method retains all the characteristic of the parental clone for several years.
2) Highly uniform and stable
3) Effective method for genetic improvement of asexually propagated crop plants.

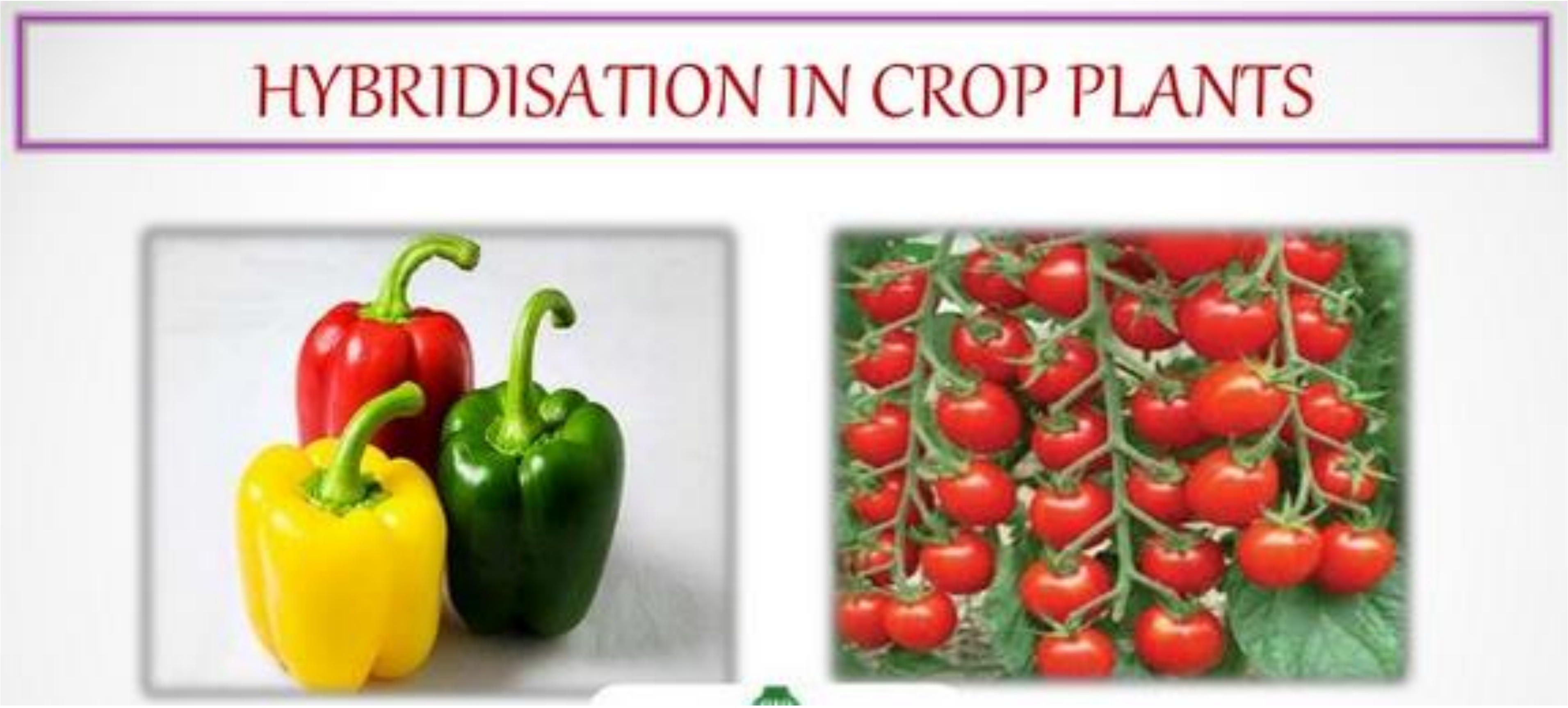
Demerits:-

1) Highly prone to new disease of new Races.
2) Can't create new variability.

Achievements in fruit crops:-

crop	Clonal var
❖ Mango:-	– Dasehari-51, Niranjan, Cardoz mankurad, Payur-1
❖ Grapes:-	– Pusa seedless, Thomson seedless, Perlet, Tas –e-ganesh, Sonaka, Rao sahebi, dilkhus.
❖ Guava:-	– L-49 Jyoti, Alandi, S-1, Arka mridula,
❖ Sapota:-	– Cricket ball, Kirthi bharti, Badami, Baramasi, Guthi, Thagarampudi.

crop	Clonal variety
❖ Papaya:-	– CO-1, CO-2, CO-5, CO-6, Pusa giant, Pusa dwarf.
❖ Pineapple:-	– Singapore Spanish, MasmerahPuerto Rico
❖ Litchi:-	– glorff,Saharanpur sel, swarna roopa.
❖ Aonla:-	– NA-4, NA-5, NA-6, NA-7,NA-8,NA-10
❖ Bael:-	– NB-1,NB-5, NB-6
❖ Pomegranate:-	– G-137,CO-1, YCD-1



Hybridization- Types, Selection of parents, Methods of Emasculation- Bagging and tagging

INTRODUCTION

Is the food produced p.a. in our country sufficient to feed the ever increasing population?????

certainly a big "NO"

Thus, there is a need to enhance our Agricultural efficiency.

WAYS TO ENHANCE AGRICULTURAL EFFICIENCY

a) Cultivate more land

b) Achieve higher yield on currently cultivated land

c) Restore the productive capacity of already degraded agricultural land

d) Reduce wastes & losses in production processes.

Here I stress upon achieving higher yield on currently cultivated land, which is possible only by CROP VARIETY IMPROVEMENT.

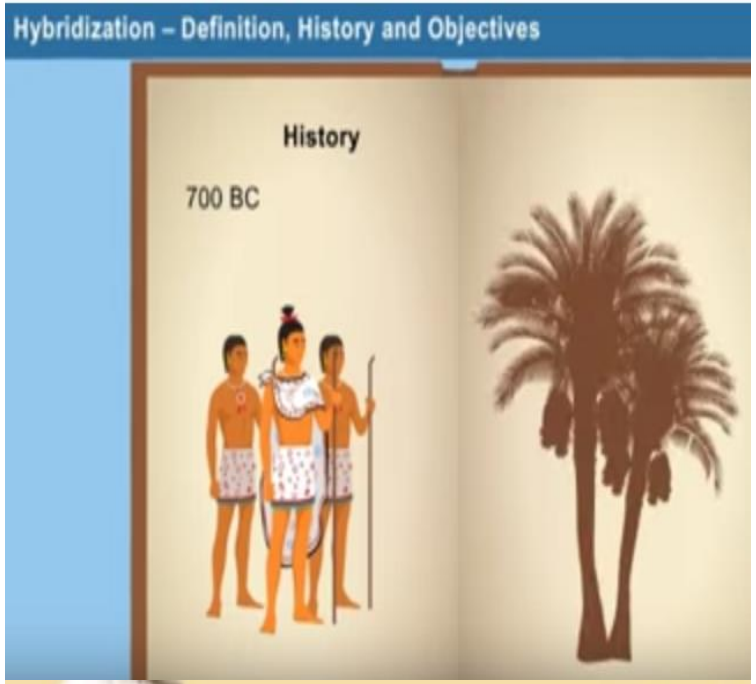
CROP VARIETY IMPROVEMENT

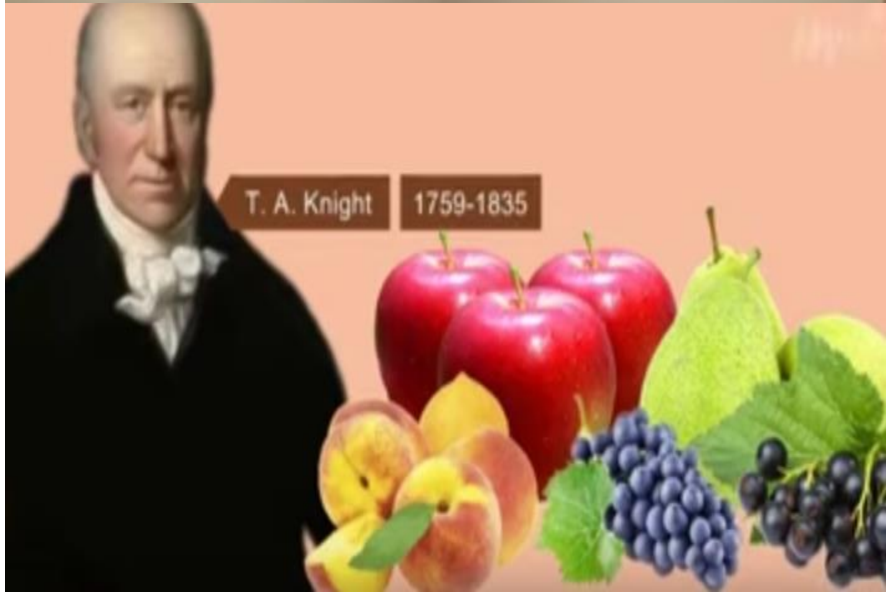
❖ Refers to finding a good variety that would be superior in quality & giving good yield.

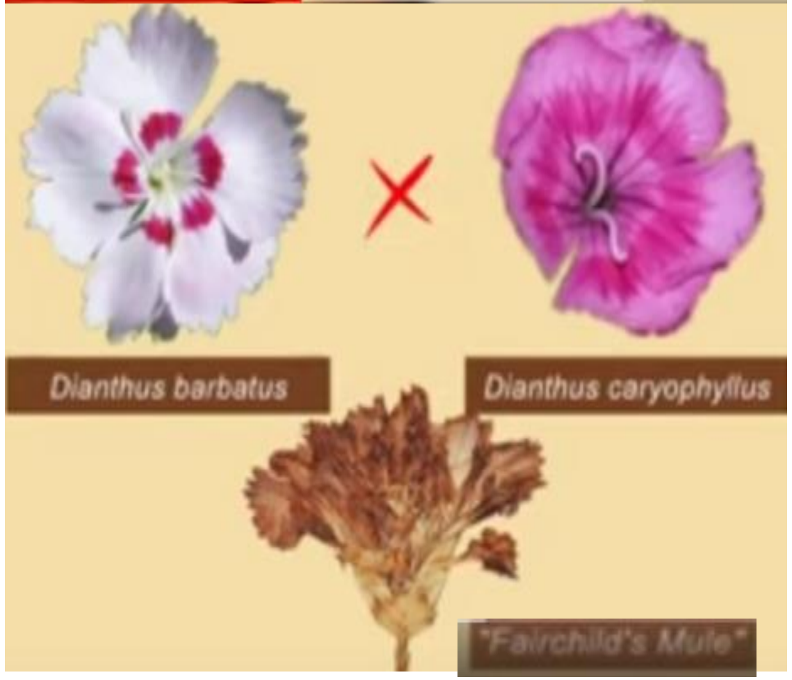
❖ **This is done by HYBRIDISATION**

Hybridisation is the crossing between genetically dissimilar plants to obtain crops having usefull and desirable characteristics like disease resistance, good quality & higher yield.

Hybridization – Definition, History and Objectives







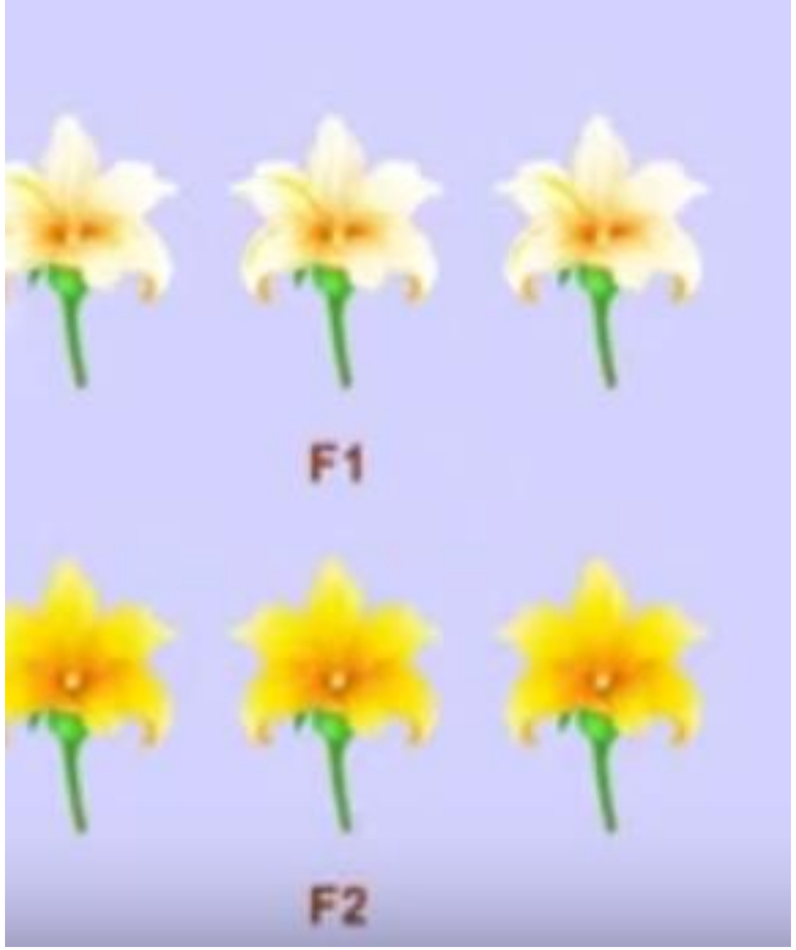

Sargaret

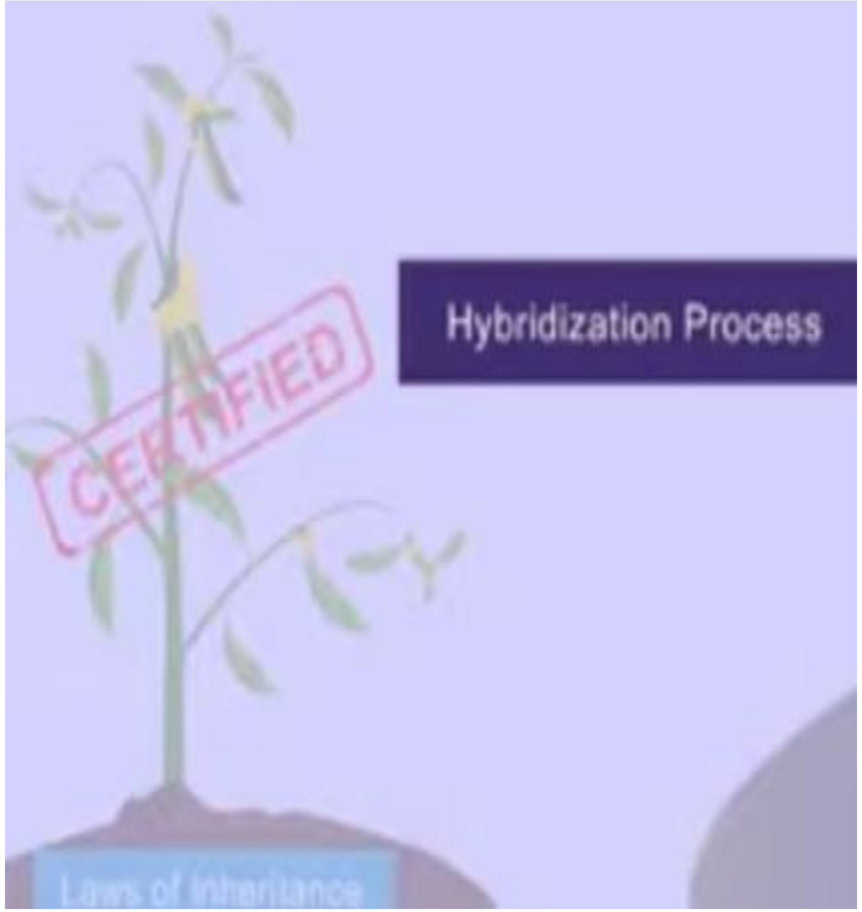

Carl Friedrich von Gaertner


1865
Gregor Mendel


Charles Naudin


John Goss


F1
F2


Hybridization Process
CERTIFIED
Laws of Inheritance

Objective and aim of hybridization

- The chief objective of hybridization is to create genetic variation.
- The aim of hybridization may be transfer of one or few qualitative characters, the improvement in one or more quantitative character or the use of F1 as a hybrid variety. These objectives are grouped into two classes

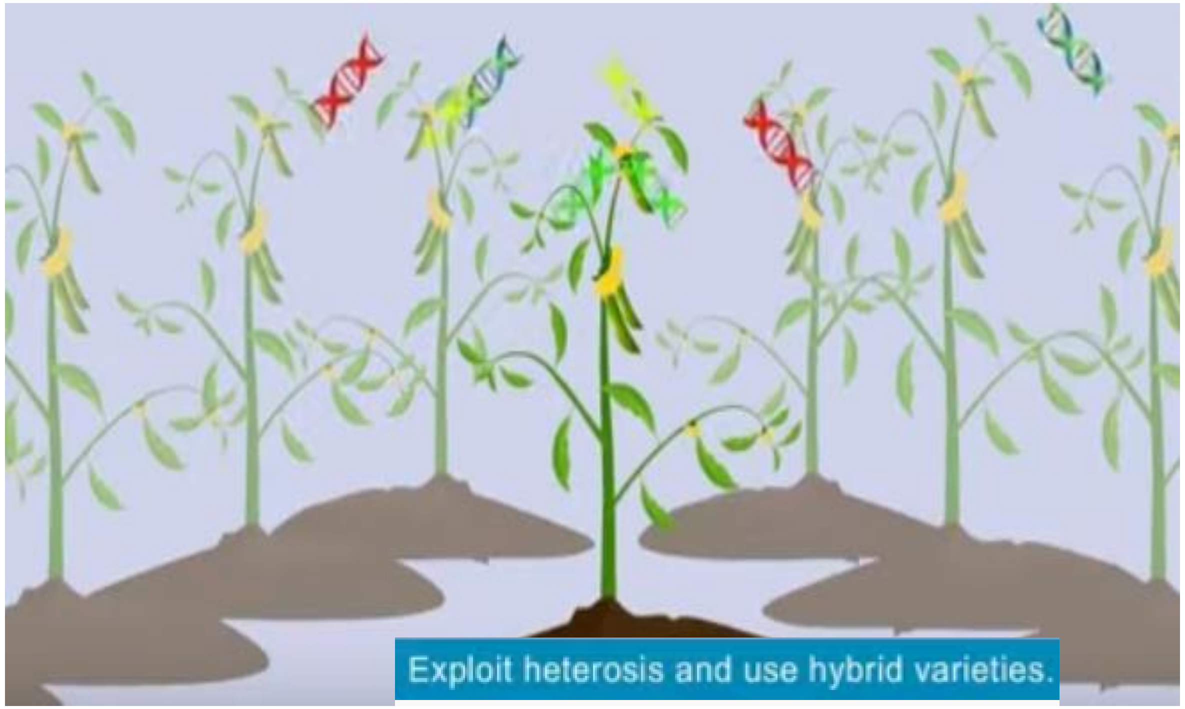
1) Combination breeding
2) Transgressive breeding

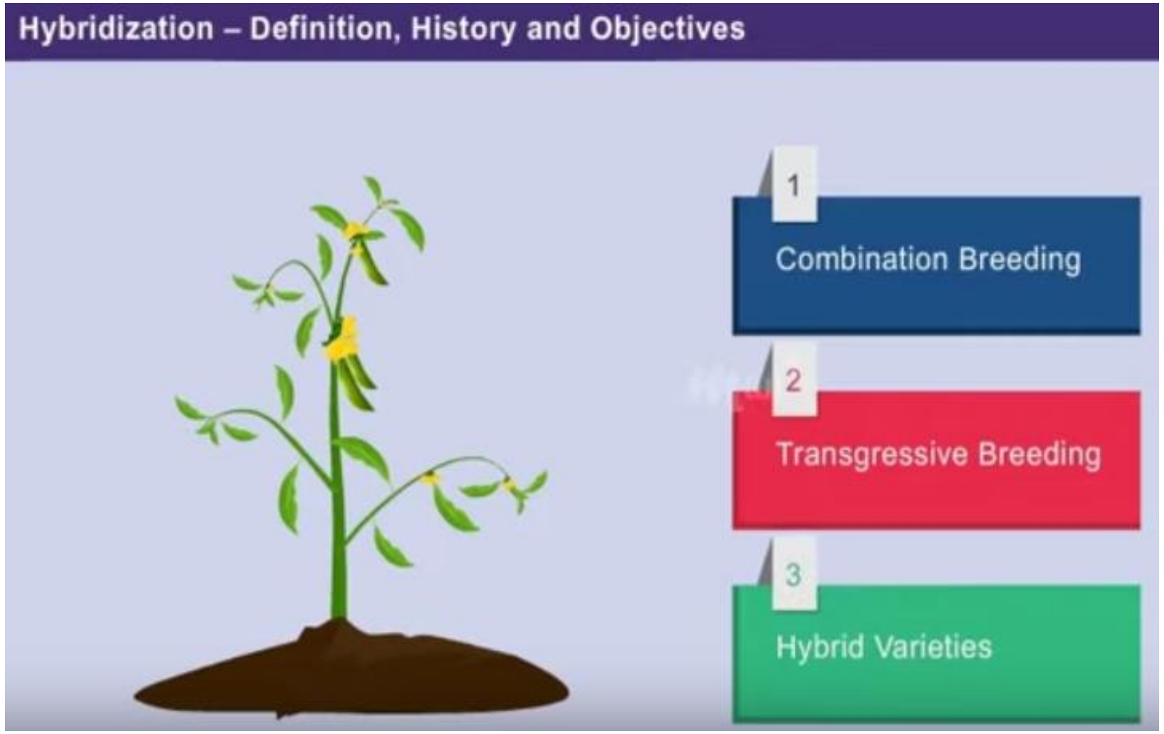
1) Combination breeding

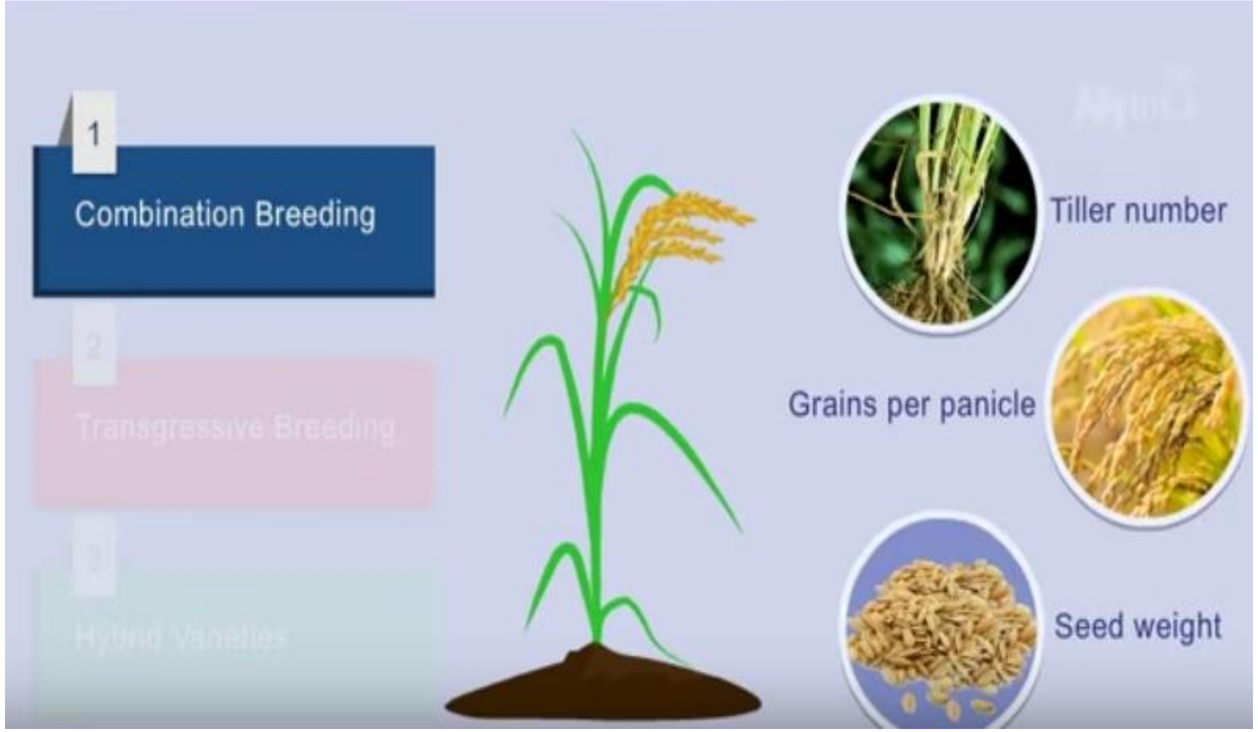
The main aim of combination breeding is the transfer of one or more characters into a single variety, from other varieties. These characteristics may be governed by oligogenes or Polygene

2) Transgressive breeding

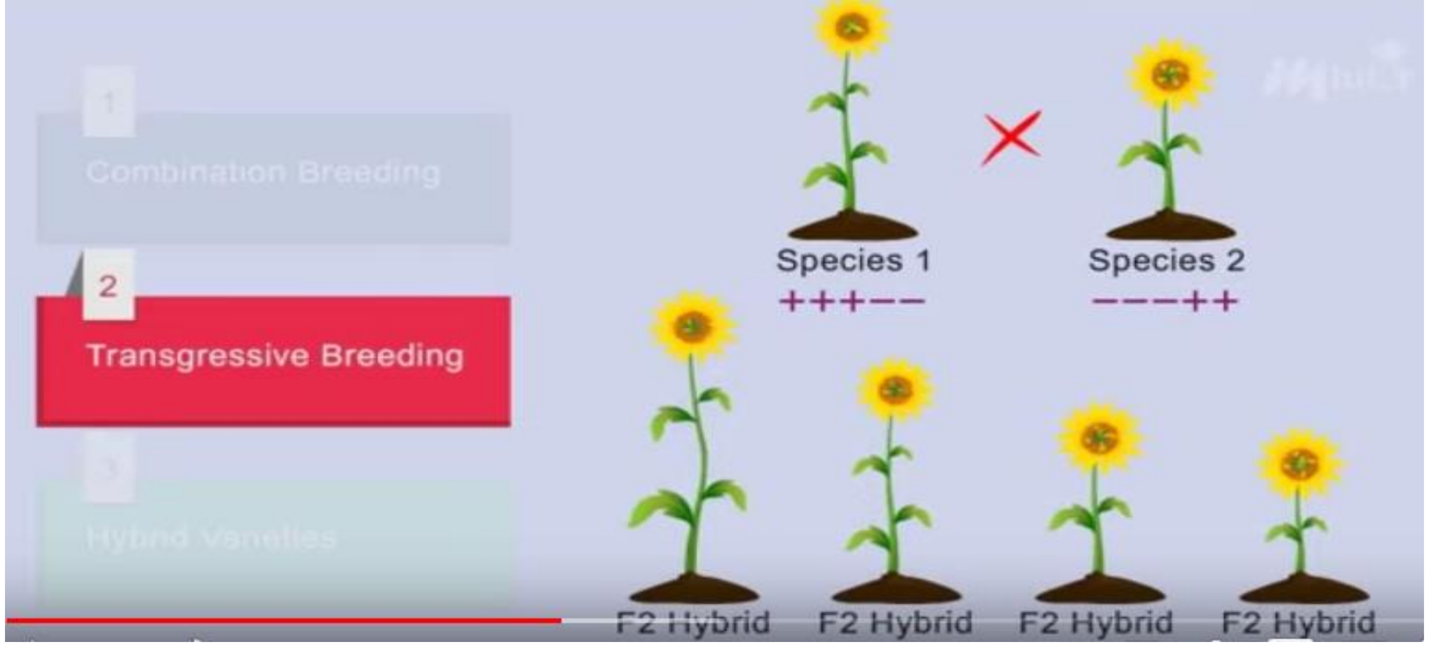
Transgressive breeding aims at improving yield or its contributing character through Transgressive segregation. Transgressive segregation is the production of plants in F2 generation that are superior to both the parents for one or more characters.




Hybridization – Definition, History and Objectives
1
Combination Breeding
2
Transgressive Breeding
3
Hybrid Varieties


1
Combination Breeding
Tiller number
Grains per panicle
Seed weight


1
Combination Breeding
Backcross Method
Pedigree Method



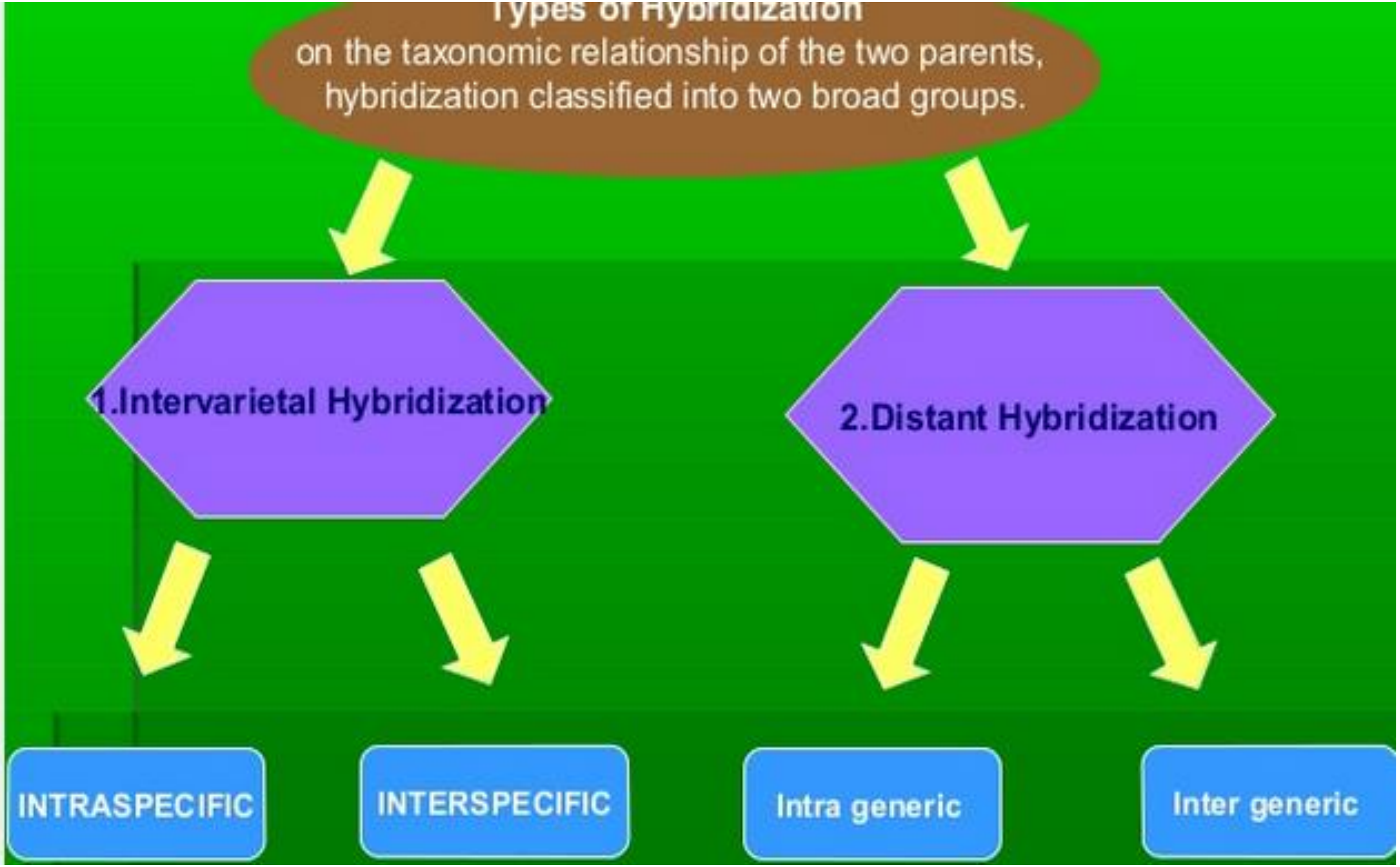
Pedigree method

1.In **pedigree method** individual plants are selected from F2 and their progenies are tested in subsequent generations. A record of the entire parent off spring relationship is maintained and known as **pedigree** record. ...

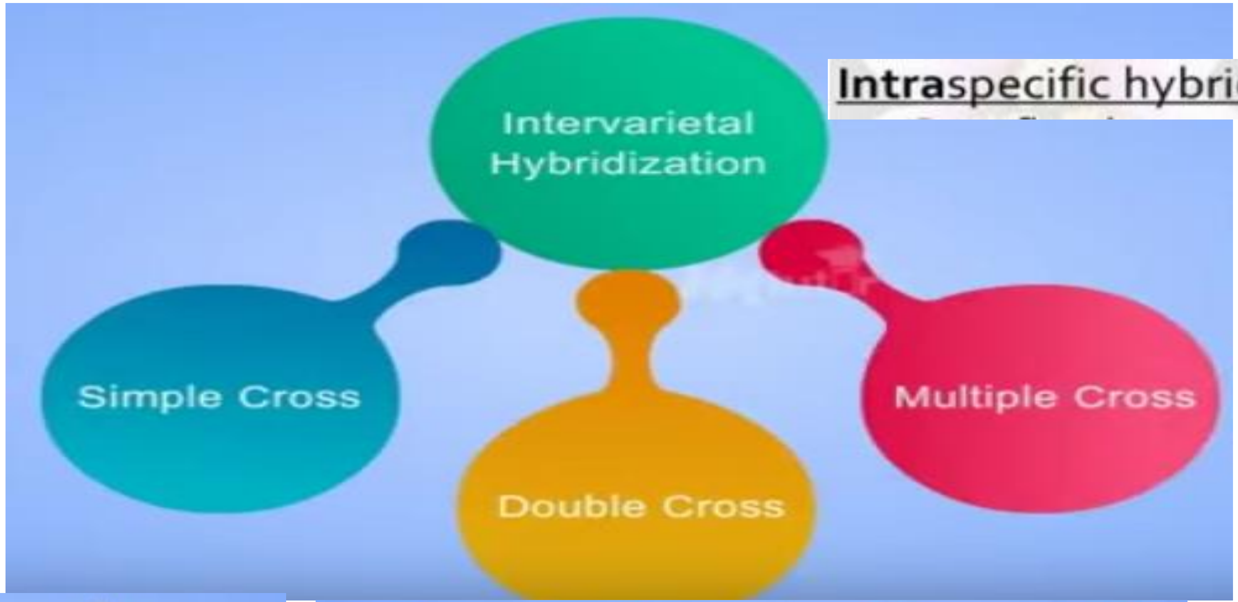
2.This **method** used for selection from segregating population of crosses in self pollinated crops.

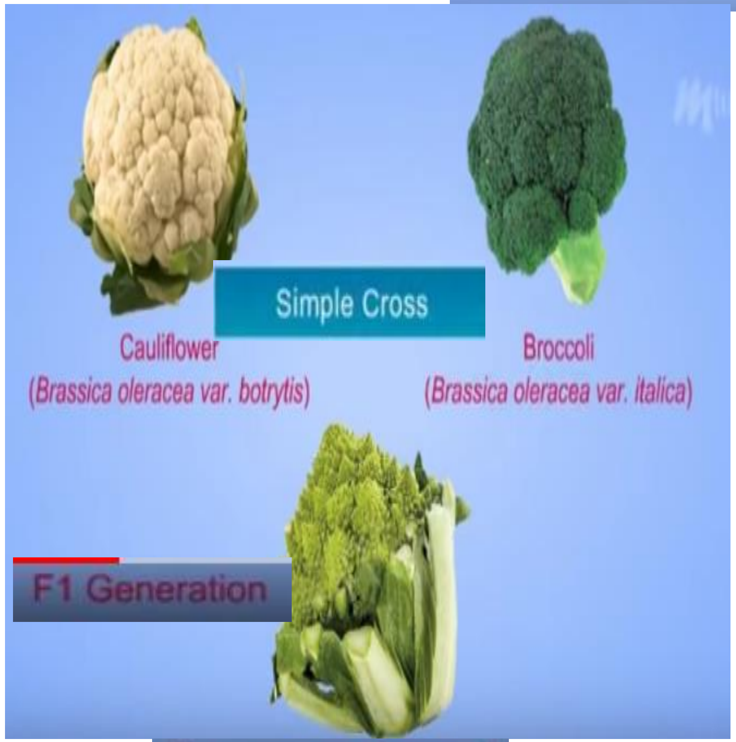
Backcross, the mating of a hybrid organism (offspring of genetically unlike parents) with one of its parents or with an organism genetically similar to the parent

In genetics, **transgressive** segregation is the formation of extreme phenotypes, or **transgressive** phenotypes, observed in segregated hybrid populations compared to phenotypes observed in the parental lines. ... As a result, the hybrid species will have some traits that are **transgressive** (extreme) in nature.

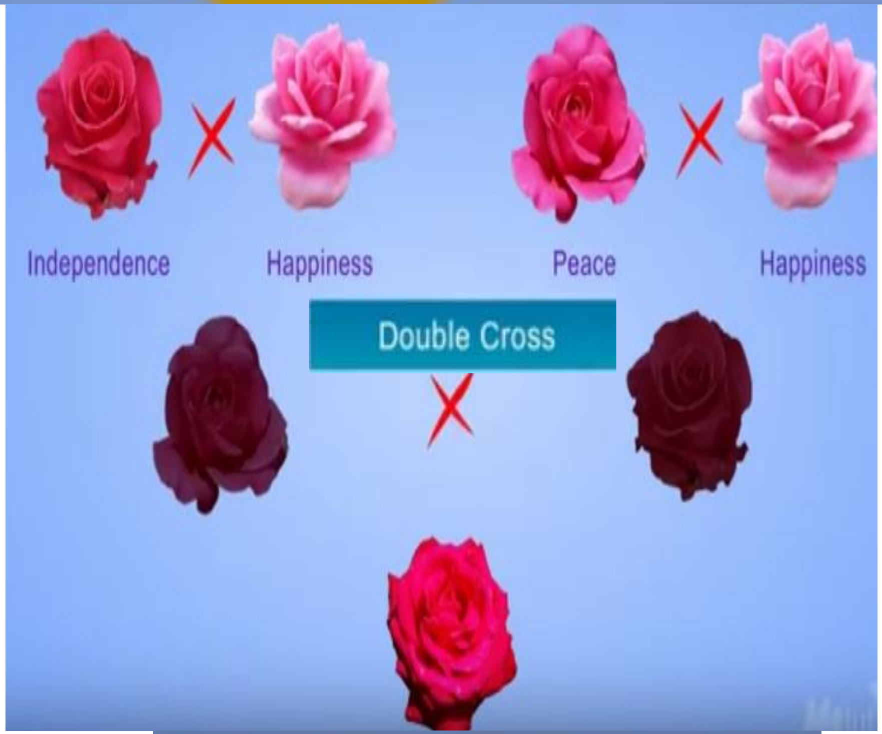

Types of Hybridization
on the taxonomic relationship of the two parents,
hybridization classified into two broad groups.
1.Intervarietal Hybridization
2.Distant Hybridization
INTRASPECIFIC
INTERSPECIFIC
Intra generic
Inter generic

Intraspecific hybridization





Romanesco broccoli



Christian Dior (Rosa 'Christian Dior')

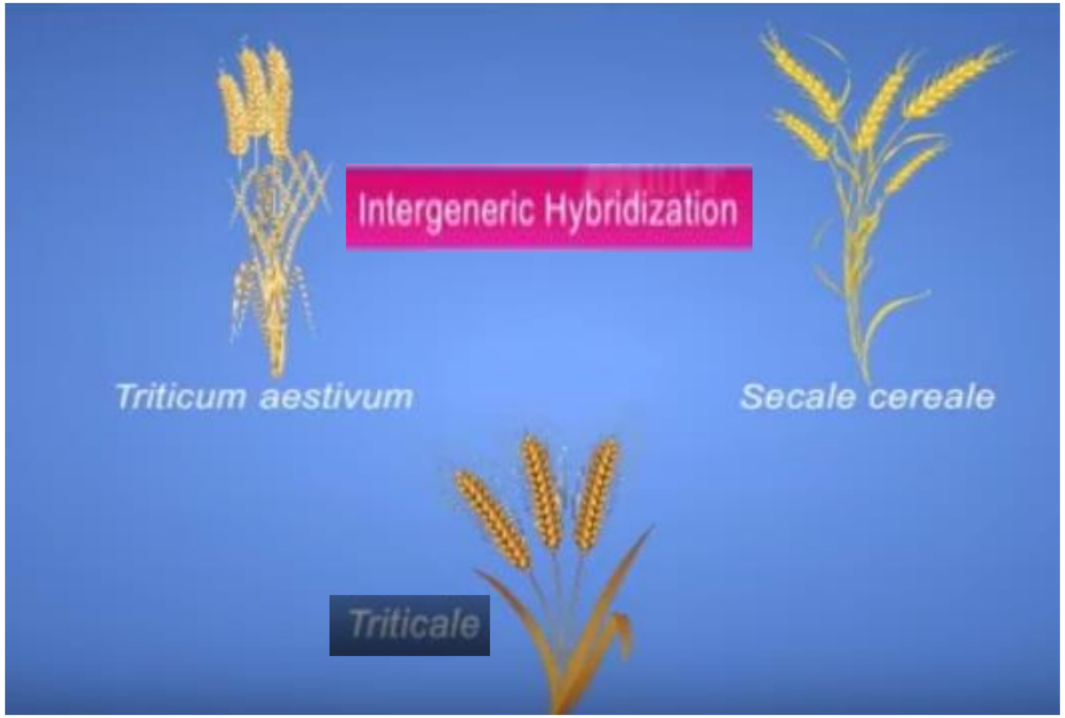
Jostaberry

Interspecific hybridization

- Gene flow between diverged species
- Increases heterozygosity and can generate new polymorphisms
- Hybrids may show intermediate, transgressive, or novel phenotypes

Interspecific Hybridization

Different genes of same species



Cross between different genera

2) Distant Hybridization

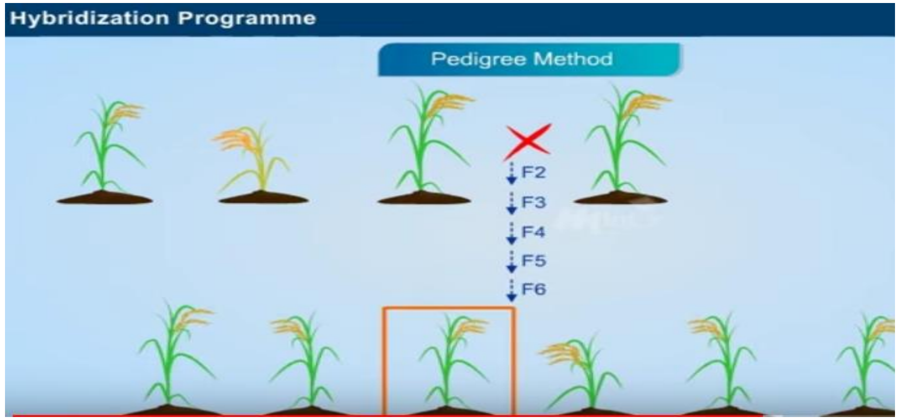
Distant hybridization includes crosses between different species of the same genus or of different genera.

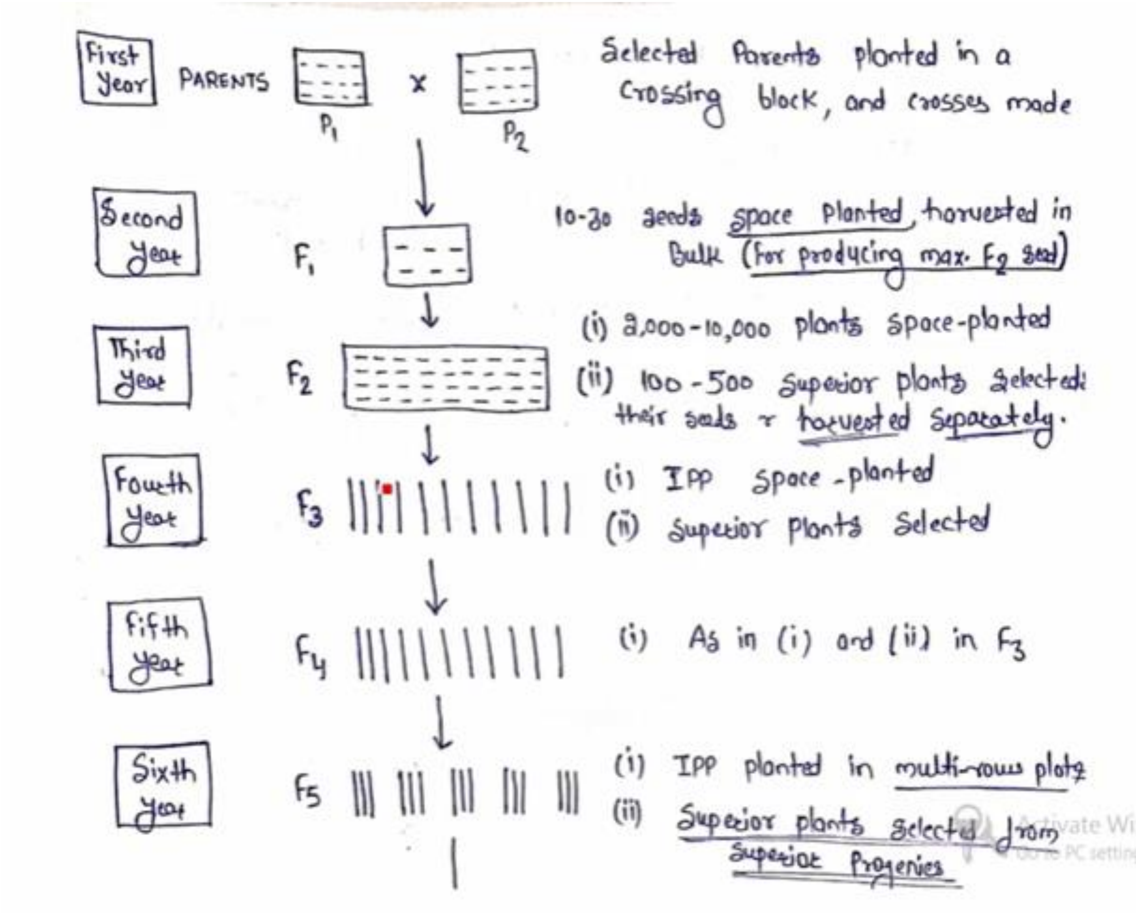
When two species of same genus is crossed ,it is known as INTERSPECIFIC HYBRIDIZATION.

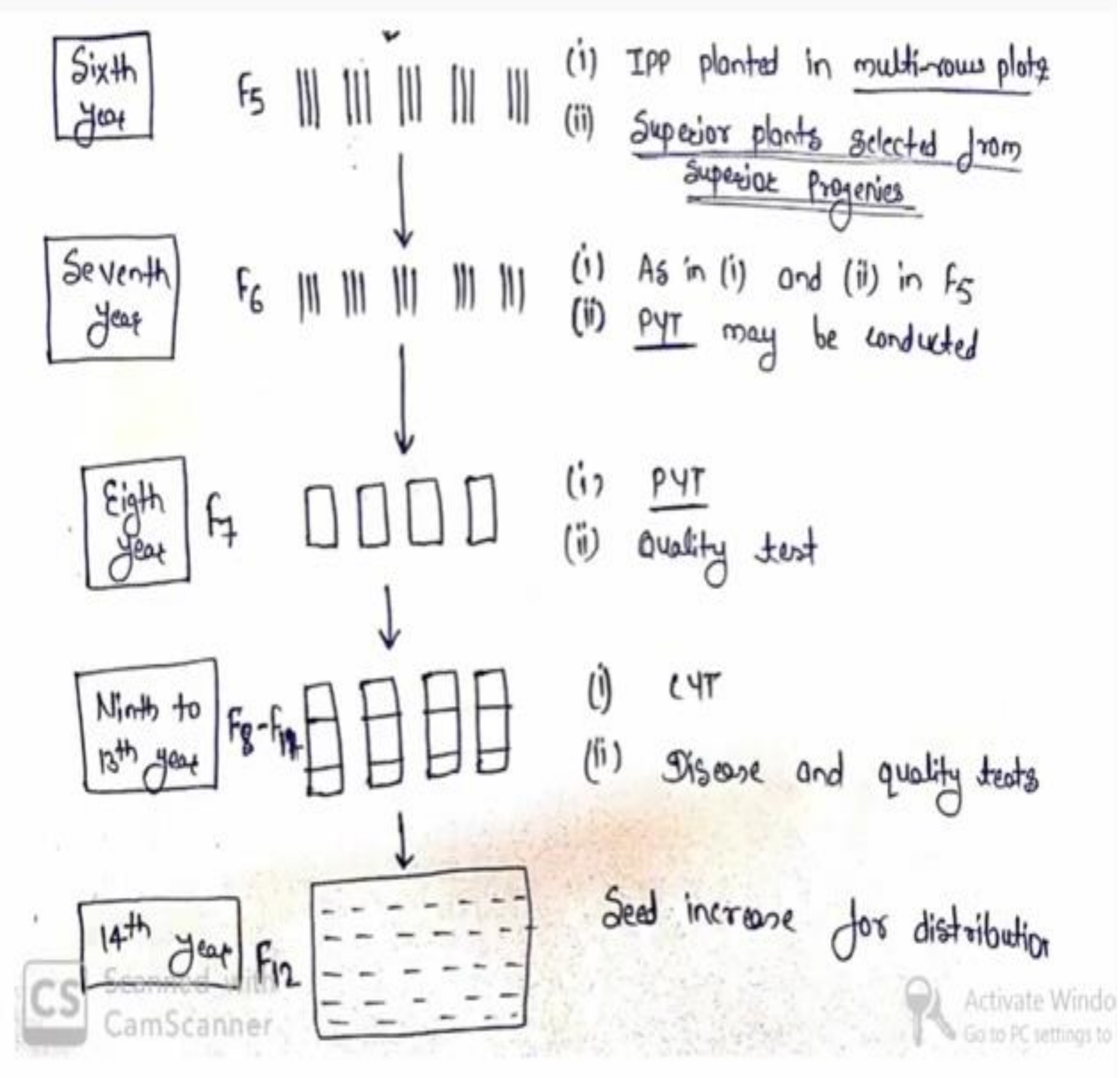
e.g. Oryza sativa var.indica X O. perennis → CO 31 rice variety

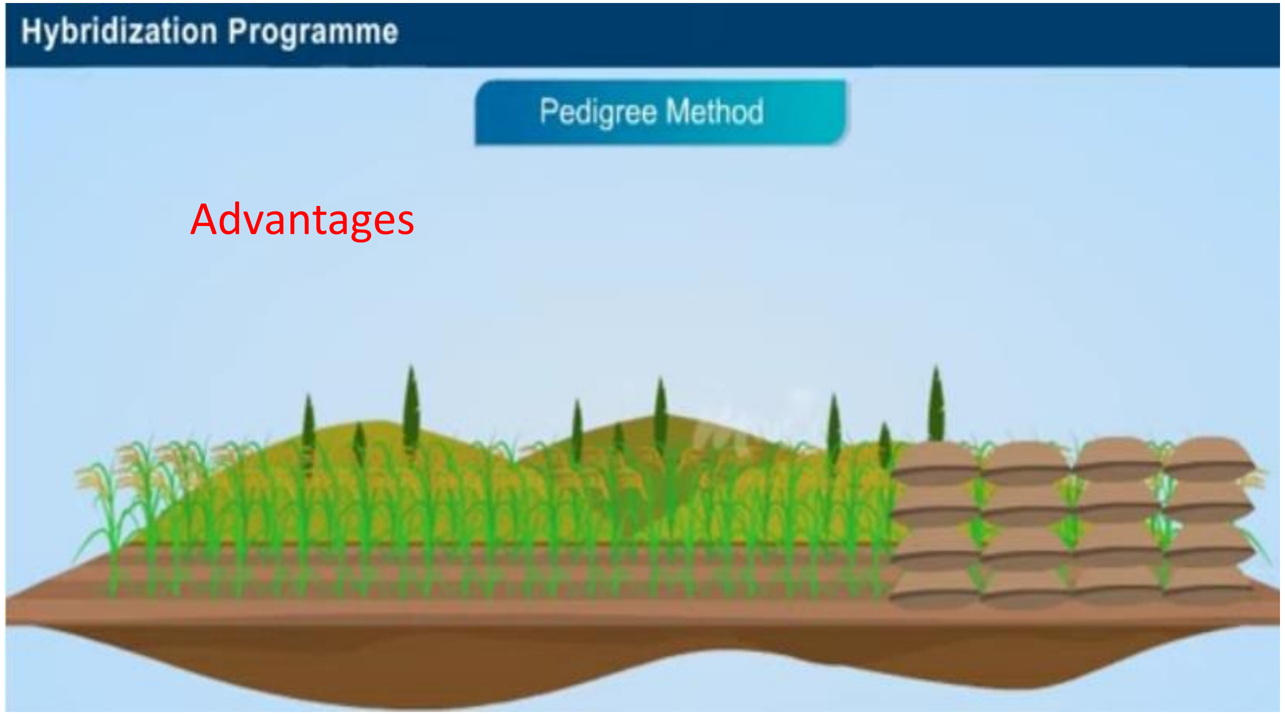
When two species of different genera are crossed, it is known as INTERGENERIC HYBRIDIZATION.

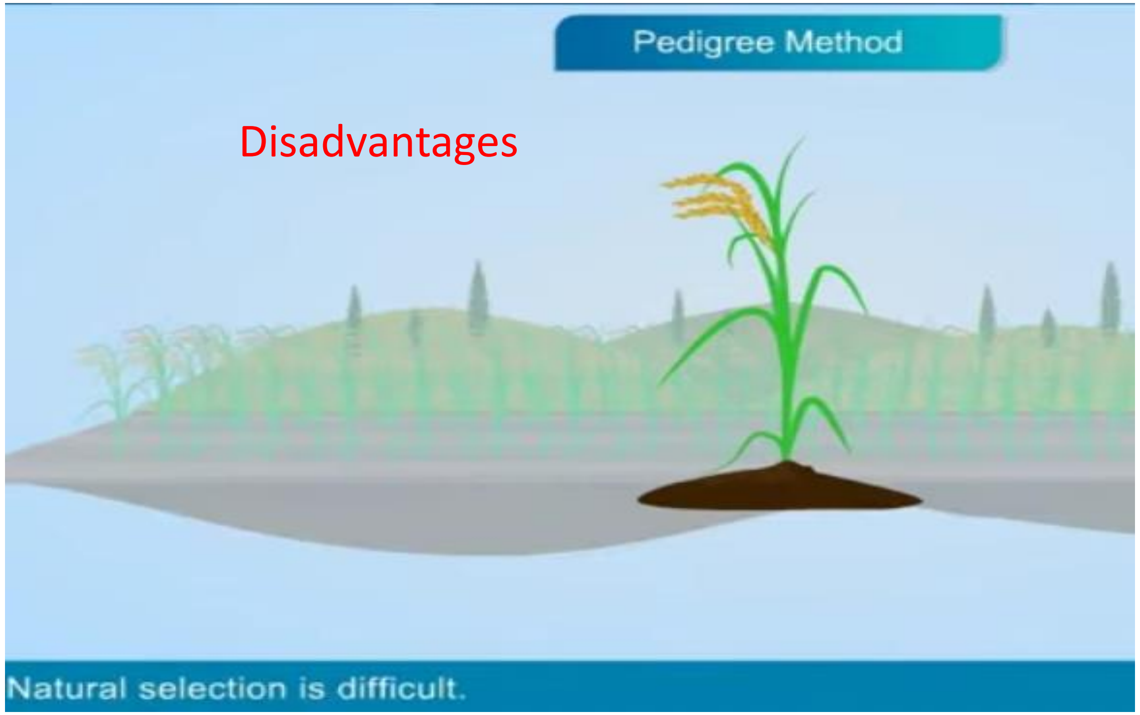
e.g. Triticum sp. X Secale cereale → triticale

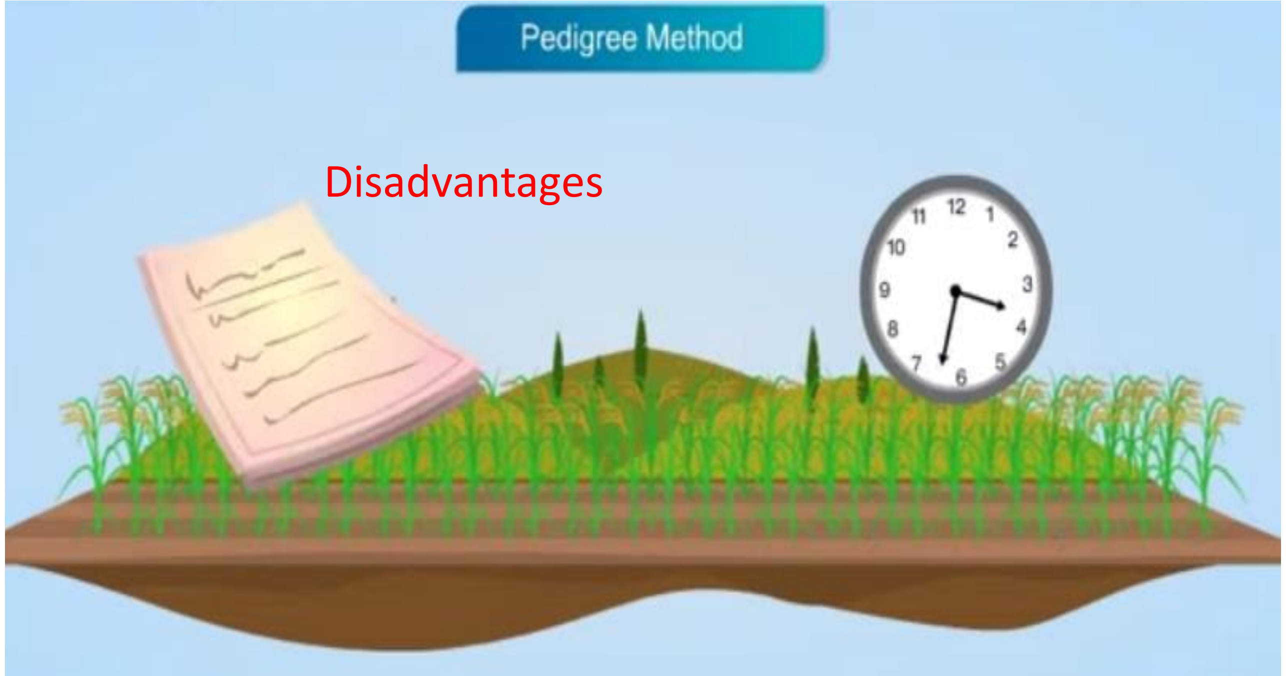

Hybridization Programme
Pedigree Method
F2
F3
F4
F5
F6

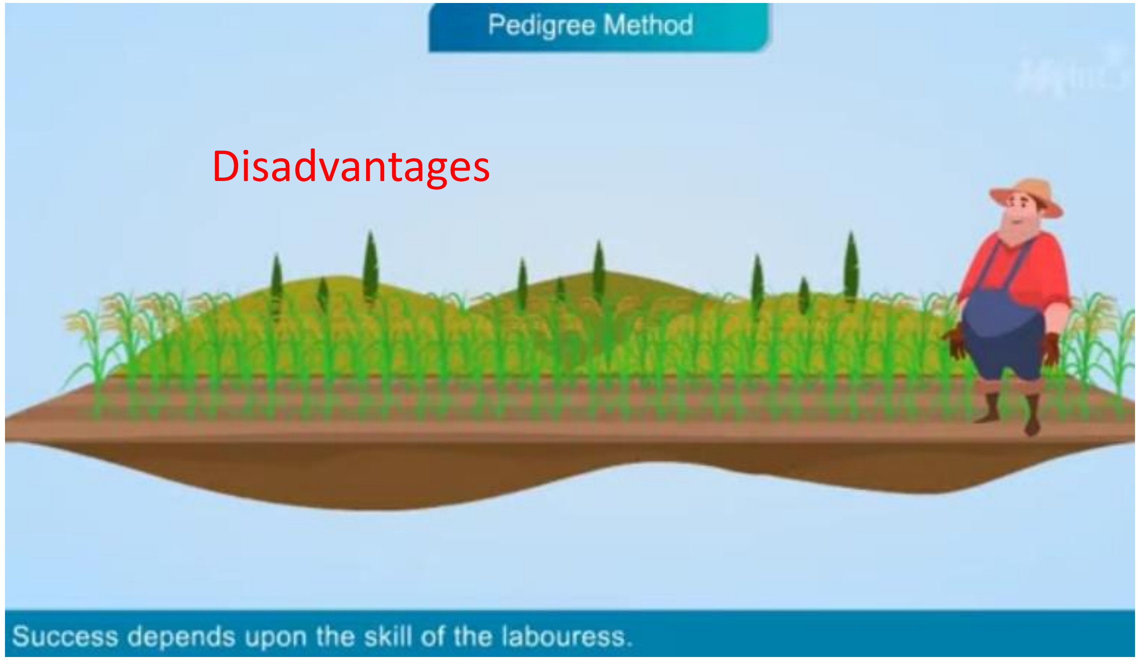

First Year
PARENTS
P1
P2
Selected Parents planted in a Crossing block, and crosses made
Second Year
F1
10-30 seeds space planted, harvested in Bulk (for producing max. F2 seed)
Third Year
F2
(i) 2,000-10,000 plants space-planted
(ii) 100-500 superior plants selected; their seeds r harvested separately.
Fourth Year
F3
(i) IPP space-planted
(ii) superior Plants selected
Fifth Year
F4
(i) As in (i) and (ii) in F3
Sixth Year
F5
(i) IPP planted in multi-rows plots
(ii) Superior plants selected from Superior Progenies

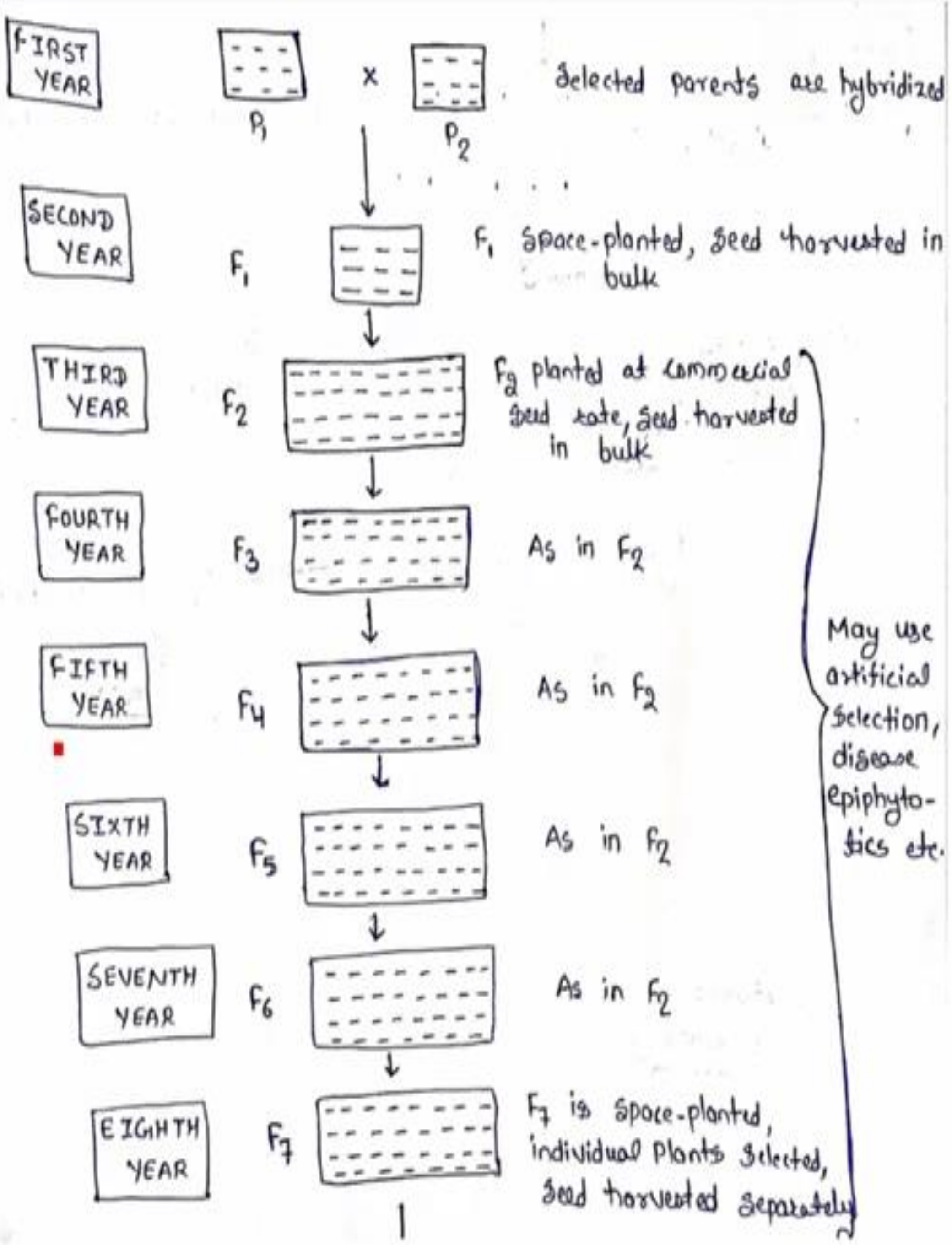

Sixth Year
F5
(i) IPP planted in multi-rows plots
(ii) Superior plants selected from Superior Progenies
Seventh Year
F6
(i) As in (i) and (ii) in F5
(ii) PYT may be conducted
Eigth Year
F7
(i) PYT
(ii) Quality test
Ninth to 13th year
F8-F12
(i) CYT
(ii) Disease and quality tests
14th Year
F12
Seed increase for distribution


Hybridization Programme
Pedigree Method
Advantages


Pedigree Method
Disadvantages
Natural selection is difficult.


Pedigree Method
Disadvantages


Pedigree Method
Disadvantages
Success depends upon the skill of the labouress.



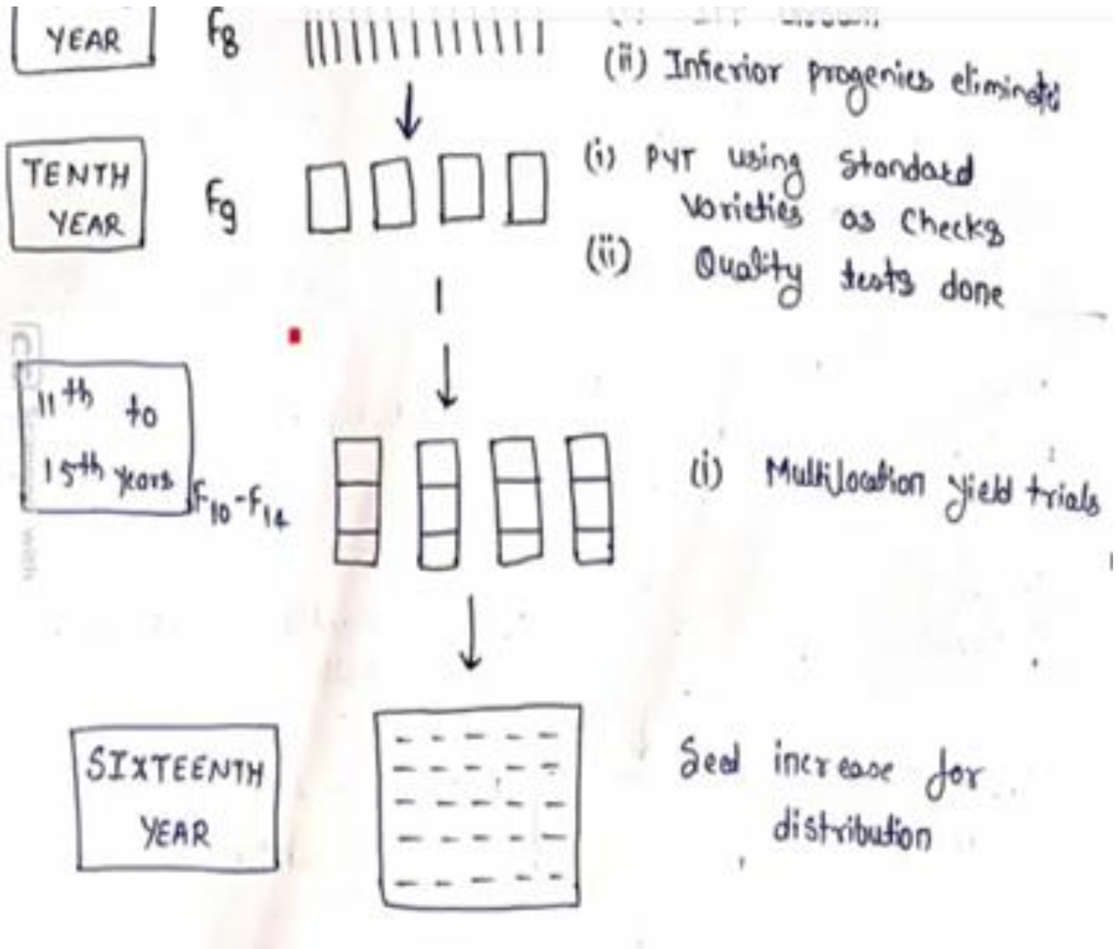
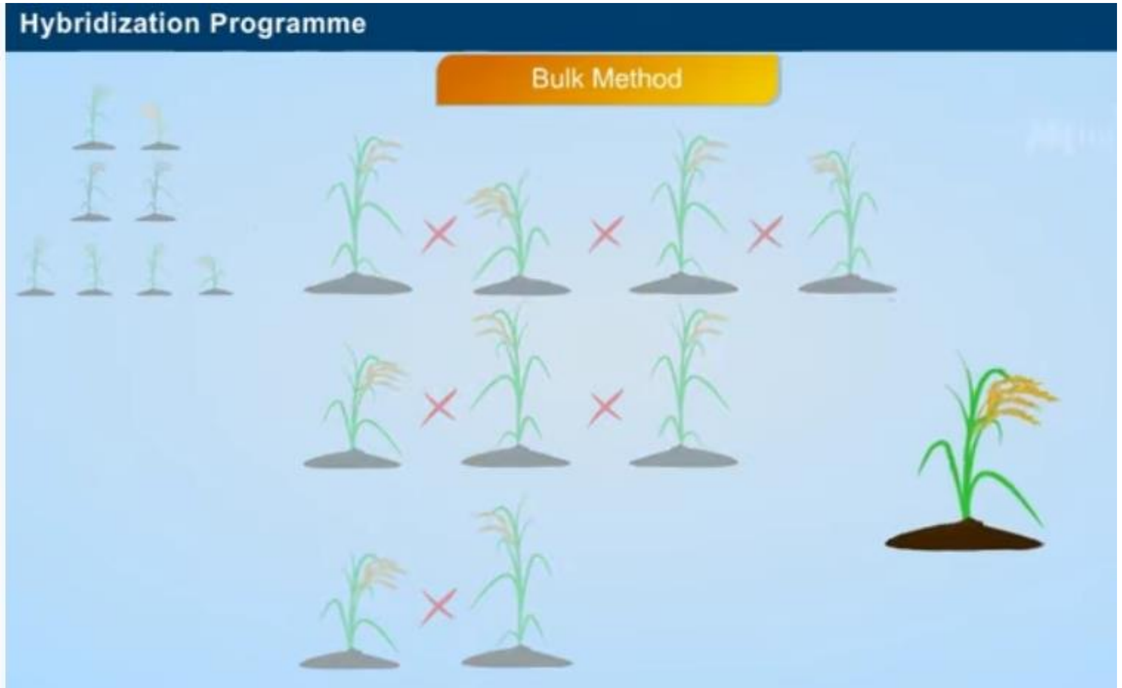
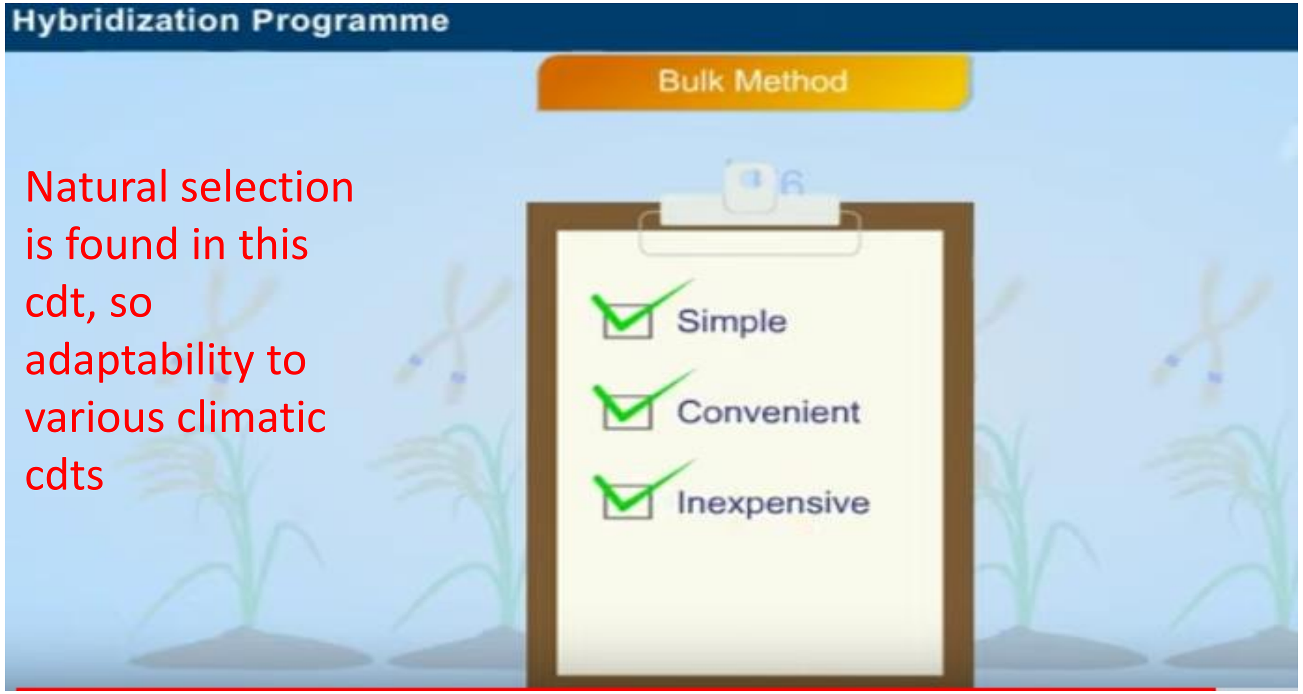
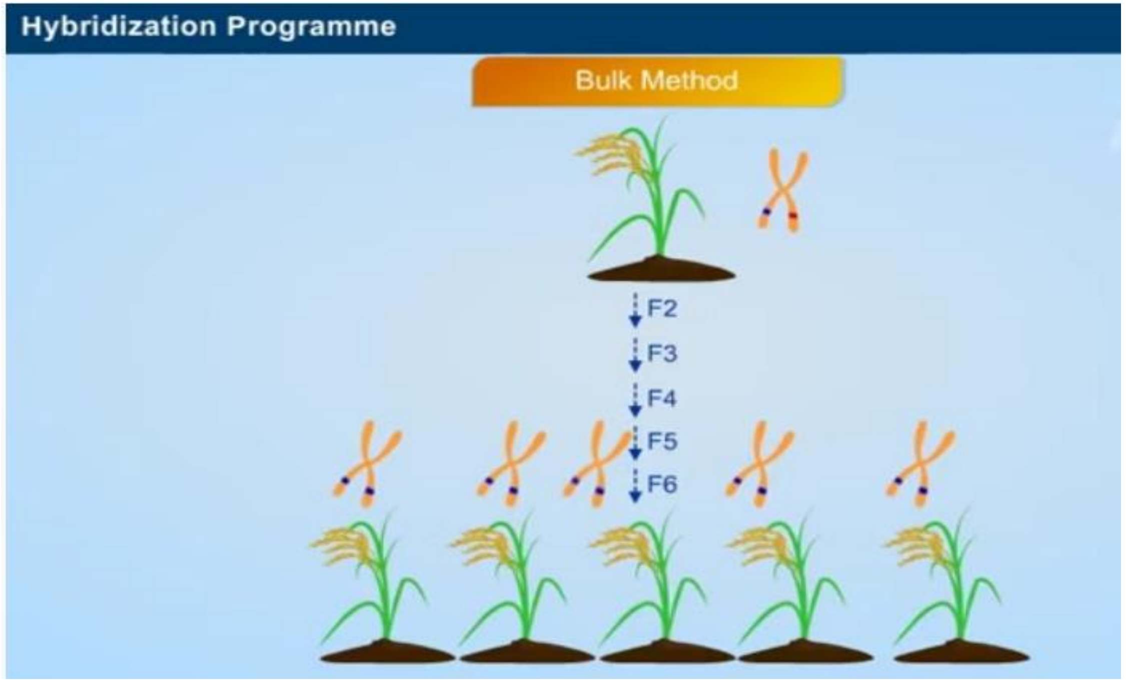


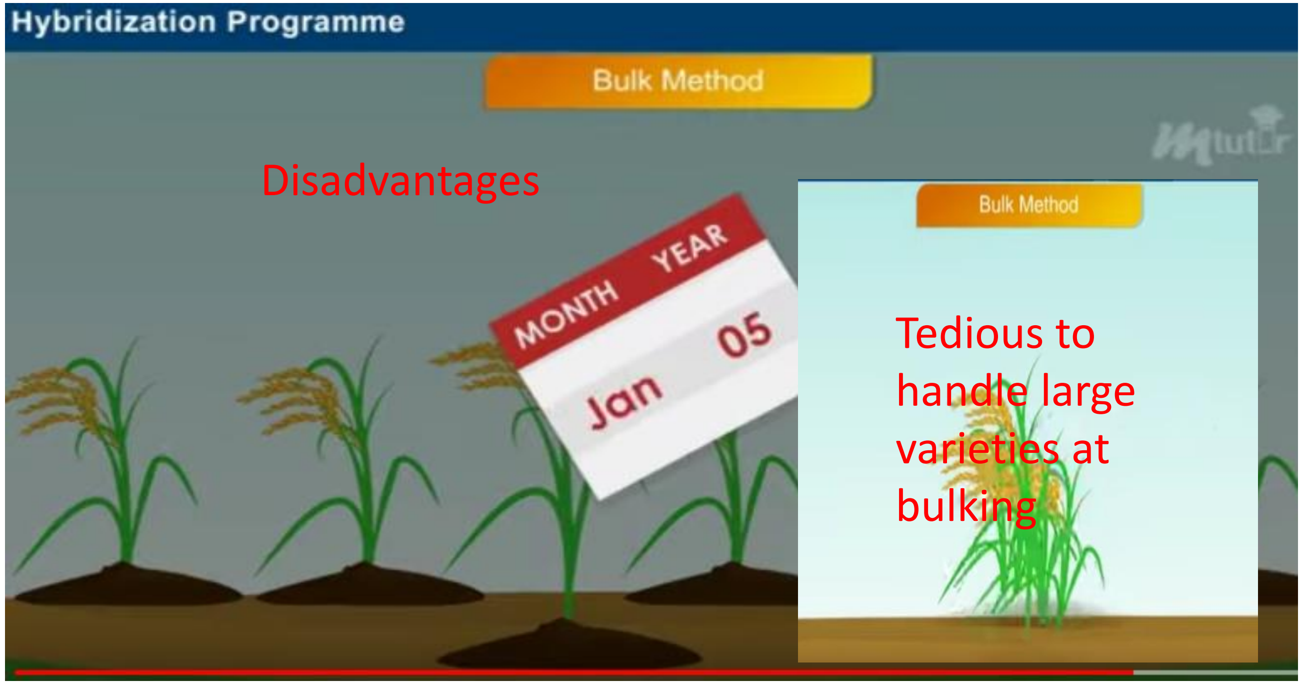
Fig : Generalised Scheme of Bulk Method

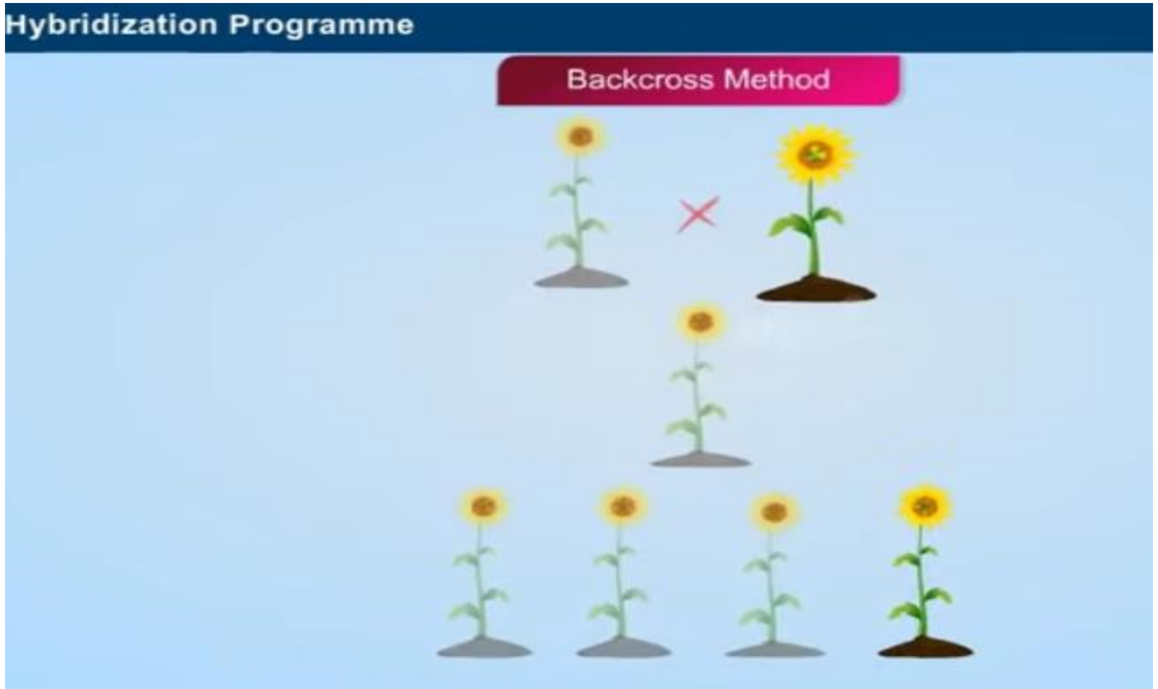
Bulk Method

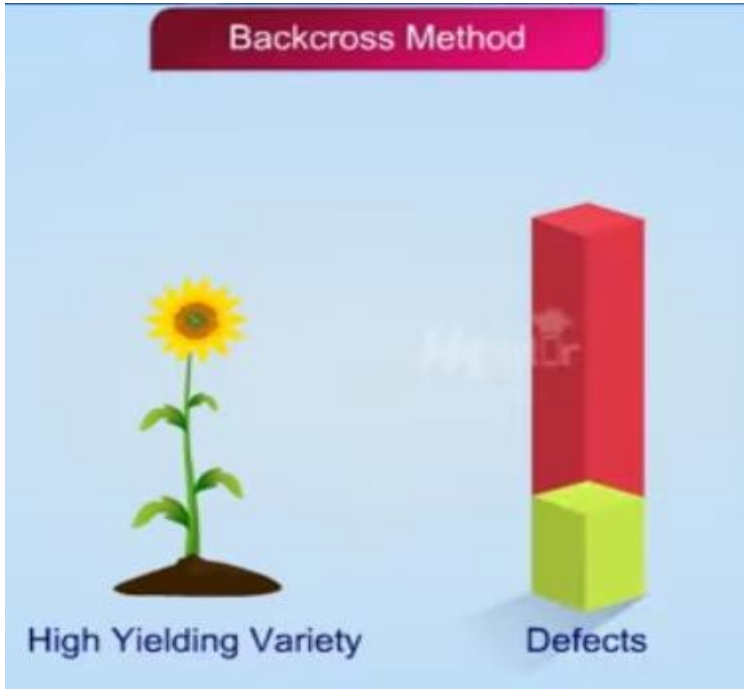

Hybridization Programme
Bulk Method


Hybridization Programme
Bulk Method
Natural selection is found in this cdt, so adaptability to various climatic cdts
Simple
Convenient
Inexpensive

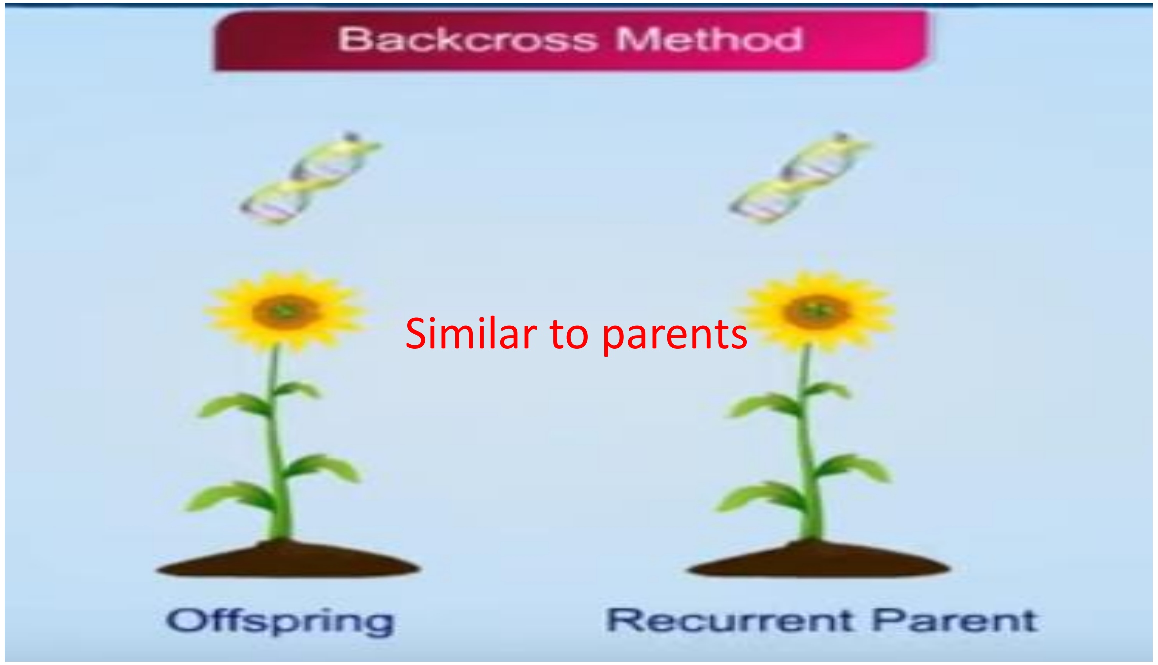

Hybridization Programme
Bulk Method
F2
F3
F4
F5
F6

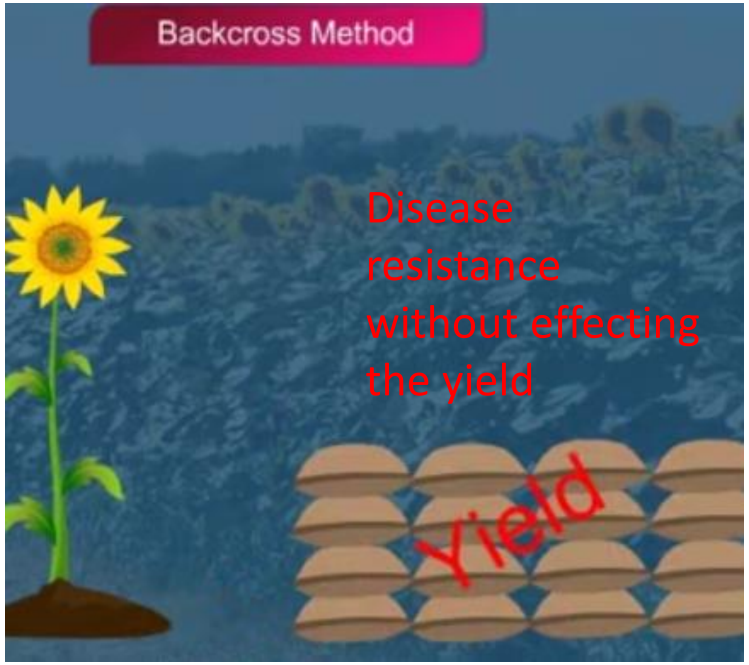

Hybridization Programme
Bulk Method
Disadvantages
MONTH
YEAR
Jan
05
Bulk Method
Tedious to handle large varieties at bulking


Hybridization Programme
Backcross Method


Backcross Method
High Yielding Variety
Defects


Backcross Method
Mainly for disease resistance


Backcross Method
Similar to parents
Offspring
Recurrent Parent


Backcross Method
Disease resistance without effecting the yield
Yield


Backcross Method
MONTH
YEAR
Aug
08

Main features of Interspecific or Intergeneric hybridization

1. It is used when the desirable character is not found within the species of a crop.
2. It is an effective method of transferring desirable gene into cultivated plants from their related cultivated or wild species.
3. It is more successful in vegetatively propagated species like sugarcane and potato than in seed propagated species.
4. It gives rise to three types of crosses viz. a) fully fertile, b) Partially fertile and c) Fully sterile in different crop species.
5. It leads to introgression which refer to transfer of some genes from one species into genome of another species.
6. F1 hybrid between two genus are always sterile. The fertility has to be restored by doubling of chromosome through colchicine treatment.

STEPS IN HYBRIDIZATION EXPERIMENT

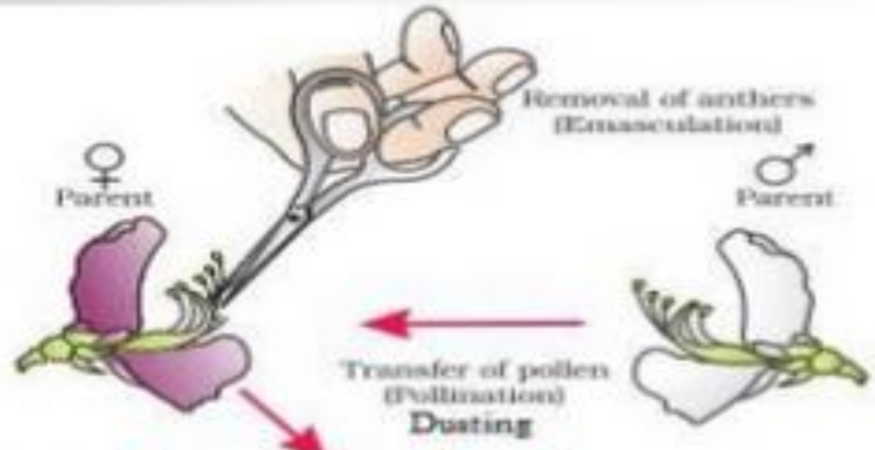
- SELECTION OF PURE BREEDING PARENTS
- Emasculation
- Bagging
- Seed setting
- Collection of seeds
- Raising of F_1 generation plants
- F_1 plants self pollinated
- Seed setting of F_1 plants
- Collection of seeds from F_1 plants
- Raising F_2 generation plants
- Raising F_3 Plants →F_4 plants→F_5 plants →→F7 plants.

PROCESS OF HYBRIDISATION

- EMASCULATION:
  Removal of anthers from bisexual flowers before they shed their pollen is known as emasculation. It is done in order to prevent self fertilisation. Emasculation is not necessary in the parents are monoecious.

- BAGGING:
  After emasculation, flower buds are kept enclose in bags made up of cloth, plastic or polythene etc. It is done to prevent pollination through unknown pollen.

- TAGGING:
  The female parents are then labelled properly. The labelling should bear the following information.
  i) Serial number
  ii) Details of male parents and female parents.
  iii) Date of emasculation and crossing



Emasculation

Bagging

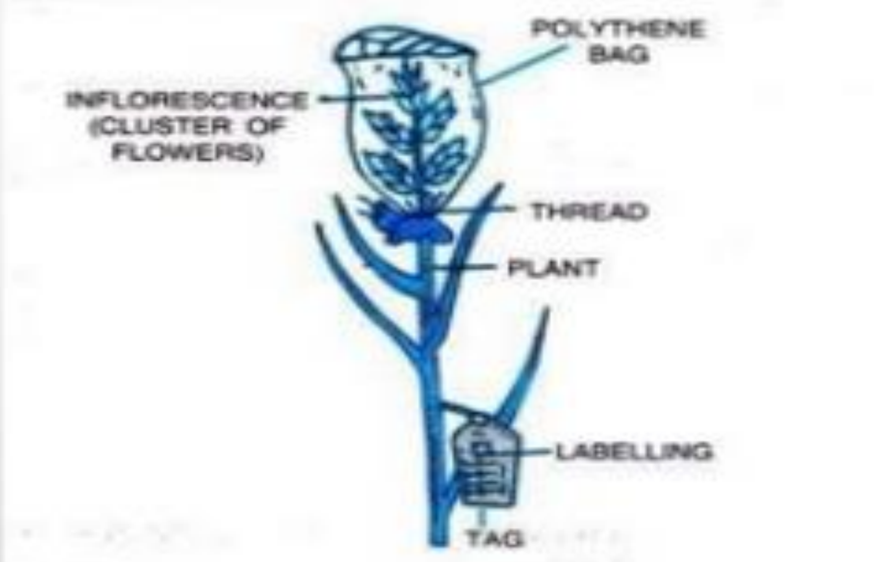
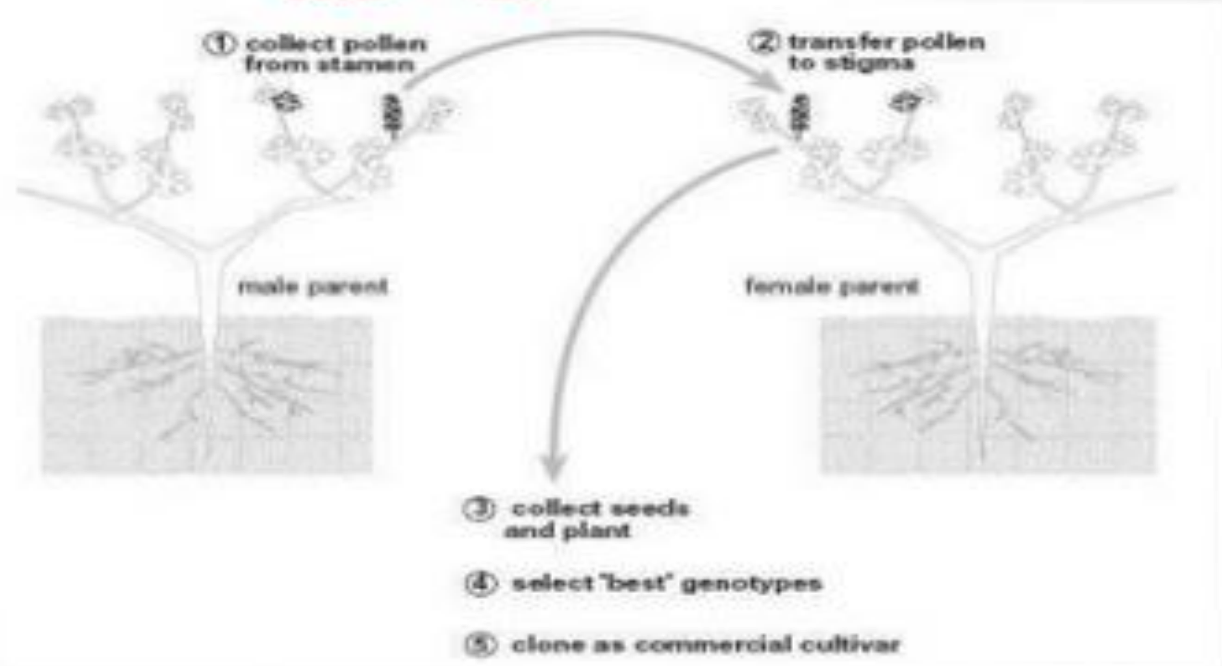


Fig. 9.14. Bagging and tagging at the time of hybridization.



HYBRIDISED PLANTS

CHARACTERISTICS OF HYBRIDISED PLANTS

- Hybridised plants have high resistance.
- Hybridised plants have high yielding capacity.
- Hybridised plants have high productivity.
- Hybridised plants have lifelongness.
- Example: Brinjal,Ladyfinger,Chilli,Paddy,
  Tomato etc....

Heterosis in crop improvement.

Introduction

- Over the past several decades, breeders have been improving many crops on the basis of the first generation (F1) hybrids.
- This method involves the annual production of progenies by artificial crossing in large cultivated areas.

Heterosis and its manifestation

- Heterosis or hybrid vigour is the superiority of the F1 hybrids over parents in one or more characters.
- The exact genetic mechanism behind heterosis is not definitely known.
- Still it is generally held that a tendancy for the expressions of the features of both the parents in the hybrids is the basis of heterosis.

Manifestations

(i) Increased size, vigour vitality and yield
(ii) Better quality of the yield
(iii) Greater adaptability to diverse environmental conditions.
(iv) High resistance and tolerance against pests, pathogens and climatic conditions.
(v) High reproductive potential
(vi) Early maturation, flowering and fruit setting

Apart from these,heterosis involves other changes at molecular, metabolic, cellular and organismal also. Some of such changes are following.

Manifestation at

- **Molecular level**

1. Increased rate of DNA duplication
2. Gentic transcription
3. Genetic translation
4. Enzyme activity

- **Metabolic level**
- Increased and effective co-ordination and regulation of metabolic processes and morphogenetic events.

- **Cellular level**
- Increased rate of cell proliferation
- **Organism level**
- High rate of cellular growth and differentiation, increased synthesis, accumulation and utilization of substances.

Practical utilisation

- In some agricultural crops, heterosis is much prominent and so it is extensively used for the production of superior varieties.
- Many ornamentals, fruit plants, vegetables, cereals, etc. have been produced in this way. Examples are maize, bajra, johar, wheat, barley, rice, cotton etc.
- The best economic advantage of heterosis is attained by using heterotic hybrid seeds in combination with advancced farming practices, mainly irrigation, application of fertilizers etc.

- In india, a lot of work has been done on heterosis breeding in a number o economically important crops such as sugarbeet, brinjal, lady's finger etc
- In 1989, ICAR launched a hybrid project entitled "Promotion of Research and Development Efforts on Hybrids in Selected Crops" to promote hybrid research.

SPECIFIC FEATURES OF HETEROSIS

- **Superiority over Parents:**

Heterosis leads to superiority in adaptation, yield, quality, disease resistance, maturity and general vigour over its parents.

Generally, positive heterosis is considered as desirable. But in some cases negative heterosis is also desirable.

- **Heterosis**, **hybrid vigour**, or **out breeding enhancement**, is the improved or increased function of any biological quality in a hybrid offspring. The adjective derived from *heterosis* is **heterotic**.
- An offspring exhibits heterosis if its traits are enhanced as a result of mixing the genetic contributions of its parents. These effects can be due to Mendelian or non-Mendelian inheritance

- In proposing the term *heterosis* to replace the older term **heterozygosis**, G.H. Shull aimed to avoid limiting the term to the effects that can be explained by heterozygosity in Mendelian inheritance.
- The physiological vigour of an organism as manifested in its rapidity of growth, its height and general robustness, is positively correlated with the degree of dissimilarity in the gametes by whose union the organism was formed . The more numerous the differences between the uniting gametes — at least within certain limits — the greater on the whole is the amount of stimulation . These differences need not be Mendelian in their inheritance. To avoid the implication that all the genotypic differences which stimulate cell-division, growth and other

HISTORY OF HYBRID VARIETIES

- Heterosis has been known since the art of hybridization came into existence. Koelreuter (1763) was the first to report hybrid vigour in the hybrids of tobacco, Datura etc. Mendel (1865) observed this in pea crosses.
- Darwin (1876) also reported that inbreeding in plants results in deterioration of vigour and the crossing in hybrid vigour. On the basis of his experiments Beal (1877-1882) concluded that F_1 hybrids yield as much as 40 percent more of the parental varieties.
- From subsequent studies on inter-varietal crosses in maize, it was observed that some of the hybrids show heterosis.

Types of Heterosis

1. **True heterosis:** It is inherited.

It can be further divided into two types:

(a) Mutational true heterosis:

It is the sheltering or shadowing of the deleterious, un-favourable, often lethal, recessive mutant genes by their adaptively superior dominant alleles.

(b) Balanced true heterosis:

It arises out of balanced gene combinations with better adaptive value and agricultural usefulness.

2. **Pseudo-heterosis:**

Crossing of the two parental forms brings in an accidental, excessive and un-adaptable expression of temporary vigour and vegetative overgrowth. It is also called luxuriance.

- **Causes of Heterosis:**
- The phenomenon of heterosis can be explained on the basis of the causes: Genetic causes and Physiological causes.
- **A. Genetic Causes:**
- **There are two possible causes of heterosis viz.;**
- (i) Dominance
- (ii) Over-dominance
- **(i) Dominance hypothesis:**
- This theory was proposed by Davenport (1910), Bruce (1910) and Keable and Pellew (1910).This theory is based on the assumption that hybrid vigour results from bringing together female dominant genes. According to this theory, genes that are favourable for vigour and growth are dominant, and genes that are harmful to the individual are recessive.

B. Physiological Causes:

(i) Greater initial capital hypothesis:

This hypothesis was proposed by Ashby (1930). He studied the physiology of inbreeds and hybrids of maize and tomato and concluded that hybrid vigour is due to an increased initial embryo size. He termed it as **'Greater initial capital.'**

(ii) Cytoplasmic-nuclear interactions:

Michelis, Shull, Lewis, and others suggested that hybrid vigour is the interaction of cytoplasmic and nuclear systems. Cytoplasm is a transparent fluid rich in RNA and mitochondria, which is usually transmitted through the female parent to the offspring

It is basically the result of the increased metabolic activity of the heterozygote Its effects are well established or manifested in the following tree ways:

1. Quantitative Effects:

(a) Increase in size and genetic vigour:

Hybrids are generally more vigorous I;e larger, healthier and faster growing than the parents e.g., head size in cabbage jowar cob size in maize, fruit size in tomato etc.

(b) Increase in yield:

Yield may be measured in terms of grain, fruit, seed, leaf tuber or the whole plant. Hybrids usually have increased yield.

(c) Better quality:

Hybrids show improved quality e.g., hybrids in onion show better keeping quality.

2. Physiological Effects:

(a) Greater resistance to diseases and pests:

Some hybrids show greater resistance to insects or diseases than parents.

(b) Greater flowering and maturity:

Earliness is highly desirable in vegetables In many cases, hybrids are earlier in flowering and maturity than the parents, e.g. tomato hybrids are earlier than their parents.

(c) Greater Adaptability:

Hybrids are usually less susceptible to adverse environmental conditions.

- **3. Biological Effects:**
- Hybrids exhibiting heterosis show an increase in biological efficiency i.e., an increase in fertility (reproduction ability) and survival ability.

Figure 2a
Corn Plants: Inbred B73 (left), Inbred Mo17(middle), Single cross B73 x Mo17 (right) *(UNL, 2004)*

Figure. 2b:
Corn Ears: Inbred B73 (left), Inbred Mo17(right), Single cross B73 x Mo17 (middle) *(UNL, 2004)*

Hybrid

A hybrid is the offspring of genetically dissimilar parents or stock, especially the offspring produced by breeding plant or animals of different varieties, species or races, something of mixed origin or composition, such as a word whose elements are derived from different languages. A hybrid is something having two kinds of components that produce the same or similar results. For instance, the offspring of two plants of different bre eds, varieties, or species, especially as p roduced through human manipulation for specific genetic characteristics.

Examples of hybrid plants include :

- Sweet corn: The vast majority of U.S. corn grown are hybrid varieties. The characteristics of these varieties have made it easier for home gardeners to grow and they are sweeter than past crops.
- Meyers lemons: Meyer lemons, originating in China, are a cross between a true lemon tree and mandarin orange tree. The fruit is much sweeter than traditional lemons, which makes this variety a favourite of gardeners and chefs alike.
- Better Boy tomatoes: Better Boys have been bred to be resistant to verticillium wilt, fusarium wilt and nematodes, which are all common tomato plant problems. Gardeners and tomato lovers favour the large, bright red fruit, which can weigh up to 1 lb. and mature within 75 days of seedlings being transplanted into the ground.

MANIFESTATION OF HETEROSIS

- ❖ Increased yield
- ❖ Increased reproductive ability
- ❖ Increased size and general vigour
- ❖ Better quality
- ❖ Earlier flowering and maturity
- ❖ Greater resistance to diseases and pests
- ❖ Greater adaptability
- ❖ Faster growth rate

Breeding achievements in Rice

2.7 billion people globally are known to be affected by iron deficiency till to date (Hirschi, 2009)

Regulates enzyme activity and plays an important role in the immune system (Lynch, 2003)

IRON

REQUIREMENT PER DAY

10-15 milligrams (mg)

HEALTH PROBLEMS CAUSED BY IRON DEFICIENCY

MENTAL AND PSYCHOMOTOR IMPAIRMENT IN CHILDREN, AND

INCREASED LEVELS OF MORBIDITY AND MORTALITY RATE OF MOTHER AND

CHILD DURING CHILDBIRTH (FROSSARD *ET AL.*, 2000)

In Asia and Africa, it is estimated that 500-600 million people are at risk for low zinc intake (Harvest Plus, 2010)

Regulates enzyme activity, essential for cell division and DNA replication

ZINC

REQUIREMENT PER DAY

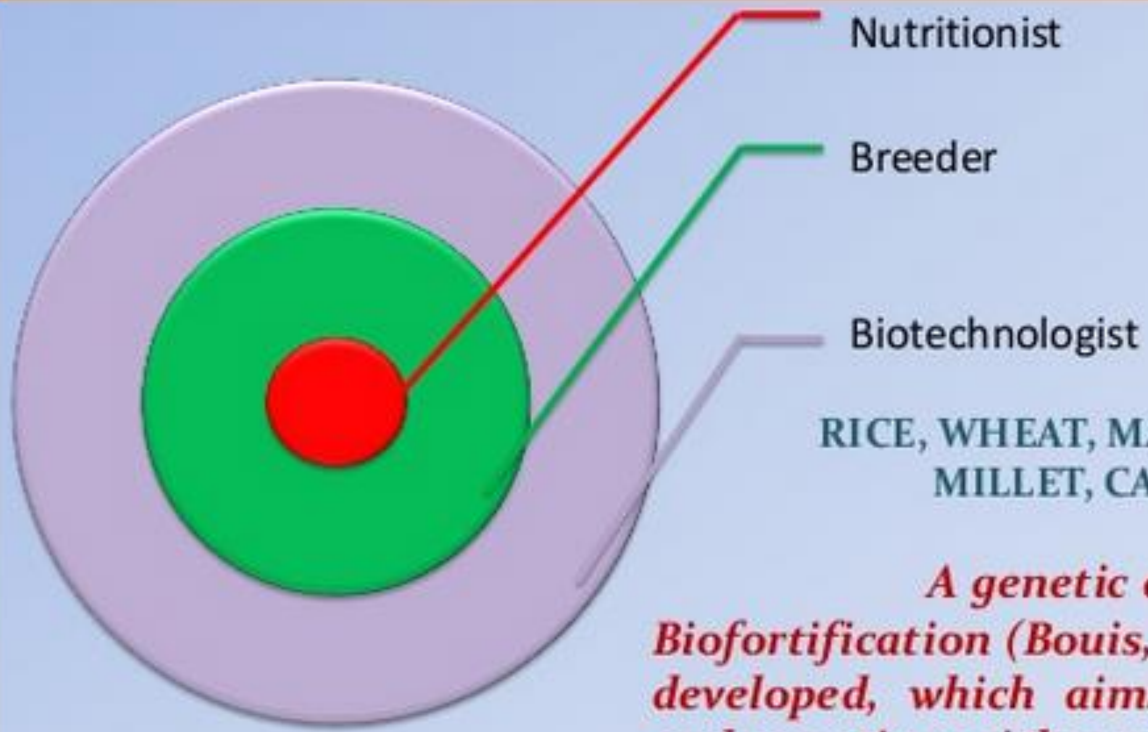
Males 12-15mg/day

Females 68 mg/day

Health problems caused by zinc deficiency

Anorexia,
Dwarfism,
Weak immune system (Solomons, 2003)
Skin lesions,
Hypogonadism, and
Diarrhoea (McClain *et al.*, 1985).

In the last two decades, new research findings generated by the nutritionists have brought to light the importance of vitamins, minerals (micronutrients) and proteins in maintaining good health



RICE, WHEAT, MAIZE, PEARL MILLET, CANOLA

A genetic approach called Biofortification (Bouis, 2002) has been developed, which aims at biological and genetic enrichment of food stuffs with vital nutrients

- Breeders are now focusing on breeding for nutritional enhancement to overcome the problem of malnutrition.
- The range in brown rice

    Iron 6.3 - 24.4 ppm

    Zinc 13.5 - 28.4 ppm
- Suggesting some genetic potential to increase the concentration of these micronutrients in rice grains (Gregorio, 2002)

Raised and Sunken Bed Technology for Marshy Land

Area in NER	2.0 lac ha
Area in Meghalaya	1557 ha
No. of crops / year	2-3
Depth of marshy soil	0.5 – 1 m

A typical marshy land

Raised and sunken bed technology has been developed and validated by the Institute. Under this technology the soil from one area is cut and used for filling the nearby area. This helps in improving the soil physio-chemical condition and improves crop productivity. Depending upon the depth of marshy soil various land configurations are used. The land configuration may be permanent or temporary. The temporary raised beds are made after harvesting of lowland rice and used mainly for cultivation of vegetables. Under such land configurations the sunken areas is left unutilized, as a results about 20-40 % land is wasted. Whereas, permanent raised and sunken beds configuration are used for cent per cent land utilization. Here vegetables and other arable crops are grown on raised beds and rice, fish etc. are grown on sunken beds.

The Green Revolution technology, centered on high-yielding, disease- and insect-resistant rice varieties, has revolutionized rice production since the late 1960s.
Many countries in the rice belt of Asia, which used to import large quantities of rice, have become self-sufficient and have some surpluses to export. As a result, rice prices on the international market and in the domestic markets of many countries have fallen, thus helping the purchasing power of weaker sections of these societies.

The consequent improvement in food security has led to political stability and allowed the governments of the developing countries to pay more attention to the pressing needs of economic development.

Population growth is continuing at more than 2% annually in many developing rice-growing countries.
The demand for rice is likely to exceed supply by the year 2000.

To feed this growing population, the growth rate of rice production needs to accelerate further. For this we need varieties with higher yield potential, greater yield stability, shorter growth duration, and superior grain quality. Innovative breeding methods and the emerging techniques of biotechnology mt~st supplement the conventional breeding methods in achieving the future rice breeding goals.

Rice breeding today is. an international effort, involving scientists worldwide. IRRI is supported by an informal organization of 34 donor agencies called the Consultative Group on International Agricultural Research (CGIAP.).
The Govern- ment of Japan is the third largest donor to the CGIAR. Numerous Japanese scientists have made notable contributions to rice science and improvement. Half of the world's yearly scientific literature on rice science is published in Japan.

Evolution

Origin of Life,

Evidences for organic evolution;

Theories of organic evolution (Darwinism, Lamarckism & Mutation Theory).

1. Archeozoic (4600-3500 millions year): it is thr first era and begins with the formation of earth and presence of solar system. There is no fossil form available from this era.

2. Proterozoic (3000-1000 millions year): it is the second era and begins with the origin of prokaryotes, primitive metazoans and eukaryotes. Reports are available about scanty fossils in this era.

3. Palaeozoic (570-280 millions year): it is the third era and known as era of ancient life. It saw the appearance of invertebrate, fishes, amphibian etc. Reports of spore bearing plants, tree ferns and origin of conifers is available. initial Reports are available about scanty fossils in this era.

4. Mesozoic (225-135 millions year): The appearance of tooth birds, therian mammals, reptiles and dominance of dinosaurs. In addition, placental mammals are also found. Reports of cycads and flowering plants is available.

5. Cenozoic (Modern era): This is the modern era and it witnessed the dominance of present age man, modern mammals, birds, fishes and insects.

Introduction: Study of living organisms such as plants, animals and human etc is the active area of life science. Now question is how you will define **"LIFE"**. Life is defined as "the ability of an organism to reproduce, grow, produce energy through chemical reactions to utilize the outside materials". But scientists and philosophers have tried to understand two important questions related to life

1. How life originated on earth?

2. How different kinds of organisms are formed in the world?

BIG BANG THEORY

According to this theory

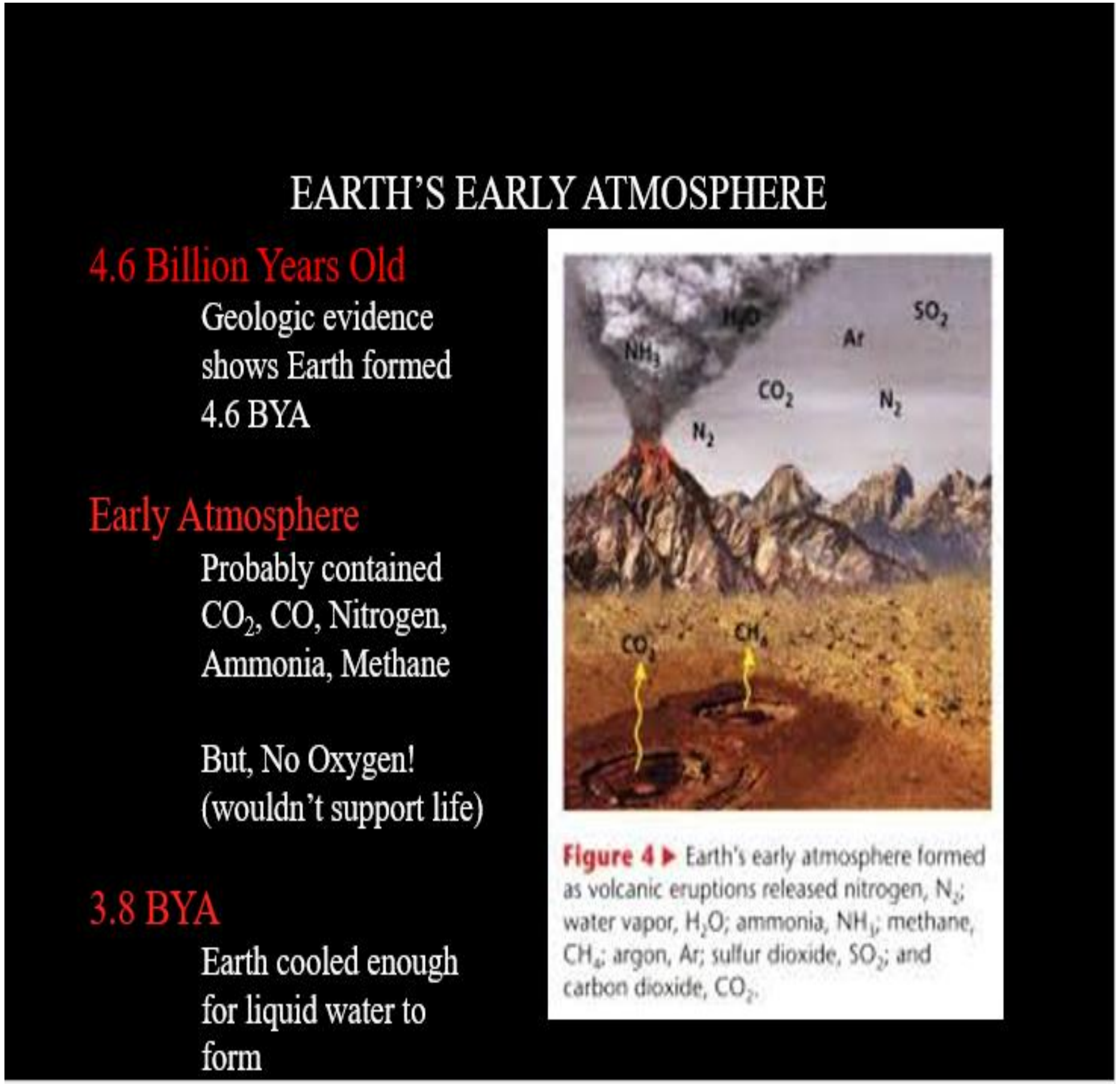
- It is assumed that in the beginning, whole energy of universe was concentrated at a point
- Due to a huge explosion- this energy got distributed which formed the present day universe.

$E = MC^2$

1. How life originated on earth?

2. How different kinds of organisms are formed in the world?

So first the question is how earth formed and how its internal structure support the life? evidences suggest that earth and other planets in solar system came to existence around 4.5-5 billion years ago. Earth originally had two components: solid mass **lithosphere** and the surrounding gaseous envelope **atmosphere**. Once the temperature of primitive earth cooled down below 1000C, liquid components known as **hydrosphere**.



- Primitive earth with little or no oxygen. The earth original had a reducing environment due to presence of hydrogen and hydrogen compounds with water (such as CH_4) and ammonia (NH_3). Due to gravitional forces, these gases remains within the atmosphere of primitive earth. **The reducing environment of primitive earth will help to synthesize organic compounds from interaction of inorganic substances.**

- Inorganic raw material for origin of life: Inorganic material in the earth interact to form organic material required to to produce life.

- **Energy source.** The energy source on primitive earth came from the following sources:

  Solar radiation

  Electric discharge

  Volcanic eruptions

  Heat

  Cosmic Rays

  Radioactive Decays

- **Infinite time:** As per estimate it tooks almost 1 billion years from the formation of earth to appearance of life. Such a lon time is needed for chemical reactions to occur without the help of enzyme.

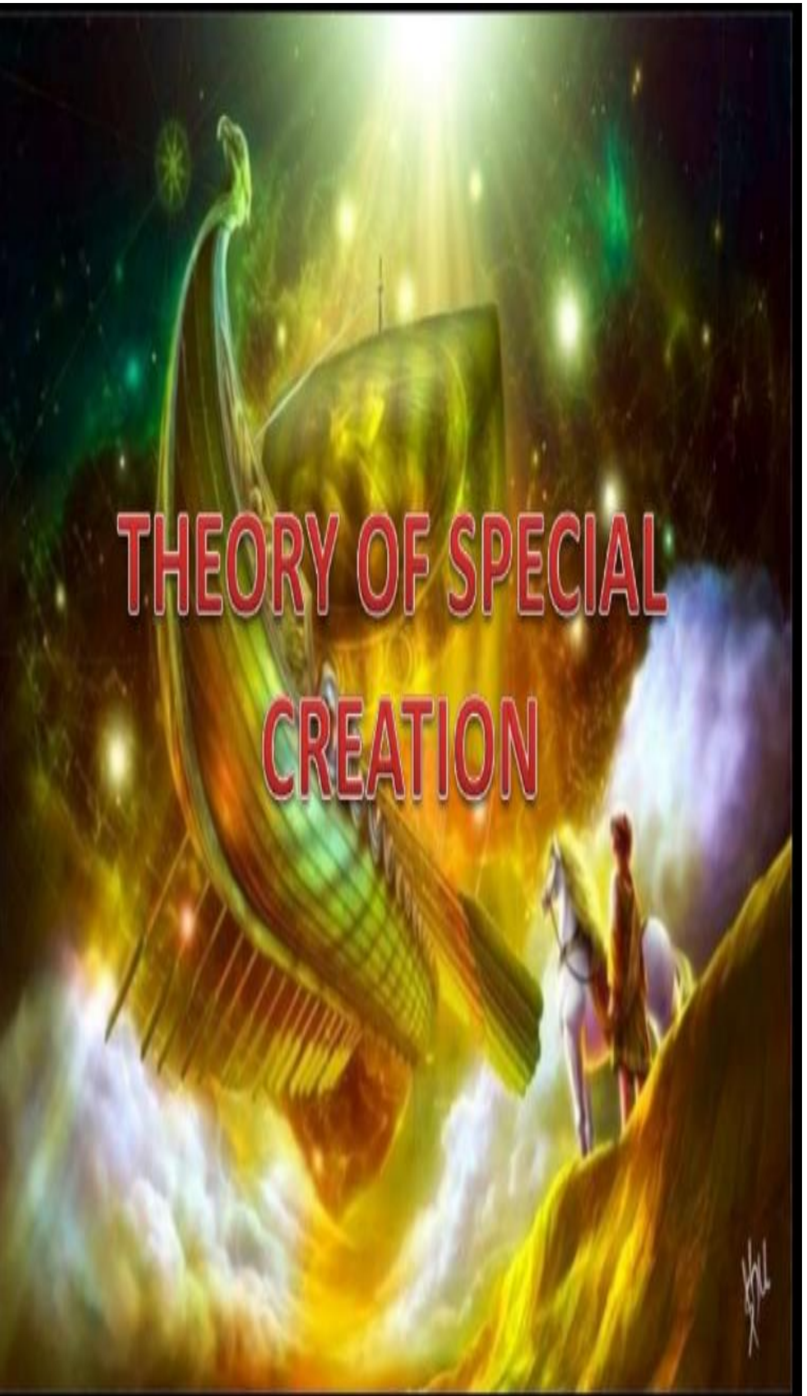
NOW COMING TO OUR FIRST QUESTION? HOW LIFE ORIGINATED ON EARTH?

Theories on Origin of life

- Theory of Creationism
- Theory of Extraterrestrial Origin
- Theory of Biochemical evolution

Creationism

- Life was put here, on Earth, by divine forces
- This is based on faith, not fact
- It relies on stories that have been passed down over the years
- Cannot be proven scientifically

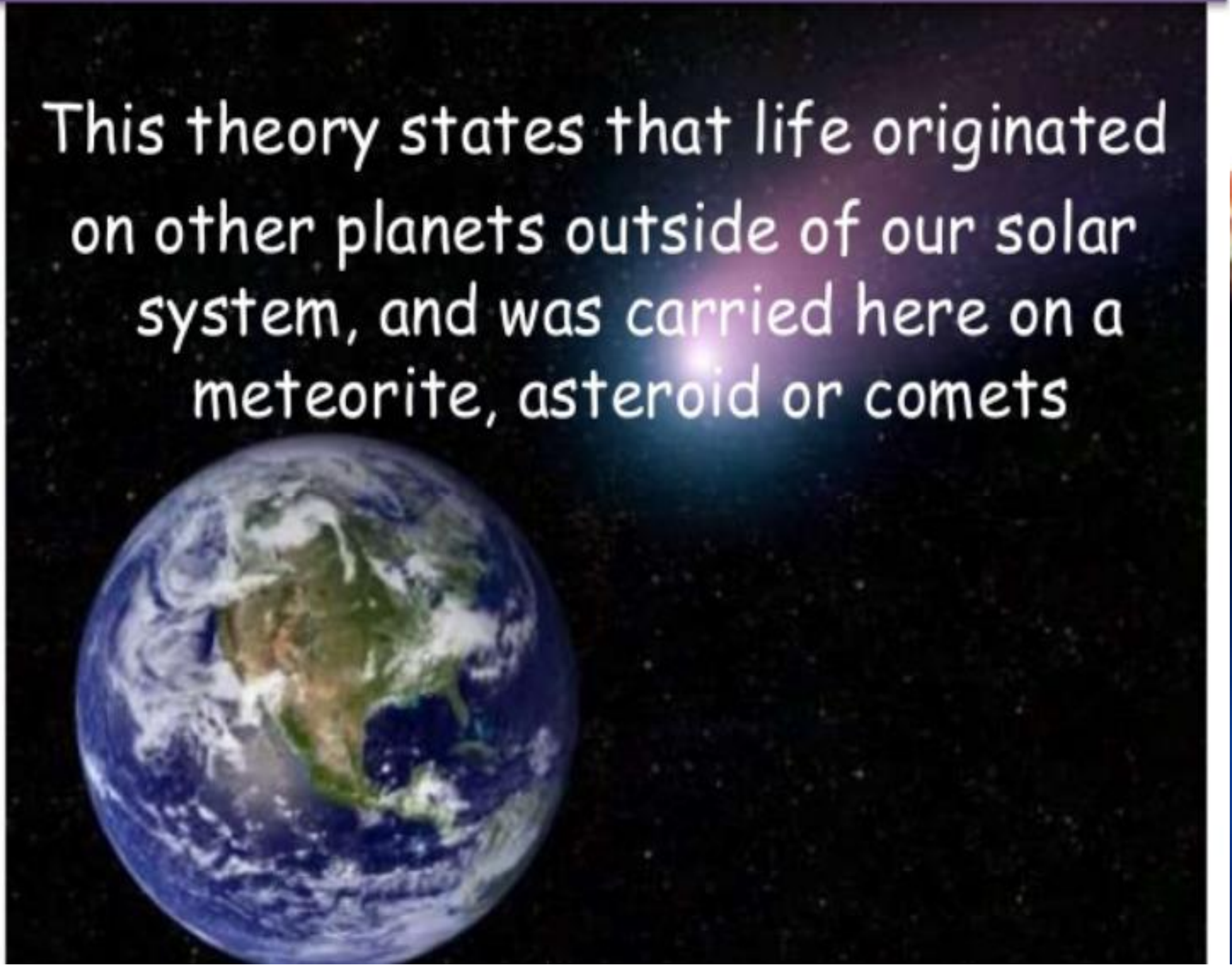


- All the different forms of life - created by God.
- **<u>HINDU CONCEPT</u>** :- Lord Brahma- created the living world in one stroke.

- **<u>CHRISTIAN & ISLAM BELIEF</u>** :- God created this universe, plants, animals and human beings in about six days.
- 3 main postulates :
  - All different kinds of animals & plants were created at once.
  - All organisms were created in the same form in which they exist today.
  - Their bodies & organs have been designed to fully meet the needs of the environment.

- It has no scientific basis.

Extraterrestrial Origin



Carl Sagan

'Comets give and comets take away'

THEORY OF SPONTANEOUS GENERATION

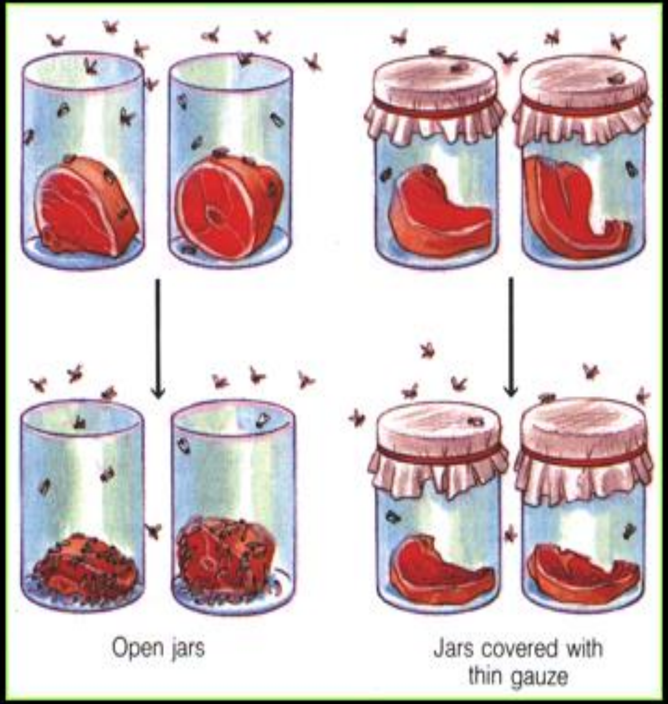
I. Early Theory

A. Spontaneous Generation (Abiogenesis)- The hypothesis that life arises regularly from non-living thing

II. Experiments That Helped to Disprove Spontaneous Generation

A. Italian physician and poet, Francesco Redi (1668)

1. Hypothesis: Maggots arose from tiny, non-visible eggs laid on meat
2. Procedures:
   a) Put pieces of meat in several jars, leaving half open to the air
   b) Cover the other half with thin gauze to prevent entrance of flies
3. Results:
   a) After a few days, meat in all jars spoiled and maggots were found only on the meat in the uncovered jars
   b) One of the first documented experiments to use a control!



II. Experiments That Helped to Disprove Spontaneous Generation cont.

B. French scientist, Louis Pasteur (1859)

The French Academy of Sciences held a contest for the best experiment either proving or disproving spontaneous generation

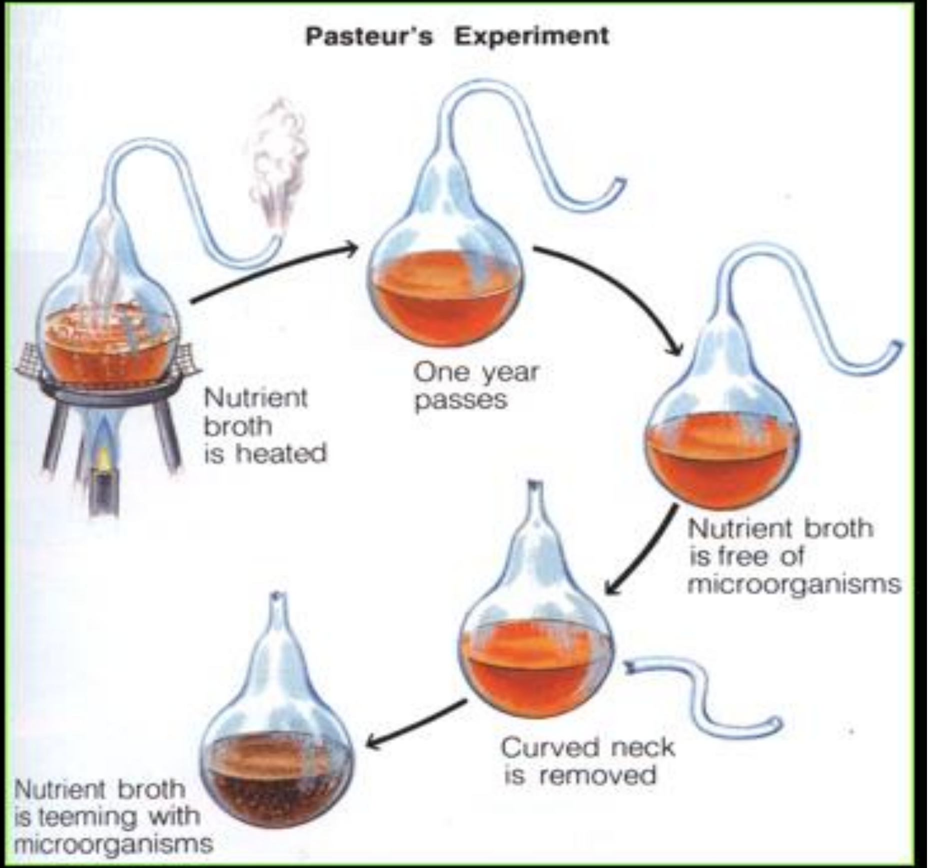
1. Hypothesis: Microorganisms do not arise from meat broth
2. Procedures:
   a) Place meat broth in a flask with a long, curved neck. (*This permitted air to enter, but trapped dust and other airborne particles*)
   b) Boil the flask thoroughly to kill any microorganisms
   c) Do NOT seal the open end of the flask
   d) Wait an entire year before gathering results

3. Results:

a) After a year, no microorganisms could be found in the broth!

b) Pasteur then removed the curved neck, permitting dust and other particles to enter. In just one day, the flask contained microorganisms!

c) Microorganisms had clearly entered the flask with the dust particles from the air



Biochemical evolution

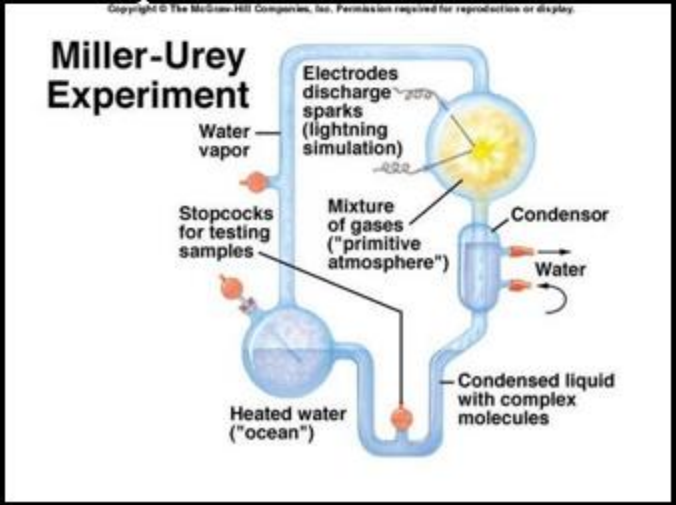
Life appeared after a period of chemical reactions

According to physical and chemical laws

III. Theories Explaining the Formation of Life

A. The Formation of Complex Molecules: the Miller/Urey Experiment (1953)

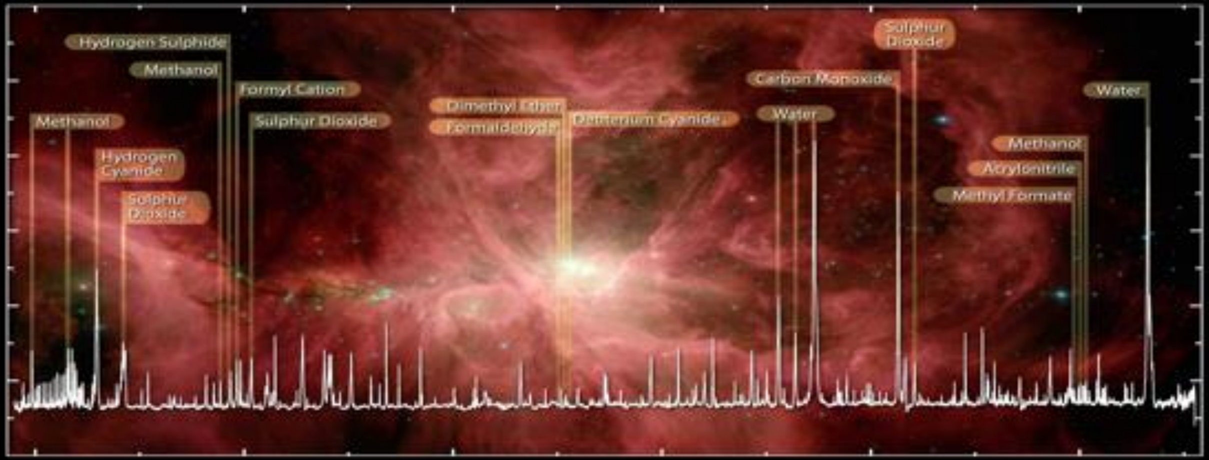
1. Miller and Urey simulated the conditions of Earth's early atmosphere and oceans, adding energy to simulate the lightning that was believed to be commonplace
2. After one week, 10-15% of the carbon had turned into organic compounds, and 2% of the carbon had created amino acids, the building blocks of proteins/life



III. Theories Explaining the Formation of Life cont.

B. Molecules from Space

1. Many of the compounds produced by the Miller/Urey experiment are known to exist in space.
2. If these compounds can survive the harshness of space, perhaps they were present when earth initially formed.
3. Organic molecules could have also been brought to earth by space debris.



HIFI Spectrum of Water and Organics in the Orion Nebula

© ESA, HEXOS and the HIFI consortium
E. Bergin

IV. Current Theories

A. The Formation of Complex Molecules

1. Collections of these molecules tend to gather together into tiny round droplets known as *coacervates*

    a) In the laboratory, these droplets have been shown to grow and divide!

    b) Coacervates are not living cells, but their existence suggests ways in which the first cell may have formed.

    c) Early oceans are the perfect environment for coacervates – warm, wet, large, and the water "protected" their delicate structure

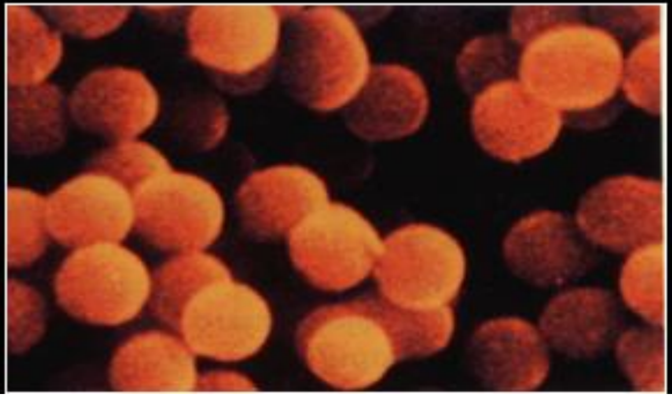
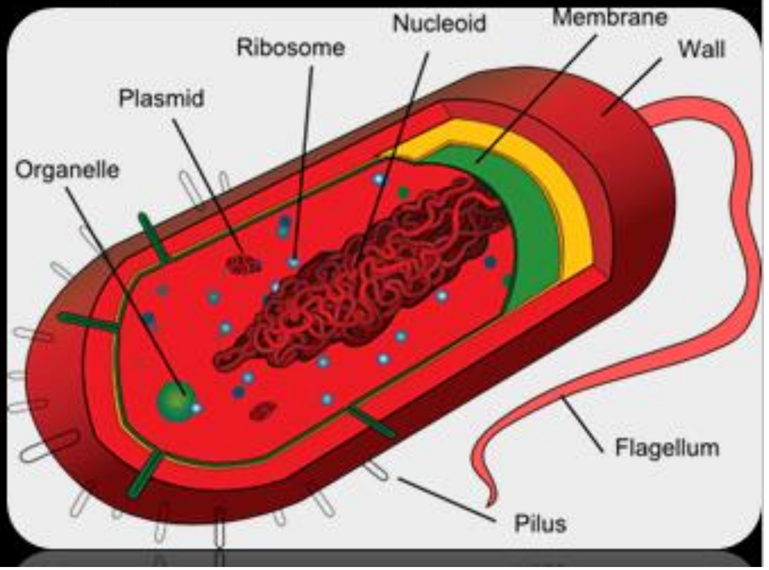


Figure 16.9

IV. Current Theories

B. The First True Cells

1. They were prokaryotic (*lacked nucleus*), anaerobic (*survived in absence of O_2*), heterotrophs that resemble types of bacteria alive today
2. Found in rock 3.5 billion years old

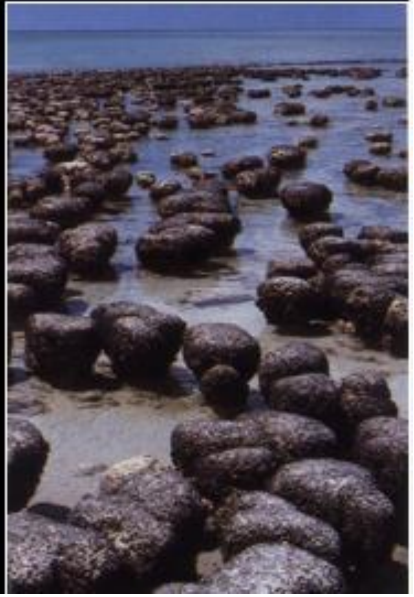


IV. Current Theories

C. The Evolution of Photosynthesis

1. Early heterotrophic bacteria fed on organic molecules, releasing CO_2 as a waste product.
2. 3.5 billion years ago, photosynthesis evolved that was mostly anaerobic, releasing sulfur as a waste product.
3. Natural selection favored organisms that could harness energy from the readily available sun
4. 2.7 billion years ago, photosynthesis that used sunlight and released oxygen as a waste product developed. Commonly used in cyanobacteria (which produce fossils called stromatolites)

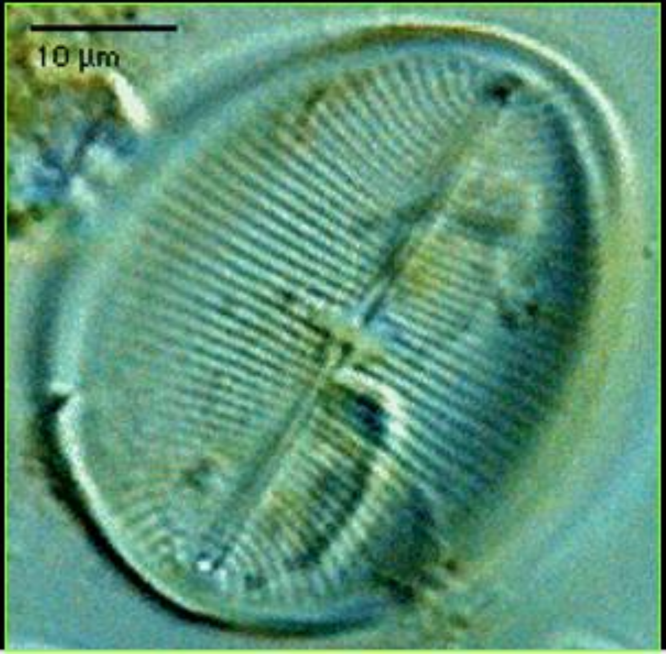
Living stromatolites still exist in Shark Bay, Australia



V. The Road to Modern Organisms

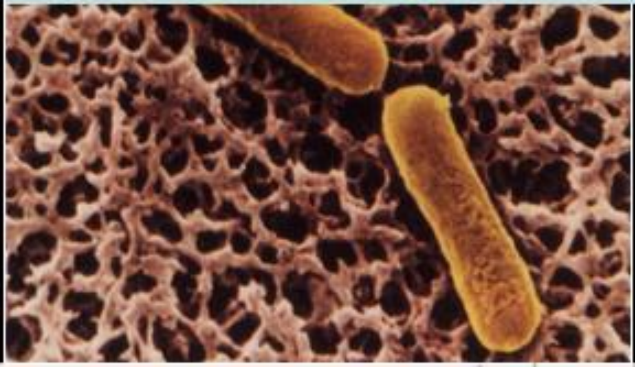
A. Oxygen and Life

1. Oxygen began to increase in the atmosphere about 2.3 bya
2. Oxygen was poisonous to early anaerobic organisms and many either died off or remained underground/underwater. Earth was transformed!



Anaerobic bacteria such as these now live only deep within the ocean , deep in mud and in other places where the atmosphere does not reach.

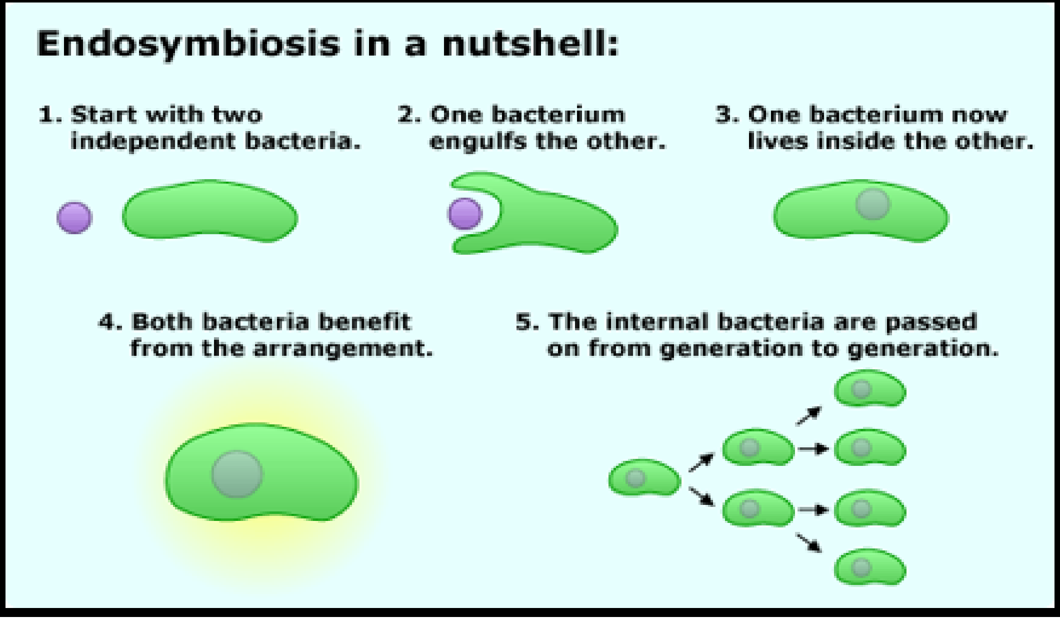
Organisms using Oxygen began to evolve and dominate the planet!



V. The Road to Modern Organisms

B. Eukaryotes and the Origin of Complex Cells

1. Eukaryotic organisms with a true nucleus, DNA and membrane-bound organelles evolved between 1.4 and 1.6 bya
2. Eukaryotes likely evolved because of endosymbiosis – one bacterium engulfing another and passing that structure on
3. For example, the modern chloroplast is the descendent of an engulfed cyanobacteria!



Chemical Evolution: The term evolution refers to change from one form to another. Change in living organism with time is known as organic or biological evolution. The process of evolution can be understood from the fact that unicellular organism appear first, simple multicellular and later development of complex multicellular organisms such as seed plants and vertebrate animals. The fishes were the initial early vertebrate and it gradually change to form amphibians. These amphibians has produced reptiles and that has evolved further to give birds and mammals. These hierarchical linking of different species is considered by ladder of chain by Aristotle as given in Figure 5.1. In the same series, mammals have evolved to human involving ape-like primates by acquiring changes over the course of time (**These changes and different intermediate forms are**

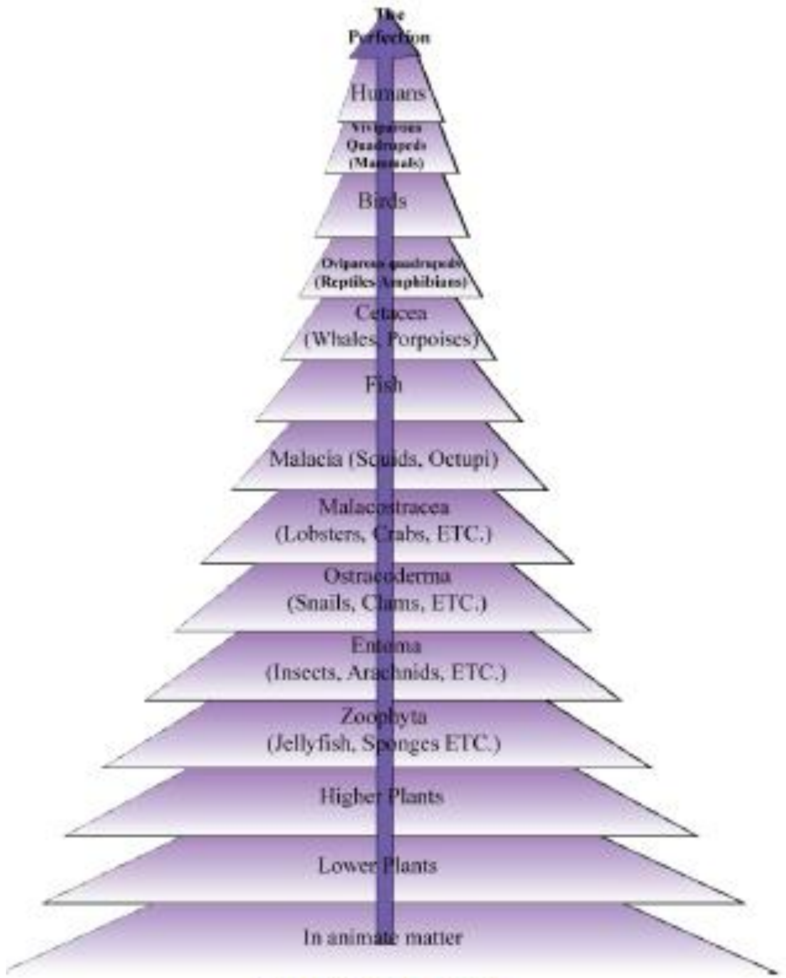
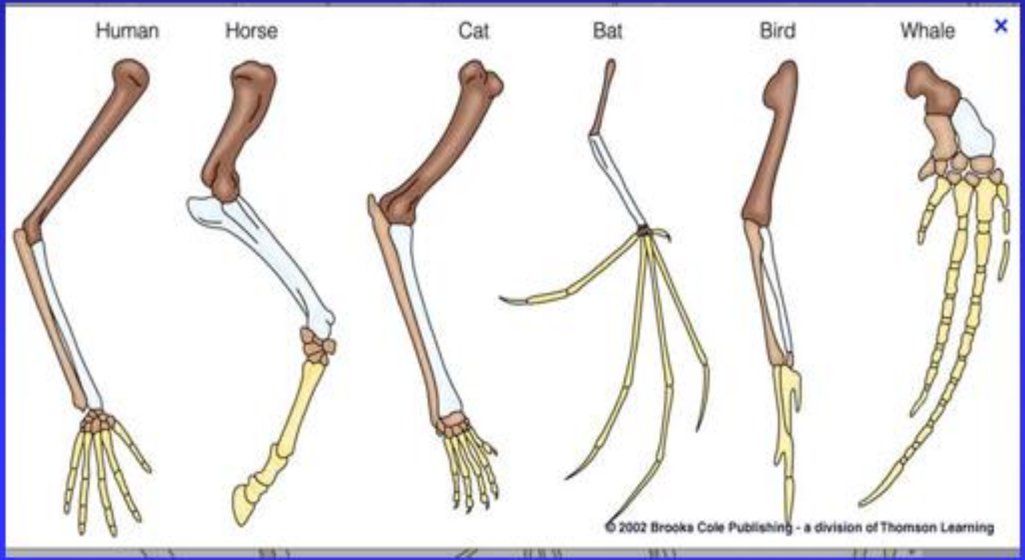


Figure 5.1 : Aristotle's ladder of Nature.

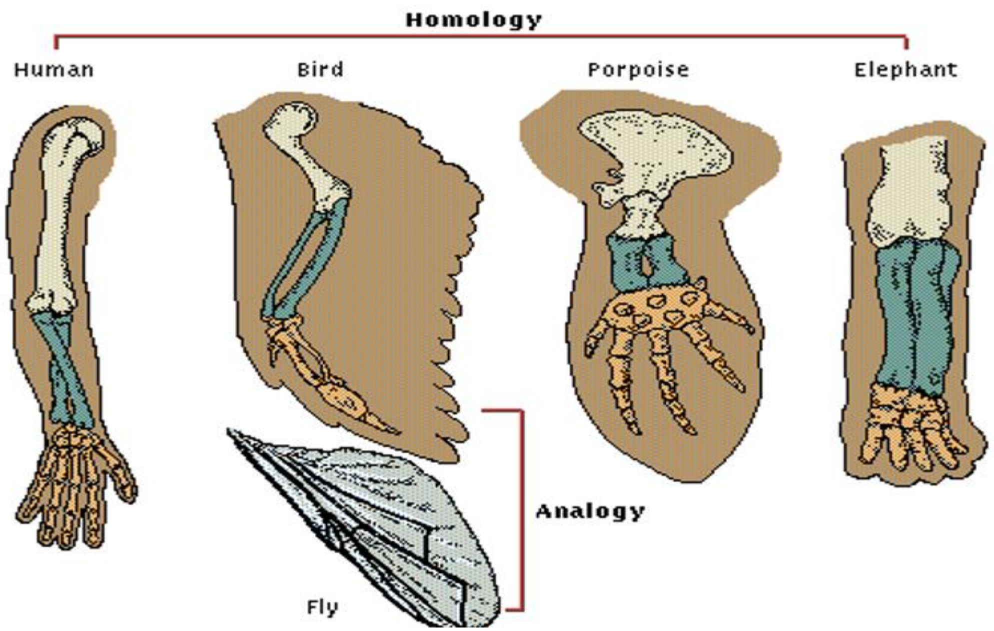
Homologous Structures

- **Homologous Structures**-structures that appear different, yet have common origin. This indicates similar DNA and ancestral origin



Evidence for Evolution

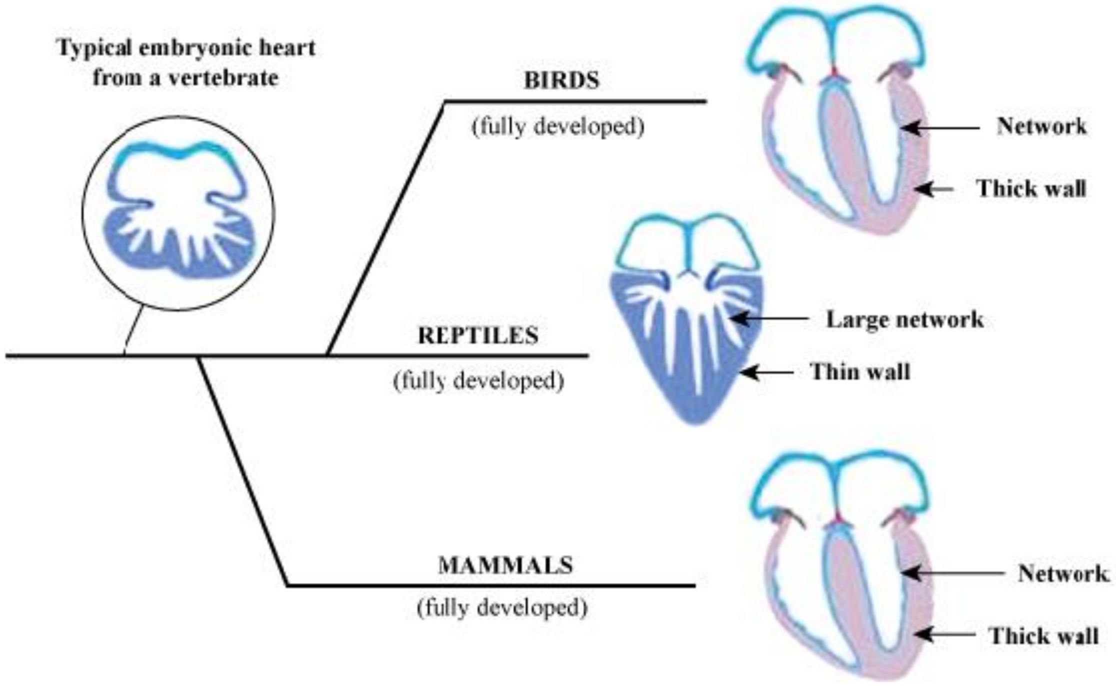
- **Vestigial organs**-organs that serve no useful function in an organism
- i.e.) appendix, wisdom teeth in humans, tailbone. Pelvic bone in whale



EVIDENCE FROM GEOGRAPHICAL DISTRIBUTION OF ORGANISMS

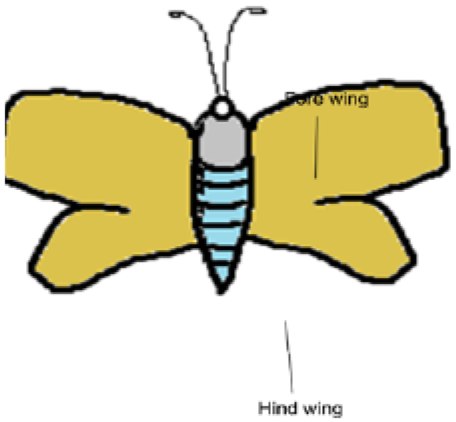
Even though climatic similarity is found at different places, the organisms found there are different if they are from different origin.

Organisms of same origin are isolated in different climatic enviroment , they vary in structure after many generations.

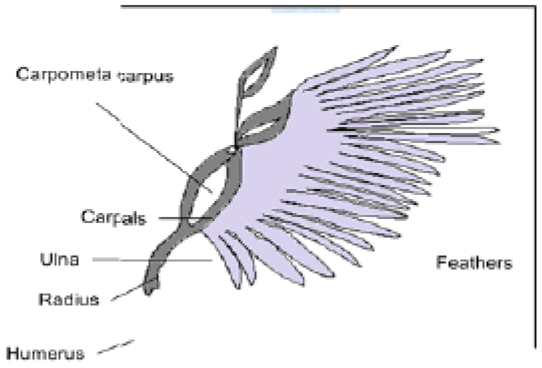


D. Gradual Modifications: In several cases, organs or tissue exhibits gradual modifications during the corse of organic evolution. For example, Heart is two chambered (one auricle and ventricle) in the fishes, 3 chambered (two auricle and ventricle) in amphibians, pseudo four chambered (two auricle and partly divided ventricle) in reptiles (snake) and 4 chambered in higher reptiles (crocodile), birds and mammals (Figure 5.6).

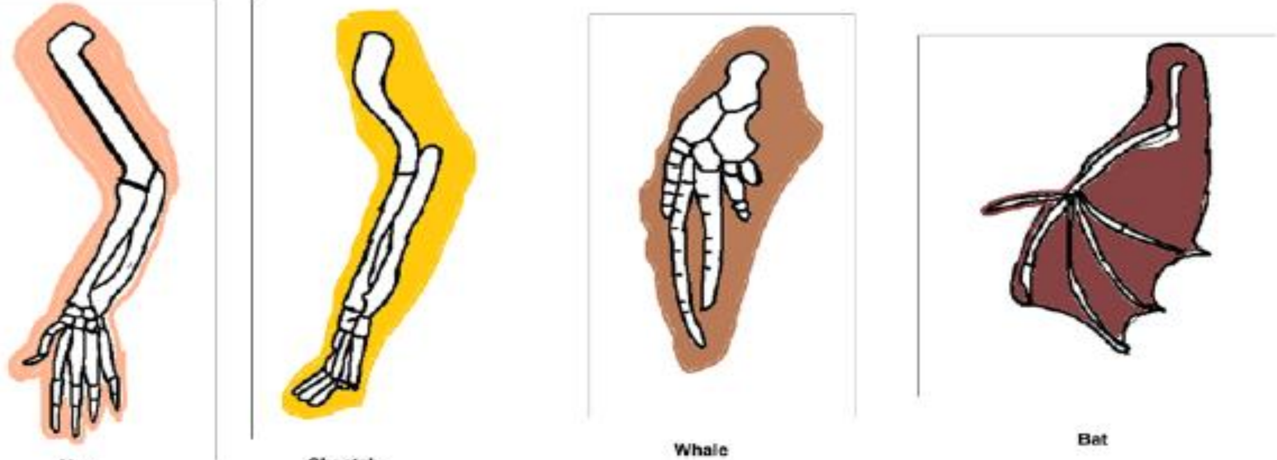
Insect and bord wings:



Insect Wings



Bird Wing



Example 1: Forelimb in vertrbrate animals: The forelimb in man, cheetah, whale and bat are different shapes and perform different functions (Figure 5.2). These are used for grasping object in man, running in cheetah, swimming in whale and flying in bat. In each case, the structure of the form arm has similar plan: upper arm having humerus, followed by radius and ulna, and hand with carpals in the wrist. All vertebrates have basic similarity in the structure of their forelimbs due to their origin from a common ancestral with five digits.

Example 3: Egg laying mammals: Egg laying mammals are the connecting link between reptiles and mammals. For example, duck-billed platypus. They have few mammalian

Example 2: Fin and flippers: The pectoral fins of fishes and flippers of dolphins are flattened organs used for swimming but both have different structure (Figure 5.5). The flippers are the modified pentadactyl forelimbs whereas fins are pentadactyl.

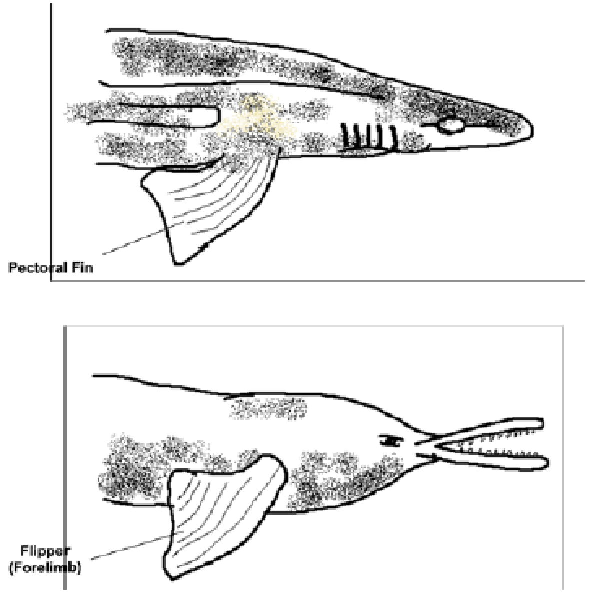
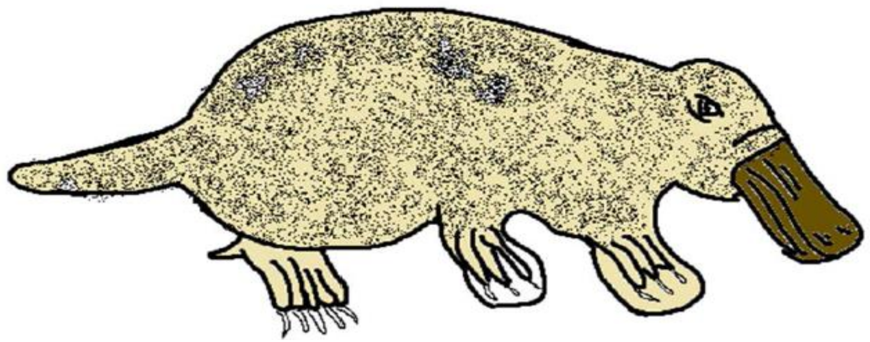


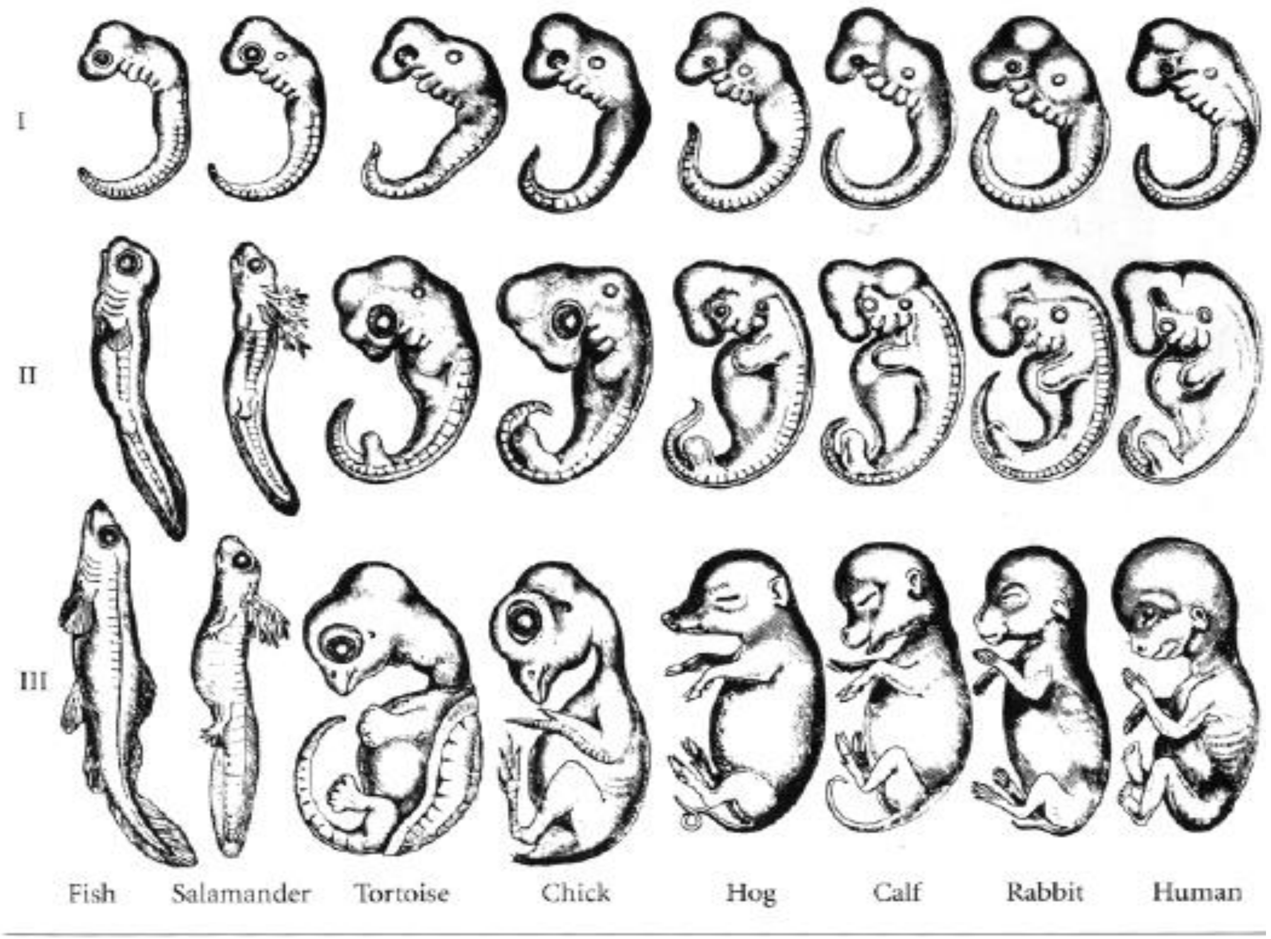
Figure 5.5 : Pectoral Fin of shark and dolphin flippers.

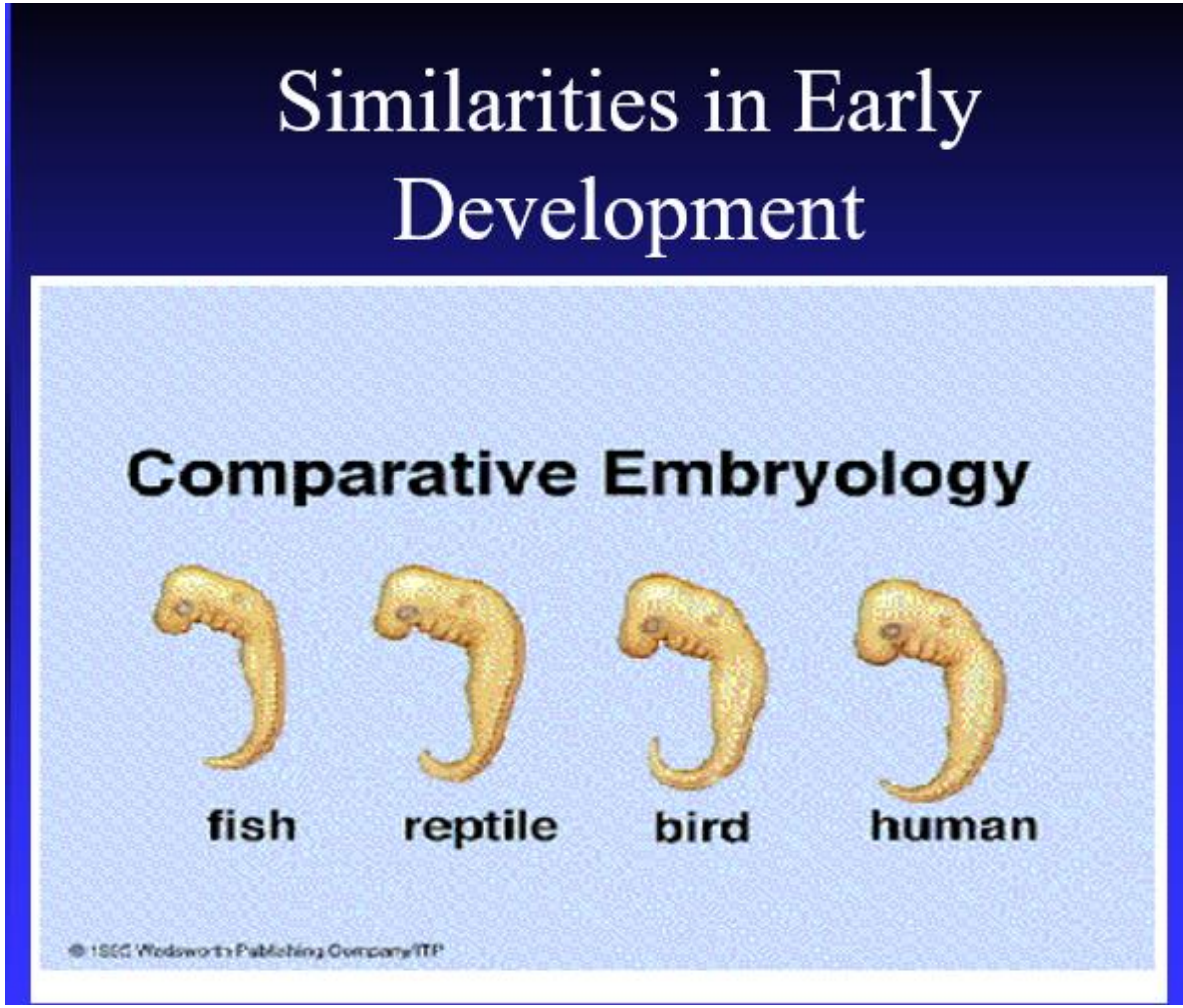
characters such as hair, mammary glands, diapharm whereas it lays eggs with yolk and egg shell similar to reptiles (Figure 5.7).



Evidence in Embryos

Vertebrates have a common ancestor

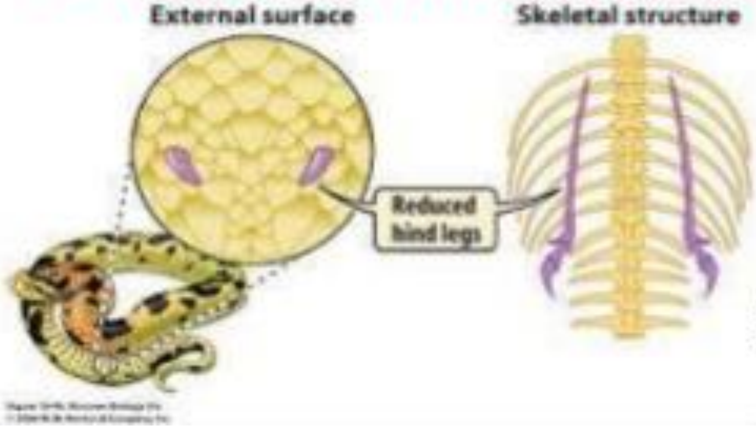




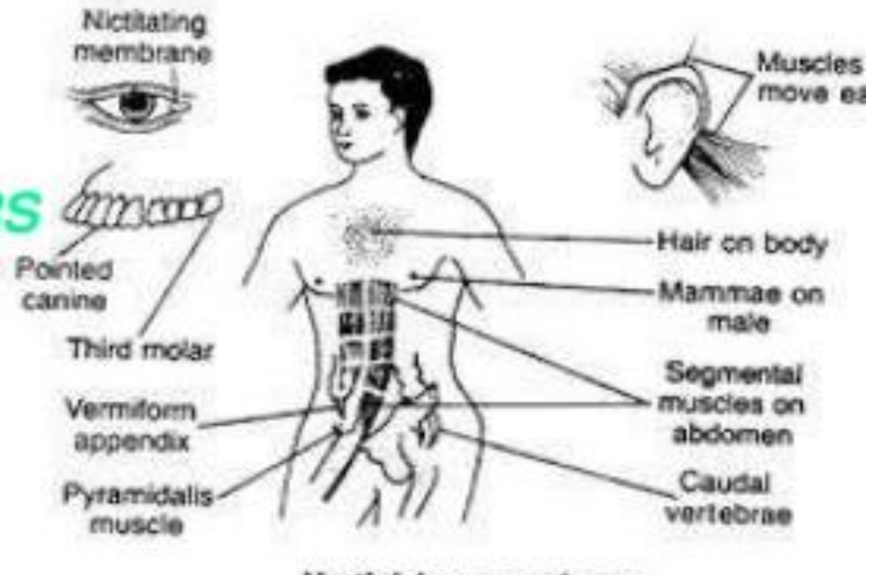
EVIDENCE FROM VESTIGIAL ORGANS

- *organs or structures remaining or surviving in a degenerate, atrophied, or imperfect condition or form..*
- *Highly developed in lower animals but in reduced form in higher animals*

PROVES THAT EVOLUTION OCCURS



VESTIGIAL ORGAN IN SNAKE



Vestigial organs of man

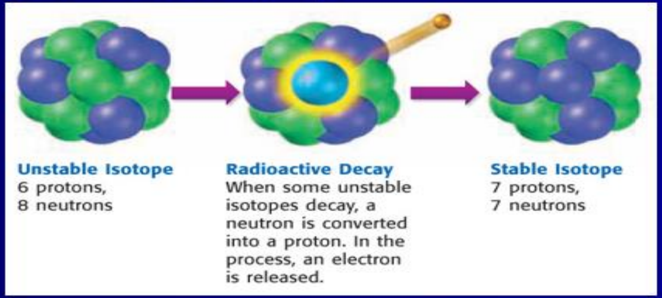
Example 2: Thorn and tendrils in plants: The thorn in bougainvillea and tendril in passion flower are the homologous organ in the plants. They looks different and help the plant in climbing but both arises from the axillary position and are modified branches (Figure 5.3).

Table 6.1: Different kinds of fossils, their formation and examples.

Fossils	Mode of formation	Examples
Entrire Organism	Frozen in ice	Woolly mammoths in syberia.
	Encased in amber	Insects Exoskeleton
	Trapped in asphalt	Mummies of mammals and birds found in California.
	Buried in peat bogs	Giant elk of Ireland.
Skeltal Materials	Trapped in sedimentary rocks	Bones, teeth, shells, chitinious exoskeletons.
Moulds nad casts	Hard part trapped in sediments that harden to rock, skeleton dissolve leaving its impression as mould.	Gastropods from Portland.
Petrified Remains	Tissue replaced by water-carried mineral deposits.	Petrified forests of Arizona.
Impressions	Remains in fine-grained sediment on which organisms died.	Archaeopteryx feathers, leaf impressions.
Imprints	Footprints, trails, tracks and tunnels of organisms made in mud rapidly baked and covered by sediments.	Dinosaur footprints.
Coprolites	Faecal pellets buried in sediments.	Coenozoic mammals.

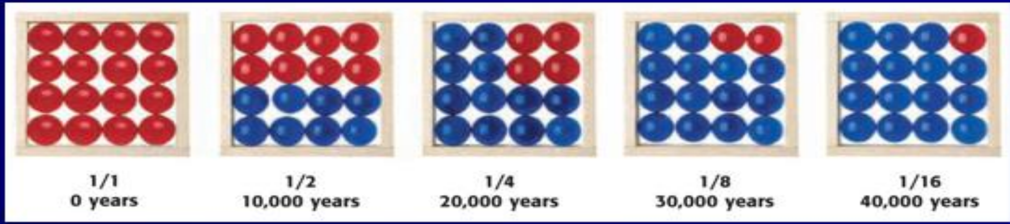
Radioactive Decay, *continued*

- Radioactive isotopes tend to break down into stable isotopes of the same or other elements in a process called **radioactive decay.**



Radiometric Dating, *continued*

- A **half-life** is the time needed for half of a sample of a radioactive substance to undergo radioactive decay.
- After every half-life, the amount of parent material decrease by one-half.



Here are the elements used in radioactive dating

Elements Used in Radioactive Dating

Radioactive Element	Half-life (years)	Dating Range (years)
Carbon-14	5,730	500–50,000
Potassium-40	1.3 billion	50,000–4.6 billion
Rubidium-87	48.8 billion	10 million–4.6 billion
Thorium-232	14 billion	10 million–4.6 billion
Uranium-235	713 million	10 million–4.6 billion
Uranium-238	4.5 billion	10 million–4.6 billion

Most **relevant** theory regarding the origin of life is

'Theory of Biochemical Evolution'

Because it is **scientifically proven**

But none of these theories is 100% correct

Research is still going on to unravel the mystery of Origin of life

Theories of Evolution

Introduction: In continuation our discussion on evolution, so far we have discussed origin of life and the evidences to support the existence of evolution to give rise diversified organisms on earth. The mechanism of evolution is not known and several theories have been put forward to explain the process of evolution. These theories are as follows:

Darwin's Theory of Evolution: The theory of natural selection was proposed by Charles Darwin and Alfred Russel Wallace in their common publication. Both of them conducted scientific data collection from individual population survey. Charles Darwin travelled for 5yrs expedition around the world on the ship H.M.S Beagle. During this journey, he made observation of several animals and plants. He keenly observed the similarities among organisms and draw evolutionary relationship. In addition, economist Thomas Malthus's report on workers recognized that competition between species leads to the struggle for existence. Considering Wallace's view and Malthus observations of workers led Charles Darwin to propose the theory of natural selection in his book **"Origin of Species"**. The theory of natural selection is based on following points:

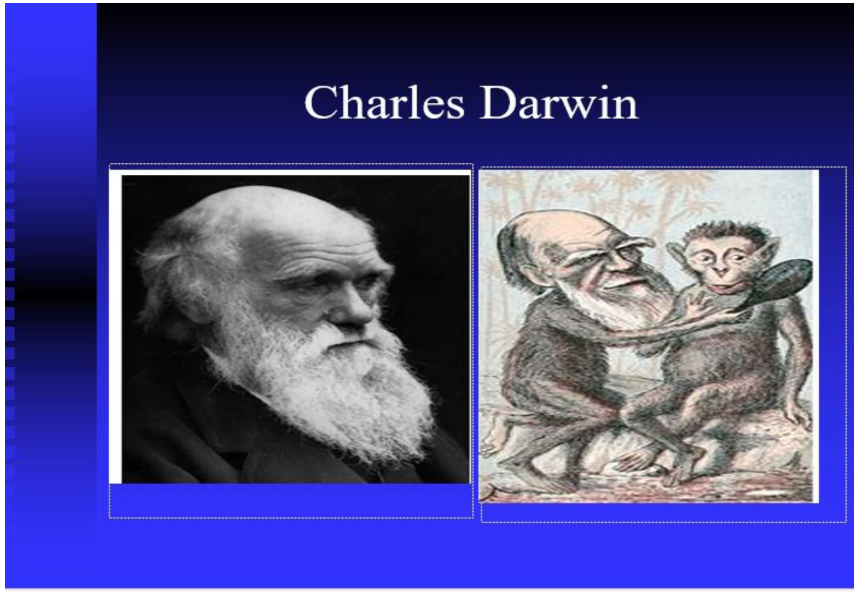


Fig. 7.36. Charles Robert Darwin (1809-1882 A.D.).

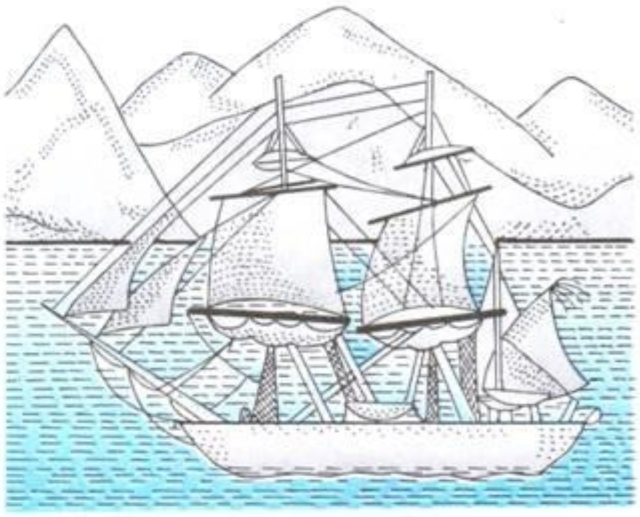


Fig. 7.37. H.M.S. Beagle ship.

I. Darwinism (Theory of Natural Selection):

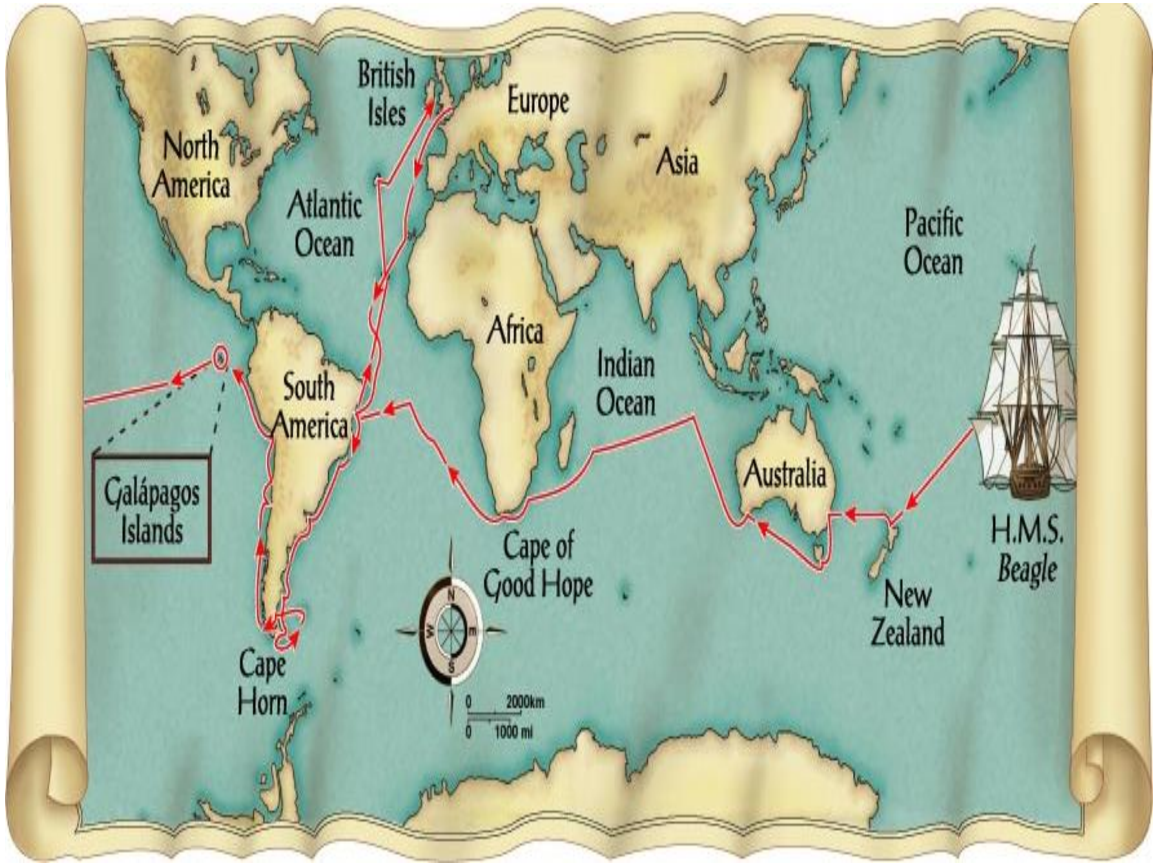
A. Introduction:

Charles Darwin (Fig. 7.36) (1809- 1882 A.D.), an English naturalist, was the most dominant figure among the biologists of the 19th century. He made an extensive study of nature for over 20 years, especially in 1831-1836 when he went on a voyage on the famous ship “H.M.S. Beagle” (Fig. 7.37) and explored South America, the Galapagos Islands and other islands.

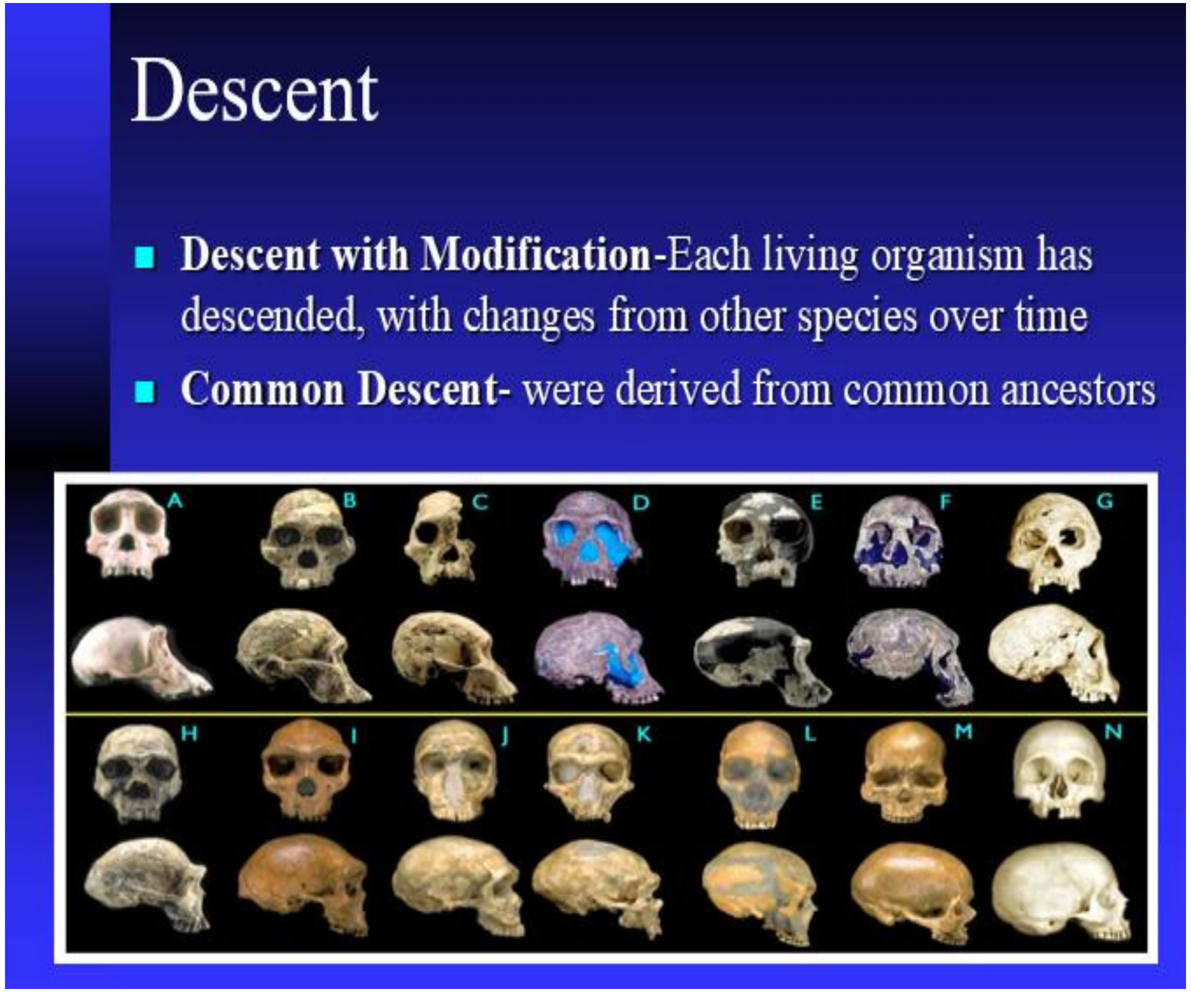
Voyage of Beagle

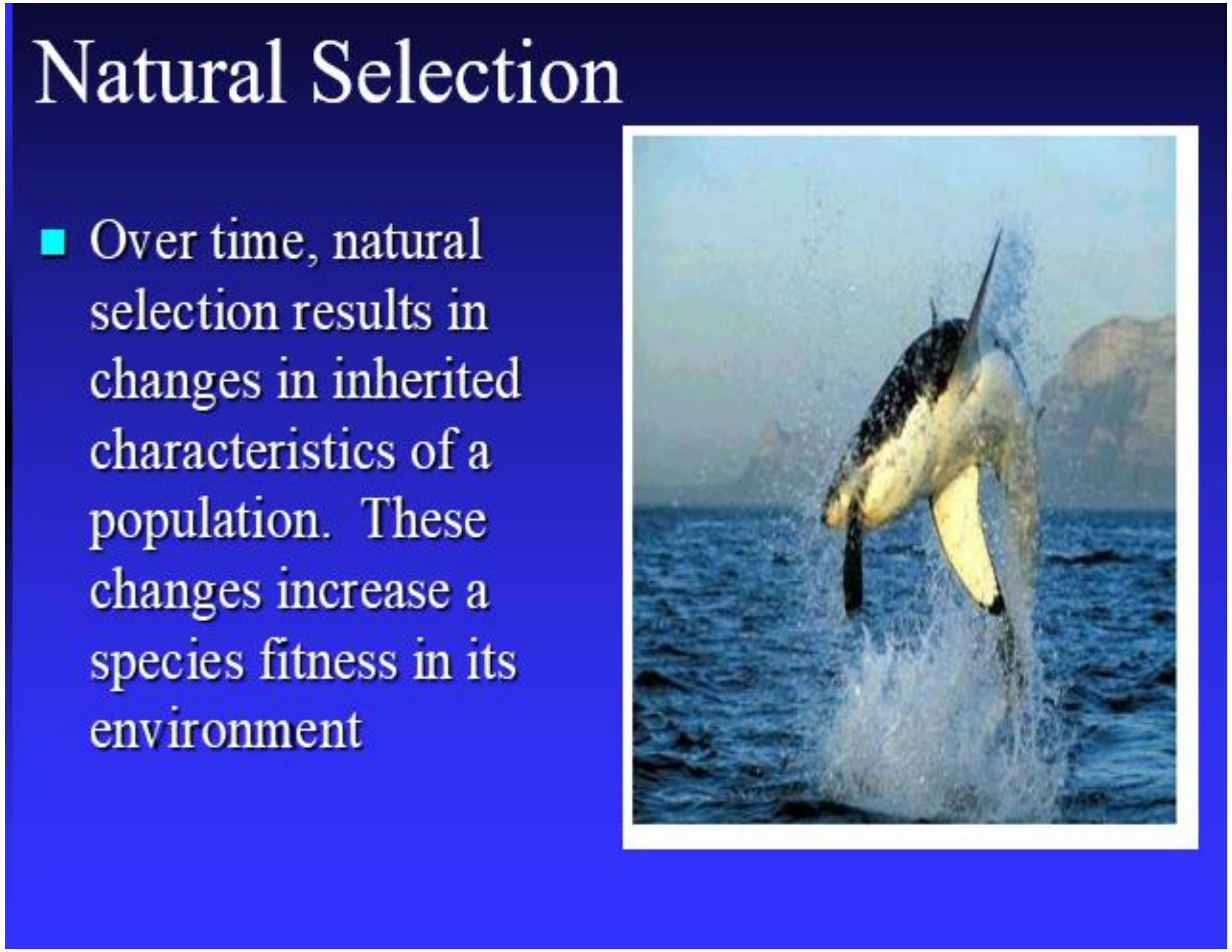
- **Dates:** February 12th, 1831
- **Captain:** Charles Darwin
- **Ship**: H.M.S. Beagle
- **Destination:** Voyage around the world.
- **Findings:** evidence to propose a revolutionary hypothesis about how life changes over time

Darwin explained his theory of evolution in a book entitled "On the Origin of Species by means of Natural Selection". It was published on 24th Nov., 1859. In this theory, Charles Darwin proposed the concept of natural selection as the mechanism of evolution.



Two key concepts of Darwinian Theory of Evolution are:
1. Branching Descent, and 2. Natural Selection.





Main postulates of Darwinism are:

1. Geometric increase.
2. Limited food and space.
3. Struggle for existence.
4. Variations.
5. Natural selection or Survival of the fittest.
6. Inheritance of useful variations.
7. Speciation.

1. Geometric increase:

According to Darwinism, the populations tend to multiply geometrically and the reproductive powers of living organisms (biotic potential) are much more than required to maintain their number e.g.,

Other rapidly multiplying organisms are: Cod (one million eggs per year); Oyster (114 million eggs in one spawning); Ascaris (70, 00,000 eggs in 24 hours); housefly (120 eggs in one laying and laying eggs six times in a summer season); a rabbit (produces 6 young ones in a litter and four litters in a year and young ones start breeding at the age of six months).

Similarly, the plants also reproduce very rapidly e.g., a single evening primrose plant produces about 1, 18,000 seeds and single fern plant produces a few million spores.

Even slow breeding organisms reproduce at a rate which is much higher than required e.g., an elephant becomes sexually mature at 30 years of age and during its life span of 90 years, produces only six offsprings. At this rate, if all elephants survive then a single pair of elephants can produce about 19 million elephants in 750 years.

These examples confirm that every species can increase manifold within a few generations and occupy all the available space on the earth, provided all survive and repeat the process. So the number of a species will be much more than can be supported on the earth.

2. Limited food and space:

3. Struggle for existence:

4. Variations:

Darwin proposed that living organisms tend to adapt to changing environment due to useful continuous variations {e.g., increased speed in the prey; increased water conservation in plants; etc.), as these will have a competitive advantage.

5. Natural selection or Survival of the fittest:

Darwin stated that if the man can produce such a large number of new species/varieties with limited resources and in short period of time by artificial selection, then natural selection could account for this large biodiversity by considerable modifications of species with the help of unlimited resources available over long span of time.

Darwin stated that discontinuous variations appear suddenly and will mostly be harmful, so are not selected by nature. He called them “sports”. So the natural selection is an automatic and self going process and keeps a check on the animal population.

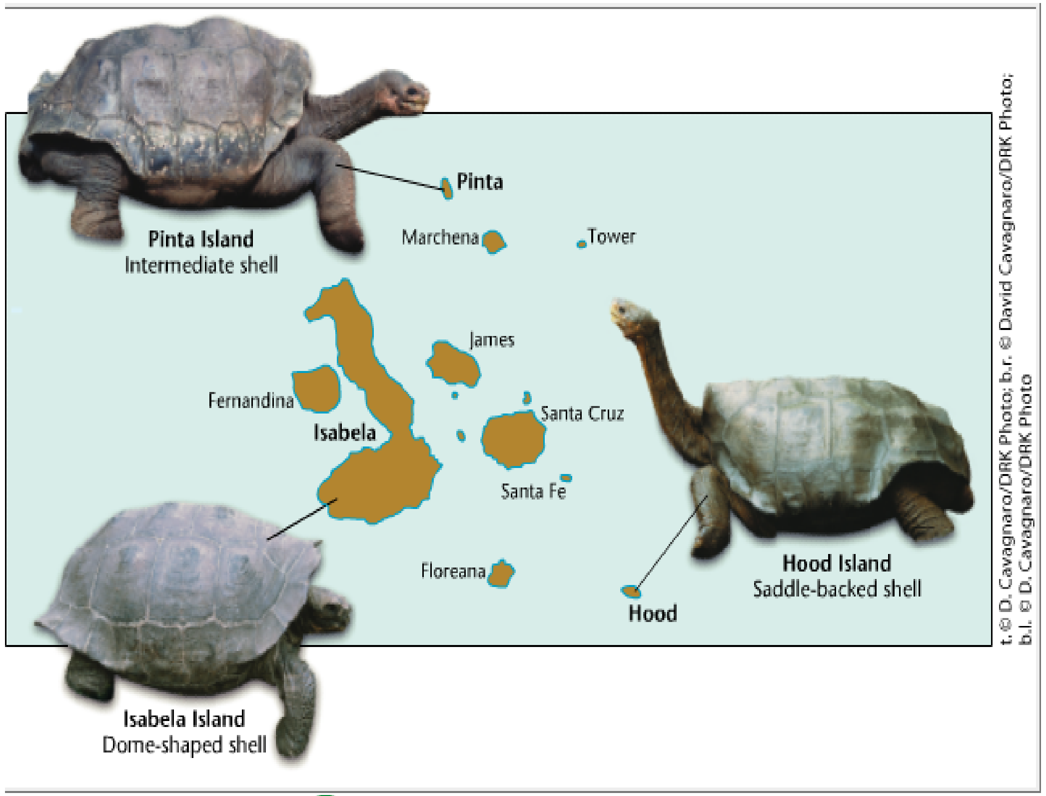
This sorting out of the individuals with useful variations from a heterogeneous population by the nature was called Natural selection by Darwin and Survival of the fittest by Wallace. So natural selection acts as a restrictive force and not a creative force.

6. Inheritance of useful variations:

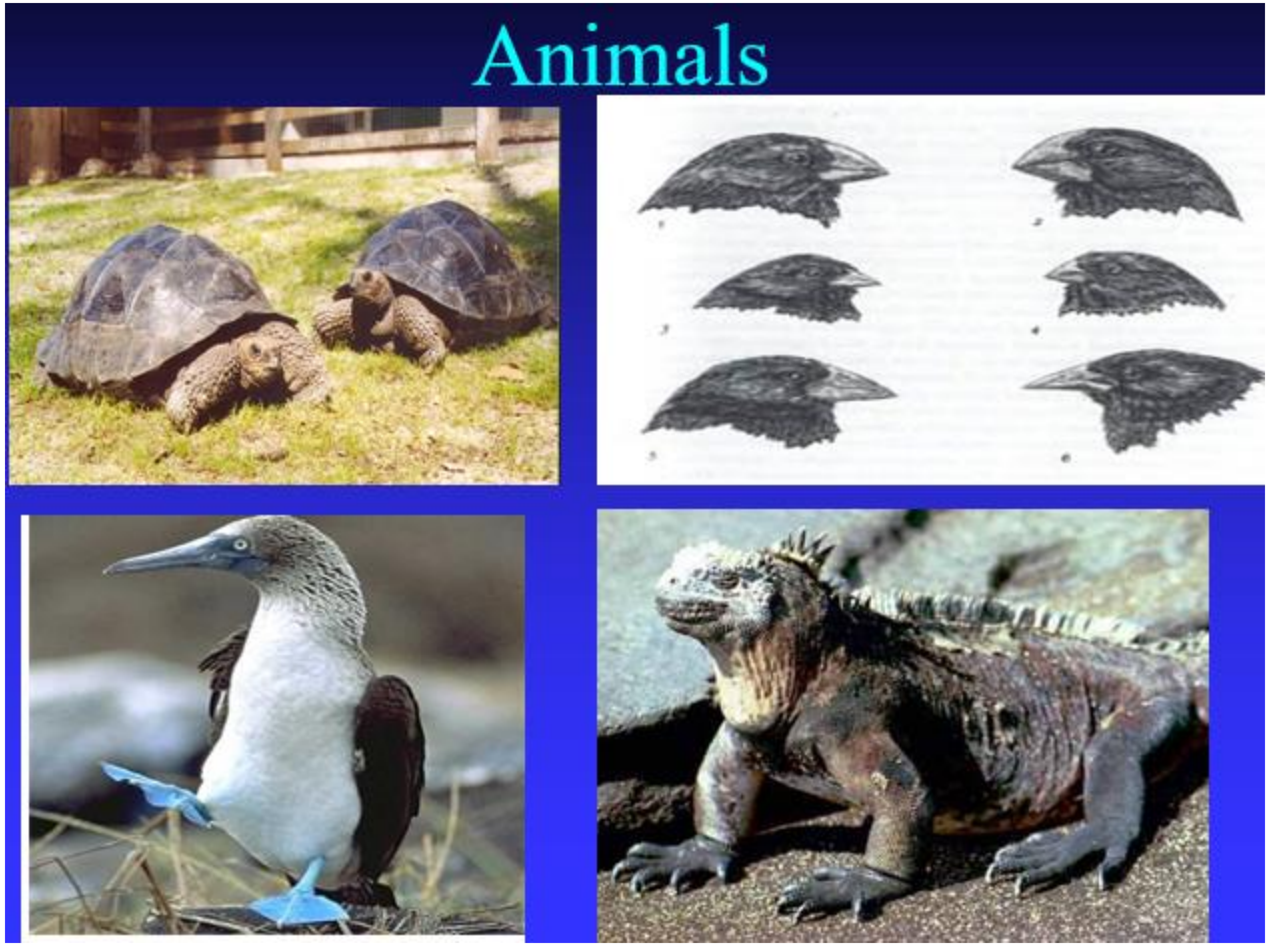
Darwin believed that the selected individuals pass their useful continuous variations to their offspring's so that they are born fit to the changed environment.

7. Speciation:

According to Darwinism, useful variations appear in every generation and are inherited from one generation to another. So the useful variations go on accumulating and after a number of generations, the variations become so prominent that the individual turns into a new species. So according to Darwinism, evolution is a gradual process and speciation occurs by gradual changes in the existing species.



Variation Among Tortoises Darwin observed that the characteristics of many animals and plants varied noticeably among the different Galápagos Islands. Among the tortoises, the shape of the shell corresponds to different habitats. The Hood Island ortoise (right) has a long neck and a shell that is curved and open around the neck and legs, allowing the tortoise to reach the sparse egetation on Hood Island. The tortoise from Isabela Island (lower left) has a dome-shaped shell and a shorter neck. Vegetation on this sland is more abundant and closer to the ground. The tortoise from Pinta Island has a shell that is intermediate between these two forms.



Off coast of Ecuador
Observed MANY different species
Many similar to those on coast of S. America
Observed tortoises, iguanas, finches, etc with slight differences on different islands
Ex: different beaks of finches

Darwin Observed that characteristics of many plants and animals vary greatly among the islands

Hypothesis: Separate species may have arose from an original ancestor

Evidences to support the theory of natural selection:

1. Artificial Selection: From ancient times, man is selecting good breed animals and plant for their use. In addition, they are performing cross breeding of these species to develop newer breed with derirable characters (Figure 8.2). The scientist supporting the Darwin's theory explained the evolution through natural selection to give rise to newer species, just like following similar mechanism as artificial selection by man. They further added that natural selection is a slow process but much more complex compared to the artificial selection procedure.

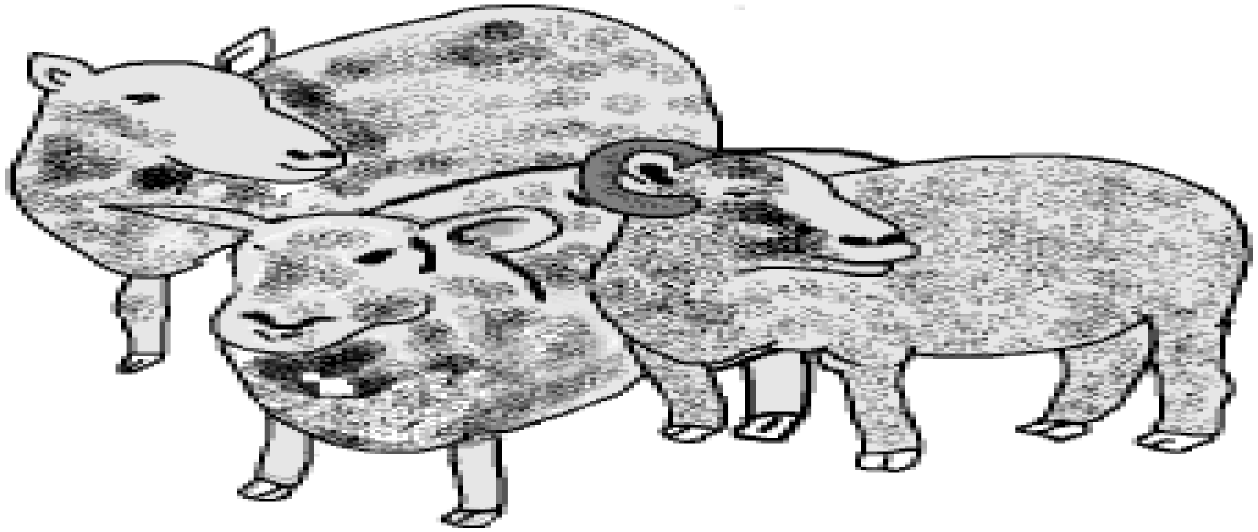


Figure 8.2: Development of small size sheep.

2. Mimicry and Protective colouration: The mimicry and protective colouration is very common in several organisms as the product of natural selection. Most of these organism acquire the pattern of coloration by gradually changing color at each stage.

3. Correlation of nectarines and proboscis: The position of nectarines and proboscis in insect correlates well and match well to facilitate pollination. This relation does not develop in single days but evolve gradually envisaged via the process of natural selection.

So this theory explains only the survival of the fittest but does not explain the arrival of the fittest so Darwin himself confessed, “natural selection has been main but not the exclusive means of modification.”

These favourable Variations accumulate over generation after generation and lead to speciation. So natural selection operates through interactions between the environment and inherent variability in the population.

Evidences Againist the theory of natural selection:

1. Perpetuation of Vestigial Organs: Vestigial organs are selected despite the fact that they are not useful for animals but even then they are preserved generation over generation.

2. No explanation for variation: Darwin could not be able to explain the source and mechanism of generation of variation in organisms.

3. Distinction between continuous and discontinuous variations: According to theory, Darwin assumed that any variation essential for animal survival will be carried forward to next generation. We know that it is not true as per present knowledge of genetics.

4. Disapproval of Pangenesis theory of Darwin: Darwin put forward the theory of Pangenesis to explain the process of inheritance. It was disapproved by the experiments performed by August Weismann in 1892.

II. Lamarckism:

It is also called “Theory of inheritance of acquired characters” and was proposed by a great French naturalist, Jean Baptiste de Lamarck (Fig. 7.34) in 1809 A.D. in his famous book “Philosphic Zoologique”. This theory is based on the comparison between the contemporary species of his time to fossil records.i

Fig. 7.34. Jean Baptiste de Lamarck (1744–1829 A.D.).

His theory is based on the inheritance of acquired characters which are defined as the changes (variations) developed in the body of an organism from normal characters, in response to the changes in environment, or in the functioning (use and disuse) of organs, in their own life time, to fulfill their new needs. Thus Lamarck stressed on adaptation as means of evolutionary modification.

Summary of four postulates of Lamarckism:

1. Living organisms or their component parts tend to increase in size.

2. Production of new organ is resulted from a new need.

3. Continued use of an organ makes it more developed, while disuse of an organ results in degeneration.

4. Acquired characters (or modifications) developed by individuals during their own lifetime are inheritable and accumulate over a period of time resulting a new species.

Evidences in favour of Lamarckism:

1. Phylogenetic studies of horse, elephant and other animals show that all these increase in their evolution from simple to complex forms.

Development of present day long-necked and long fore-necked giraffe from deer-like ancestor by the gradual elongation of neck and forelimbs in response to deficiency of food on the barren ground in dry deserts of Africa. These body parts were elongated so as to eat the leaves on the tree branches. This is an example of effect of extra use and elongation of certain organs.

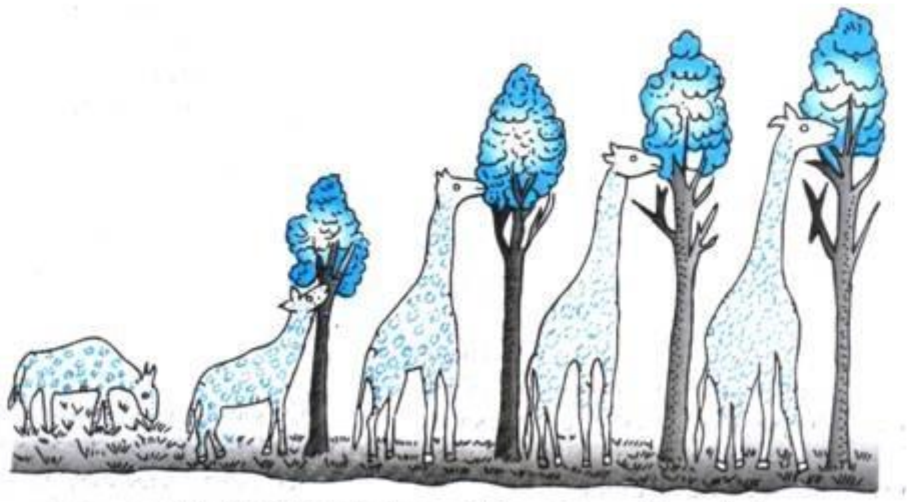


Fig. 7.35. Stages in the evolution of present-day giraffe.

What happened to the giraffe's?

- Survival of the fittest or natural selection
- Natural selection said the giraffes with short necks had less food to eat
- Why
- the food resources changed to leaves only on the upper branches

- What happened
- short necks could not reach upper branches and did not survive (couldn't pass on genes .
- Long neck giraffes survived & reproduced because they were able to reach the food

Snakes:

Development of present day limbless snakes with long slender body from the limbed ancestors due to continued disuse of limbs and stretching of their body to suit their creeping mode of locomotion

Aquatic birds:

Development of aquatic birds like ducks, geese etc. from their terrestrial ancestors by the acquired characters like reduction of wings due to their continued disuse, development of webs between their toes for wading purposes.

Flightless birds:

Development of flightless birds like ostrich from flying ancestors due to continued disuse of wings as these were found in well protected areas with plenty of food.

Horse:

The ancestors of modem horse (Equus caballus) used to live in the areas with soft ground and were short legged with more number of functional digits (e.g. 4 functional fingers and 3 functional toes in Dawn horse-Eohippus). These gradually took to live in areas with dry ground. This change in habit was accompanied by increase in length of legs and decrease in functional digits for fast running over hard ground.

Weismann mutilated the tails of mice for about 22 generations and allowed them to breed, but tailless mice were never born. Pavlov, a Russian physiologist, trained mice to come for food on hearing a bell. He reported that this training is not inherited and was necessary in every generation. Mendel's laws of inheritance also object the postulate of inheritance of acquired characters of Lamarckism.

Similarly, boring of pinna of external ear and nose in Indian women; tight waist, of European ladies circumcising (removal of prepuce) in certain people; small sized feet of Chinese women etc are not transmitted from one generation to another generator.

Presence of weak muscles in the son of a wrestler was also not explained by Lamarck.
Finally, there are a number of examples in which there is reduction in the size of organs e.g. among Angiosperms, shrubs and herbs have evolved from the trees.

So, Lamarckism was rejected.

MUTATION

- DEFINED AS SUDDEN CHROMOSOMAL CHANGE
- BRINGS VARIATION IN SAME ORIGIN
- RESULTS INTO VARIATION IN ORGANIS

RESULT OF MUTATION IN A SNAKE

VARIATION IN CARROT DUE TO MUTATION

III. Mutation Theory of Evolution:

The mutation theory of evolution was proposed by a Dutch botanist, Hugo de Vries (1848-1935 A.D.) (Fig. 7.38) in 1901 A.D. in his book entitled “Species and Varieties, Their Origin by Mutation”. He worked on evening primrose (Oenothera lamarckiana).

Fig. 7.38. Hugo de Vries (1848—1935 A.D.)

A. Experiment:

Hugo de Vries cultured O. lamarckiana in botanical gardens at Amsterdam. The plants were, allowed to self pollinate and next generation was obtained. The plants of next generation were again subjected to self pollination to obtain second generation. Process was repeated for a number of generations.

B. Observations:

Majority of plants of first generation were found to be like the parental type and showed only minor variations but 837 out of 54,343 members were found to be very different in characters like flower size, shape and arrangement of buds, size of seeds etc. These markedly different plants were called primary or elementary species.

A few plants of second generation were found to be still more different. Finally, a new type, much longer than the original type, called O. gigas, was produced. He also found the numerical chromosomal changes in the variants (e.g. with chromosome numbers 16, 20, 22, 24, 28 and 30) upto 30 (Normal diploid number is 14).

So according to mutation theory, evolution is a discontinuous and jerky process in which there is a jump from one species to another so that new species arises from pre-existing species in a single generation (macrogenesis or saltation) and not a gradual process as proposed by Lamarck and Darwin.

Evidences in favour of Mutation theory:

Appearance of a short-legged sheep variety, Ancon sheep (Fig. 7.39), from long-legged parents in a single generation in 1791 A.D. It was first noticed in a ram (male sheep) by an American farmer, Seth Wright.

Fig. 7.39. Appearance of short-legged Ancon sheep mutant.

Mutation theory can explain the origin of new varieties or species by a single gene mutation e.g. Cicer gigas, Nuval orange. Red sunflower, hairless cats, double- toed cats, etc.

It can explain the inheritance of vestigial and over-specialized organs.

It can explain progressive as well as retrogressive evolution.

Origin of mammals: Mammals appeared on earth in the Jurassic period, approximately 195 millions years ago. Mammals, birds and snakes are considered to be originated from the common ancestor, cotylosaurs or stem reptiles (Figure 10.2). The initial mammals, tree shrew lived for several million years along with giant reptiles dinosaurs. The extraordinary ability of mammals to the changed environment, active life due to warm body and sensitivity towards environment. Post extinction of dinosaurs, mammals evolved into a variety of forms to capture the available space (water, land and air) on earth.

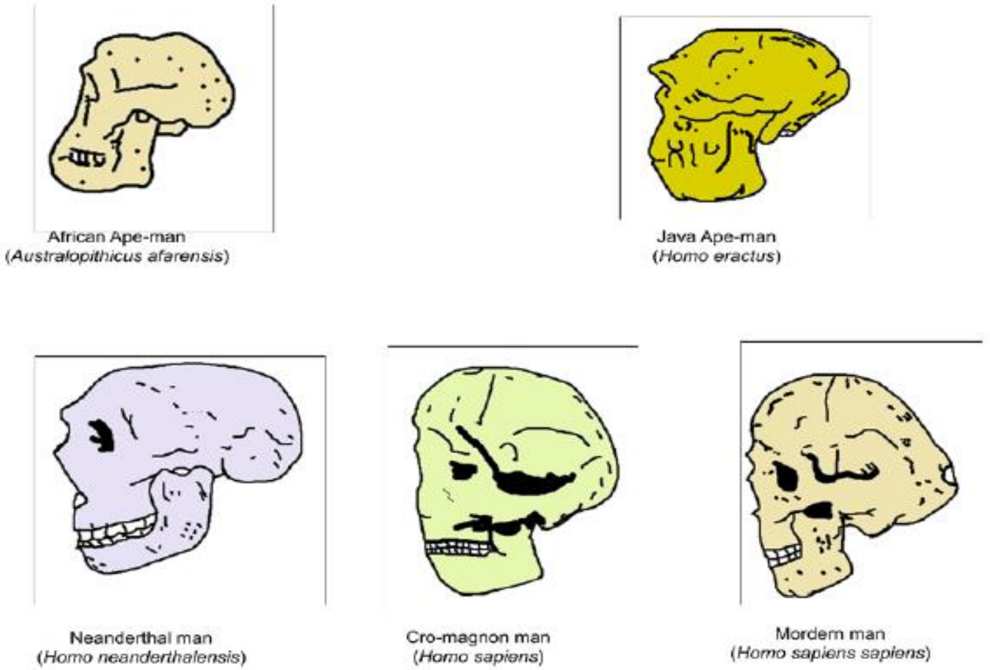


Figure 10.5 : Skulls of early and modern men.

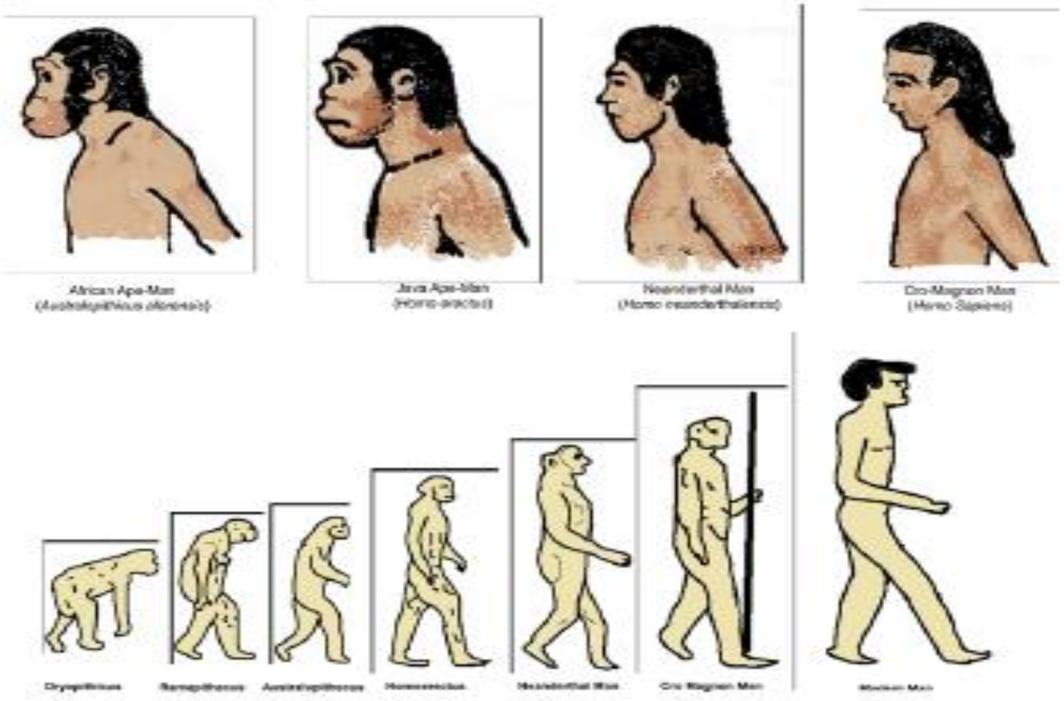


Figure 10.6 : Different evolutionary stages in human evolution.