**CLONING**

 Cloning is a process of producing genetically identical organisms that already occur in the nature. Cloning is asexual reproduction method. Cloning in biotechnology is intentional cloning of an organism or molecular cloning of DNA fragments. In biotechnology, scientists mainly use three types of cloning, Cloning in [biotechnology](http://en.wikipedia.org/wiki/Biotechnology) refers to processes used to create copies of [DNA](http://en.wikipedia.org/wiki/DNA) fragments ([molecular cloning](http://en.wikipedia.org/wiki/Molecular_cloning)), [cells](http://en.wikipedia.org/wiki/Cell_%28biology%29) (cell cloning), or [organisms](http://en.wikipedia.org/wiki/Organisms). Many modern techniques are now developed for making identical copies of genes, cells, organisms etc. of both plants as well as animals known as Reproductive Cloning, Therapeutic Cloning and DNA Cloning.

The exact carbon copy or copies of a single parent is called **‘clone**’ and the process of making clones is called **‘cloning’.** A clone is an organism or a group of organisms created from a single parent. The word cloning means the production of an organism from just a single cell taken from the body of a plant and animal. The production of clone is a non-sexual method. There is only one parent and the offspring has the hereditary traits of that single parent. Webber (USA) introduced the term clone in 1903.

The word **‘clone’** is used only in living species. Natural cloning occurs in bacteria ( eg: E.coli) and protists (eg: Amoeba proteus).The first artificial cloning was done in sheep, and this artificial clone was named **“Dolly.”**

**Microbial Cloning**

The process of making exact copies of microbial cell is called **‘microbial cloning’ .**The microbial cells produced by cloning are called **‘microbial clone’.** It is possible to produce millions of microbial cells within a few days. Each cell carries a copy of the original donated gene. Genetically altered strains of microorganisms are produced in this way for various applications. Microbial clones are cultures of bacteria or yeasts that were derived from a single parent cell.  Recently, gene cloning and genetic engineering techniques are being used to improve useful microbes (microorganisms) for a number of purposes. Many microorganisms are being used in industries for performing various functions like the removal of undesired lignin.

**Cell Cloning**

The process of making exact copies of a cell is called **‘cell cloning’**. The exact copies of a cells produced by cloning are called **‘cell clones’.** The cell cloning is based on **‘totipotency’.**The totipotency of plant cells was first explained by **Haberlandt** in 1902.This technique was first demonstrated by **Steward** in 1950. Now this technique has been employed for propagating plants through tissue culture. Naturally occurring or genetically engineered, plant cell, animal cell, bacterial cell, or virus, can be used for cell cloning. In cell cloning the normal cells from the plants, animals and bacteria, or their transformed cells with the desired gene can be used. Cell cloning is more complex than the other cloning. Cell cloning is the method used in the multiplication of microorganisms with genetically engineered cells.

 **Plant Cloning**

The process of making of desirable plants within a short time is called **‘plant cloning’**. Many orchids producing beautiful flowers are ‘cloned plants’. For this, a bit of healthy root tips, shoot tips, leaves etc. are used for culturing. Through plant cloning it is possible to make **‘genetically modified food’ (GMF)** like Vit.A rich rice and ‘lysine’-rich pulse etc. In **Plant cloning,** a bit oftissue (explant) is separated from healthy root tips, shoot tips, leaves, anthers, pollen grains, ovules, embryo etc. for culturing. Under sterile conditions, the separated explant is cultured in a culture medium. By 2 or 3 weeks, an undifferentiated mass of tissue known as **callus** is developed on the explant. Later embryo like structure called **embryoids** is formed from the callus. From the embryoids, small plants called **plantlets** are produced. The plantlets thus produced, are transferred to small pots kept in a glasshouse environment. Later, they can be transferred to larger pots containing sterile compost. Plant cloning or tissue culture enables the production of an unlimited number of plants within a relatively short time.

**Animal Cloning**

The process of making of desirable animal by cloning is called **‘animal cloning’.** It is a difficult process than plant cloning because the animal cells lose their **‘totipotency’** on reaching the gastrula stage of animal development.

 Robert Briggs and Thomas king in 1952.They-cloned frogs made the first animal cloning from tadpole cells. In 1962, **John Curson** also cloned frogs using cells from older tadpoles.

**Dr. Ian Wilmut** in 1996 has created sensational news in the field of reproductive biology by cloning a fully viable mammal, **the Dolly.**

 **Ian Wilmut** (Roslin Institute, Edinberg, Scotland) took cells from the udder (mammary gland) of a 6-7 year old female sheep (Finn Dorset Ewe) .These cells are transferred to a culture medium devoid of nutrients. This halted the starved cells from dividing and switched off their active genes. Meanwhile, an unfertilised egg was collected from another sheep (Scottish black face ewe) and its nucleus was sucked out leaving an empty cell containing all the necessary materials to produce an embryo. The nucleus of the udder cell was separated and transferred to the non-nucleated egg cell. Then he fused the udder cell nucleus with the empty egg cell by mild electrical stimulation. The fused cell began to develop. At 32 cell stage, the embryo was transferred into the womb (uterus) of a surrogate mother (substitute mother) of the same breed (Scottish black face ewe) from which the egg was taken. After 5 months, the lamb was born. The first successful animal clone was named **‘Dolly’**. She was genetically identical to the mother sheep from which the nucleus of the udder cell was taken. Later ‘Dolly’ conceived in natural way and gave birth to a lamb named **Bonny**. This proves that an animal clone can lead a normal life.

 **Egg mother (Black Face Ewe)**

**Clone mother (Finn Dorset Ewe)**

 **Udder cell**

 **Egg**

**Non-nucleated egg**

 **Culture**

 **Udder cell nucleus**

 **Electrical stimulation**

**Fusion**

 **Surrogate mother (Black face ewe)**

 **32 cell stage embryo**

 **Dolly**

By the same technique in 1998 American scientists, produced first cloned calf named as **‘Jefferson’**. In the next year ie, 1999 scientists of Holland produced two calves named as **‘Holly and Bell’.** In a different way scientists from Japan have cloned eight identical calves from a single fertilized cell of mother.

 **The procedure is as follows;**

 The mother cow was mated in natural way with bull and as a result the egg was fertilized. The fertilized egg divided in to two blstomeres then in to four and then in to eight. This embryo is carefully removed from the womb and the embryonic cells are separated using enzyme. Each isolated cell is kept in a nutrient medium and later implanted in the womb of different host mother cow. Each cell grows into a normal and healthy baby calf.