Chapter 77

Growth of Human Population

- **Clark (1954) defined population** as a group of individuals of a species occupying a definite geographic area at a given time.
- Human population all over the world belongs to single species *i.e. Homo sapiens*.
- The scientific study of human population is called **demography**. It involves three major phenomenon – **changes in population size; the composition of population; the distribution of population**.
- There are **five** "**demographic processes**", namely **fertility, mortality, marriage, migration and social mobility**. These five processes **determine size**, **composition and distribution**.
- Population growth is determined by biotic potential and environmental resistance.
- **Biotic potential** is the capacity of organisms to produce offspring.
- The environmental factors which can check the growth of population size constitute **environmental resistance**. The factors include non-availability of food and shelter; drought, cloud burst etc. and certain biotic factors like pathogens, parasites, predators etc. Thus environmental resistance does not allow population growth to soar towards infinity.
- **Population grows** when the number of births is greater than the number of deaths.
- Population size may change when individuals enter or leave the population.
- If more individuals **enter** then population **will grow** and if more individuals **leave** the population, the population **will shrink**.
- The rapid increase in human population size over a relatively short period is called **human population explosion**.
- Human population growth rate is measured as the '**annual average growth rate**'. It is calculated as follows:

Average annual growth rate (in %)

$$= \left(\frac{p_2 - p_1}{p_1 \times N} \right) \times 100.$$

where, P_1 = Population size in the previous census,
P_2 = population size in the present census.
N = Number of years between the two census.

- The time required for a population to double itself is called the **doubling time**.
- Population growth rate **depends on factors like fertility, mortality, migration, age and sex structure**.
- **Fertility** is the ability of reproductively active individuals to produce babies.
- The number of babies produced per thousand individuals is called **birth rate** (natality). The birth rates do not indicate the current fertility pattern. It increases the population size and population density.
- **Total fertility rate** (TFR) is the average number of children that would be born to a woman during her life time, assuming the age-specific birth rate of a given year.
- **Replacement level** (RL) is the number of children a couple must produce to replace them. The actual RL is always slightly higher than 2.0 since some children will die before reaching reproductive age. In developed countries, RL is attained at 2.1, where as in developing countries, it is around 2.7 due to a higher death rate at immature age, and shorter life expectancy.
- **Mortality** is the death rate per thousand individuals.
- The death rate has dropped mainly due to improved personal hygiene, sanitation and modern medicines. A **decrease in death rate** results in **increased population growth rate**.
- The difference between the number of births and that of deaths is the **rate of natural increase**. If birth and death rates are equal a zero population growth rate will result, which is called

demographic transition.

- **Migration** refers to the movement of individuals between different places. The movement of individuals into a place/country is called **immigration**, while the migration out of a place/ country is called **emigration**. Migration between the countries influences a nation's population.
- The movement of individuals into a place/country is called **immigration**, while the migration out of a place/country is called **emigration**.
- Migration emigration and immigration are three types of population dispersal. **Population dispersal** is the movement of individuals or propagules into or out of population for preventing overcrowding, obtaining food, avoiding predators and other adverse conditions.
- The population of individuals of different ages within a particular population is called its **age structure**, while the population of male and female individuals in a population is called its **sex structure**.
- The proportion of reproductively active males and females in a population influence the population growth. Most of the developing countries like India have larger number of young people and represent rapidly growing populations.
- **Age composition** or **age ratio** is relative abundance of pre-reproductive, reproductive and post-reproductive individuals in a given population.
- **Pre-reproductive** is before the age of child bearing. It is 14-18 years in human beings; **reproductive** have individuals in the age group of child bearing, 14-45 years in woman and 18-59 years for men and **post-reproductive** have individuals after the age of 45-59 years when they are not able to bear children.
- **Age pyramid** is graphic representation of abundance of individuals of different age groups with per-reproductive at the base, reproductive in the middle and post-reproductive at the top.
- Age pyramids are of **three types – triangular age pyramids**, **bell shaped age pyramid** and **urnshaped age pyramid**.
- **Triangular age pyramid** has high proportion of pre-reproductive individuals, moderate number of reproductive individuals, and fewer post-reproductive individuals. It represents **young** or rapidly **growing population**.
- In **bell-shaped age pyramid** the number of pre-reproductive and reproductive individuals is almost equal. Post reproductive individuals are comparatively fewer. It represents stable or **stationary population** where growth rate is near zero.
- In **urn-shaped age pyramid** the number of reproductive individuals is higher than the number of pre-reproductive individuals. It represents **declining** or **diminishing population**.
- **Growth of a population** can be **expressed by a** mathematical expression, called **growth curve** in which logarithm of total number of individuals in a population is plotted against the time factor.
- Growth curves **represent interaction between biotic potential and the environmental resistance**.
- Population growth curves are of **two major types**: the **J-shaped curve** and the **S-shaped curve**.
- The **J-shaped curve** shows **three stages**: lag phase, exponential phase and crash phase.
- The J-shaped curve is a biopotential curve when environmental resistance is zero; it is produced because larger populations increase more rapidly than smaller ones.
- **J-shaped growth curve** is shown by small population of reindeer experimentally reared in a natural environment with plenty of food but no predators.
- **Lag phase** is period of adaptation of animals to new environment so is characterised by slow or no growth in population.
- **Logarithmic or exponential phase** is characterised by rapid growth in population which continues till enough food is available. But with the increase in reindeer population, there is corresponding decrease in the availability of food which finally becomes exhausted, which leads to mass starvation and mortality. This **sudded increase in mortality is called populatio crash** or **crash phase**.
- The **S-shaped curve (sigmoid curve)** is generated when a population approaches the environment's carrying capacity.
- Carrying capacity is defined as the feeding capacity of an environmet of a ecosystem for a population of a species under provided set of conditions. The limit beyond which no major increase can occur is represented by *K*. **When population reaches the carrying capacity of its evironment, the population has zero growth rate**.
- The S-shaped curve shows three phases –
  - **Early phase** (**Lag phase**): Little or no growth takes place due to small size of population and lack of adaptation.

- **Middle phase (Log phase or exponential phase)**: There is geometrical increase in population size owing to abundance of food and other favourable conditions.
- **Stationary phase (Zero growth or Plateau rate)**: Birth and death rates are equal, the population stabilizes around the carrying capacity of the environment. So there is zero growth phase.

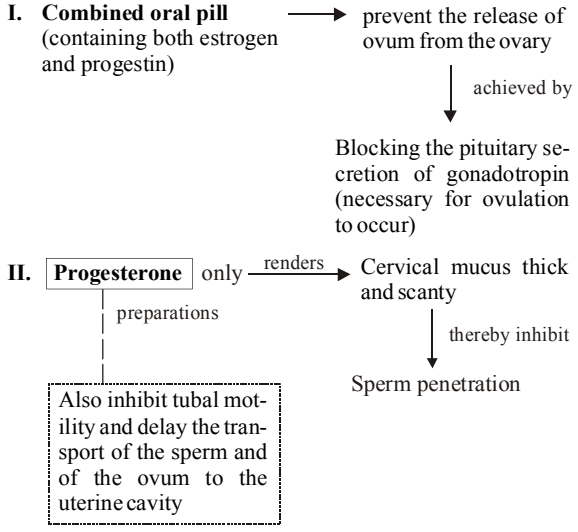
- S-shaped growth is **shown by yeast cells and most of organisms**. Sigmoid growth curve was described by **Verhulst** (1839).
- In 1798, T.R. Malthus, a British economist, **put forward a theory of human population growth**.
  - He stated that population grows geometrically when unchecked, whereas the means of its subsistence like food grow only arithmetically.
  - Naturally, after some time an imbalance would occur in the population and the environment.
  - When the imbalance reaches a certain value, some factors like hunger, epidemics, floods, earthquakes, war etc, will bring the population to desired level. Such a population crash is called **catastrophic control of population**. These factors were called positive checks by Malthus.
- **Causes of icrease in human population** are –
  - **Control of disease (decline in death-rate)** : In old days, people used to die in thousands because of illness. But the development of medical sciences has protected them from such unnatural deaths. So there is decrease in death rate and not the increase in birth rate that has led to the increase in population.
  - **Development of agriculture** : Man needs food for all his body requirements. For this he developed the techniques to grow more food. Thus he could afford food for more people on this earth. Not only agriculture, but other animals that are used as food by man were also reproduced successfully using scientific methods.
  - **Storage conditions** : Food is not available at all the times. So people used to die of starvation when food was not available. With the better storage conditions, the food could be made available at all times.
  - **Transport** : With the development of means to go from one place to another safely, the population also increased. Food growth in one region could be transported to another region where it could not be grown. Thus people living in remote places were also fed.
  - **Protection from nature** : Man formed houses so that he can protect himself from wild animals and enviornmental calamities. He then formed villages, cities and countries.
- **Consequences of over population** leads to a number of not only national but also individual family problems. Some of them are described below–
  - **Poverty** : If in a family there are more persons and the income is less, so naturally it becomes poor. With the addition of evey child, the poverty increases.
  - **Food supply** : If the population increases and the production of food does not increase, this will lead to a shortage of food supply.
  - **Hygenic condition** : More people in a small area generally make the hygenic conditions bad. There will be an accumulation of waste material as it is not removed that early.
  - **Unemployment** : More number of people means more jobs and if sufficient number of jobs are not available, it leads to unemployment.
  - **Housing problem** : For more people, more houses are required and the houses are not built at high rate.
  - **Pollution** : There will be an added problem of population. As every thing is taken from environment in excess, so it will result in pollution.
  - **Education problem** : It becomes difficult for the government to provide education to all.
- **Measures to control over population** are – (i) **Education** : People, particularly those in the reproductive age group, should be educated about the advantages of a small family. Mass media and educational institutions can play an important role in this campaign. (ii) **Age of marriage :** Raising the age of marriage is more effective means to control the population. (iii) **Family planning :** There are many birth control measures which can check birth rate.

BIRTH CONTROL

- The regulation of conception by preventive methods or devices to limit the number of offspring is called **birth control.**

- A variety of methods are known for birth control. The birth control methods which deliberately prevent fertilization are referred to as **contraception.**
- **Contraceptive methods** are preventive methods to help woman avoid unwanted pregnancies. These methods are of 2 main types: **temporary** and **permanent**.
- Temporary methods includes **natural methods** (safe period, coitus interruptus, abstinence), **chemical method, mechanical means** and **physiological (oral) devices (hormonal)**.
- A week before and a week after menses is considered the **safe period (rhythm method)** for sexual intercourse. The idea is based on the following facts: (i) ovulation occurs on the 14th day (may be 13th to 16th day) of menstruation; (ii) ovum survives for about 2 days; (iii) sperms remain alive for about 3 days. This method may reduce the chances of pregnancy by about 80 percent. It has certain drawbacks also.
- **Coitus Interruptus** is the oldest method of birth control. It involves withdrawal of the penis by the male before ejaculation so that semen is not deposited in the vagina and there is no fertilization. This method also has some drawbacks. Male produces some lubricating fluid from his Cowper's glands before ejaculation. This fluid contains many sperms.
- **Abstinence** is the best and 100% reliable way to avoid conception is to abstain from sexual intercourse. It is an unnatural mode of birth control, and seems impracticable. Some couples practice abstinence at certain times with success.
- **Chemical means (Spermicides)** : Foam tablets, jellis, pastes and creams, if introduced into the vagina before sexual intercourse, adhere to the mucous membrance and immobilise and kill the sperms by inhibiting oxygen uptake. These contain spermicides such as lactic acid, citric acid, boric acid, potassium permanganate and zinc sulphate.
- **Mechanical means** are of **3 types** – condom; **diaphragm and cervical cap;** and **intrauterine devices**.
- **Condom** (Nirodh) is a rubber sheath to cover the erect penis. It is the most widely used contraceptive by males in India as it is cheap and easily available. It is also given free by government. It is a simple but effective method and has no side effect. It checks pregnancy by preventing deposition of semen in the vagina. Condom should be used regularly and put on before starting coital activity, otherwise sperm-containing lubricating fluid may be left in the vagina. Condom should be discarded after a single use. Condom is also a safeguard against AIDS and sexual diseases.
- **Diaphragm and cervical cap** are rubber plastic covers that are fitted on the cervix in the female's vagina, and check the entry of sperms into the uterus. These must be kept fitted for at least six hours after sexual intercourse. They are smeared with a spermicidal jelly or cream cap and is the counterpart of condoms in the female.
- **Intrauterine devices** (IUDs) are plastic or metal objects placed in the uterus by a doctor. These include loop, copper-T , spiral, ring, bow, shield, etc. They prevent the fertilization of the egg or implantation of the embryo. Their presence perhaps acts as a minor irritant and this makes the egg to move down the fallopian tubes and uterus rather quickly before fertilization or implantation. Hormone releasing devices increases the viscosity of the cervical mucus and thereby prevent sperm from entering the cervix. They also maintain high levels of progesterone in the endometrium and thus, releasing low levels of estrogen, thereby sustaining an endometrium unfavourable to implantation.
- Commonly used IUDS are **plastic loop** and **copper T**.
  - **Copper T** releases Cu^{2+} which prevents implantation of fertilized eggs. Copper seems to enhance the cellular response in the endometrium. It also affects the enzymes in the uterus. By altering the biochemical composition of cervical mucus, copper ions may affect sperm motility, capaciation and survival.
  - **Plastic loop** (especially **Lippes loop**) is double S-shaped device made of polyethylene that is non-toxic, non tissue reactive material. The larger sized loop usually has a greater anti fertility effect and a lower expulsion rate but a high removal rate because of side effects such as pain and bleedings.
- **Drawbacks of IUDs** include their spontaneous expulsion, even without the woman's knowledge, occasional haemorrhage; and chance of infection.
- **Physiological (Oral) Devices (Hormonal)** includes birth control pills.

- **Birth control pills (oral contraceptives)** check ovulation by inhibiting the secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) that are necessary for ovulation. High (but not too high) levels of these hormones prevent follicle development (high estrogen/ progesterone from the pill inhibits GnRH release from the anterior pituitary) and hence inhibits FSH (estrogen effect) and LH (progesterone effect) release so follicle does not rupture. The low LH prevents the follicle from rupturing so there is no ovulation. Hence, no eggs are released in a woman on the pill and conception cannot occur.
- The **birth control pills have side effects** such as nausea, breast tenderness, weight gain and break through bleeding (slight blood loss between menstrual periods) and high blood pressure. On the other hand, the oral contraceptives reduce the chances of certain types of cancer to occur in their users.
- A **combined pill** is the most commonly used birth control pill. It contains synthetic progesterone and estrogen in doses high enough to check ovulation. Pill Mala D is taken daily, and the pill Saheli is taken weekly.



Flow chart : Mechanism of action of oral pills

- **Abortion** is the medical termination of pregnancy (MTP) before the foetus becomes viable. It is one of the most widely used methods of fertility control in the world. Certain pills act as abortants. They function by inducing menstruation which checks the implantation of the zygote or detaches the implanted egg.
- **Permanent method** includes **sterilization**.
- **Sterilization** provides a permanent and sure birth control. It is called **vasectomy in man** and **tubectomy in woman**.
- **Vasectomy** involves a cut in the scrotal sac, cutting or burning of the vas deferens (tubes that carry sperm), and blocking both cut ends. Vasectomy **prevents the passage of sperm into seminal fluid by blocking the vas deferens**.
- Following vasectomy, sperm production and hormone output are not affected. Production of testosterone continues and its distribution does not need the ducts. The sperm produced are destroyed intraluminally by phagocytosis. This is a normal process in the male genital tract, but the rate of destruction is greatly increased after vasectomy. Vasectomy is a simpler, faster and less expensive operation than tubectomy.
- **Female sterilization** prevents fertilization by interrupting the passage through fallopian tube. Eggs continue to be produced because the ovaries are intact, but they fail to pass into the uterus and sperms fail to reach the eggs for fertilization.
- Female sterilization can be done as an interval procedure, postpartum or at the time of abortion. Two procedures have become most common, namely laparoscopy and minilaparotomy.
- **Laparoscopy** is a technique of female sterilization through abdominal approach with a specialized instrument called "laparoscope". The abdomen is inflated with gas (carbon dioxide, nitrous oxide or air) and the instrument is introduced into the abdominal cavity to visualise the tubes. Once the tubes are accessible, the Falope rings (or clips) are applied to occlude the tubes. Laparoscopy is not advisable for postpartum patients for 6 weeks following delivery. Haemoglobin per cent should not be less than 8. There should be no associated medical disorders such as heart disease, respiratory disease, diabetes and hypertension.
- **Minilaparotomy (minilap operation)** is a modification of abdominal tubectomy. It is a much simpler procedure requiring a smaller abdominal incision of only 2.5 to 3 cm conducted under local anaesthesia. The minilap/Pomeroy technique is considered a revolutionary procedure for female sterilization. It has the advantage over other methods with regard to safety, efficiency and ease in dealing with complications. Minilap operation is suitable for postpartum tubal sterilization.

End of the Chapter