



**CLASS-XII (CBSE)**

# Zoology

*Workbook Cum Question Bank with Answers*



**SCHEDULED CASTES & SCHEDULED TRIBES  
RESEARCH & TRAINING INSTITUTE (SCSTRI)  
ST & SC DEVELOPMENT DEPARTMENT  
BHUBANESWAR**



# ZOOLOGY

## *Workbook Cum Question Bank with Answers*

**CLASS-XII (CBSE)**

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## CHAPTER - 3

# HUMAN REPRODUCTION

## MULTIPLE CHOICE QUESTIONS (MCQ)

### I. CHOOSE THE CORRECT ANSWER

1. **The canal through which the testes descend to the scrotum:**
  - (a) Inguinal canal
  - (b) Central canal
  - (c) Excurrent canal
  - (d) Radial canal
2. **Retention of extra-abdominal testis in the abdomen in mammals is known as:**
  - (a) Eunochoidism
  - (b) Cryptorchidism
  - (c) Dimorphism
  - (d) Albinism
3. **The plexus of blood capillaries that helps maintain the temperature of the testes for normal functioning is:**
  - (a) Alveolar plexus
  - (b) Branchial plexus
  - (c) Pampiniform plexus
  - (d) Glomerular plexus
4. **The connective tissue capsule of the testis is known as:**
  - (a) Tunica media
  - (b) Tunica albuginea
  - (c) Tunica externa
  - (d) Tunica interna
5. **The seminal fluid contains a monosaccharide as the energy source for the spermatozoa:**
  - (a) Glucose
  - (b) Galactose
  - (c) Mannose
  - (d) Fructose
6. **The passage through which both the semen and urine are expelled in human male is known as :**
  - (a) Urethra
  - (b) Ureter
  - (c) Ejaculatory duct
  - (d) Ductus deferens
7. **Sex determining region of the Y chromosome (SRY) encodes a polypeptide factor, known as:**
  - (a) Mullerian inhibiting factor
  - (b) Testis determining factor
  - (c) Sperm maturation factor
  - (d) Anti-xerophthalmic factor
8. **The disintegration of the Mullerian ducts in the human male fetus is due to the secretion of:**
  - (a) Mullerian proliferating factor
  - (b) Mullerian developing factor
  - (c) Mullerian inhibiting factor
  - (d) Mullerian elaborating factor

9. **The low count of spermatozoa in the semen is known as:**
  - (a) Aspermia
  - (b) Microspermia
  - (c) Oligospermia
  - (d) Polyspermia
10. **The wall of the seminiferous tubules contain non-germinal cells called:**
  - (a) Sertoli cells
  - (b) Interstitial cells
  - (c) Leydig cells
  - (d) None of these
11. **The column of erectile tissue along the ventral side of the penis is:**
  - (a) Corpus cavernosum
  - (b) Corpus callosum
  - (c) Corpus spongiosum
  - (d) Corpus luteum
12. **Which of the following features is not associated with testosterone?**
  - (a) Maintenance of secondary sexual characters
  - (b) Responsible for maintaining primary sex characters
  - (c) It's the principal androgen
  - (d) It's a peptide hormone
13. **Which of the following is not a function of Sertoli cells?**
  - (a) Phagocytize excess spermatid cytoplasm as development progresses
  - (b) Control the movement and release of spermatogenic cells into the lumen of the tubule
  - (c) Produce fluid for sperm transport and secrete the hormone inhibin
  - (d) Regulate the effect of LH
14. **Leydig cells are located:**
  - (a) Within the seminiferous tubules
  - (b) In the interstitial space of the seminiferous tubules
  - (c) In the wall of the epididymis
  - (d) In the seminal vesicle
15. **Which of the following male accessory glands is not a paired structure?**
  - (a) Seminal vesicle
  - (b) Prostate gland
  - (c) Bulbourethral gland
  - (d) None of the above
16. **Which of the following carries sperms from the scrotum for ejaculation?**
  - (a) Epididymis
  - (b) Ductus deferens
  - (c) Ejaculatory duct
  - (d) Urethra
17. **Which of the following surrounds the urethra at the base of the bladder that produces secretions for sperm motility and viability?**
  - (a) Prostate gland
  - (b) Cowper's gland
  - (c) Seminal vesicle
  - (d) None of the above
18. **Which of the following ejects semen into the urethra just before ejaculation?**
  - (a) Epididymis
  - (b) Ductus deferens
  - (c) Ejaculatory duct
  - (d) None of the above

19. Which of the following secretes an alkaline fluid that neutralizes acids in the female reproductive tract? It also secretes fructose as the main energy source for sperms.
- (a) Prostate gland
  - (b) Cowper's gland
  - (c) Seminal vesicle
  - (d) Ejaculatory duct
20. Which of the following is not a gonadotropin?
- (a) FSH
  - (b) LH
  - (c) hCG
  - (d) Testosterone
21. Which of the following hormones is not a steroid?
- (a) Relaxin
  - (b) Progesterone
  - (c) Estradiol
  - (d) Testosterone
22. Fallopian tube is a part of:
- (a) Ureter
  - (b) Oviduct
  - (c) Uterus
  - (d) Ductus deferens
23. In human, fertilization usually occurs in:
- (a) Vagina
  - (b) Cervix
  - (c) Uterine cavity
  - (d) Uterine duct
24. Which of the following is not a male secondary sexual character?
- (a) Beard
  - (b) Enlarged penis
  - (c) Coarse voice
  - (d) Increased fat in the buttocks
25. Stromal cells surrounding the granulosa cells are known as:
- (a) Thecal cells
  - (b) Interstitial cells
  - (c) Myoid cells
  - (d) Germinal cells
26. The chief source of circulating estrogen is:
- (a) Theca interna
  - (b) Granulosa
  - (c) Theca externa
  - (d) Stroma
27. Inhibin that inhibits the secretion of FSH is secreted from:
- (a) Anterior pituitary cells
  - (b) Both granulosa and Sertoli cells
  - (c) Granulosa cells only
  - (d) Sertoli cells only
28. Relaxin is secreted from:
- (a) Seminiferous tubule
  - (b) Graafian follicle
  - (c) Corpus luteum
  - (d) Corpus albicans

- 29. Which of the following is not an accessory sex organ?**
- (a) Testis
  - (b) Epididymis
  - (c) Bulbourethral gland
  - (d) Seminal vesicle
- 30. Delivery of a human baby is known as:**
- (a) Oviposition    (b) Abortion
  - (c) Parturition    (d) Ovulation
- 31. Sertoli cells are regulated by:**
- (a) GH                      (b) LH
  - (c) FSH                      (d) TSH
- 32. Which of the following is mismatched?**
- (a) Interstitial cells-Testosterone secretion
  - (b) Seminiferous tubule-Spermatozoa formation
  - (c) Corpus luteum-LH secretion
  - (d) Placenta-Relaxin secretion
- 33. The immediate cause of menstruation is the cessation of secretion of:**
- (a) FSH
  - (b) Progesterone
  - (c) Estrogen
  - (d) Testosterone
- 34. Painful menstruation is known as:**
- (a) Oligomenorrhoea
  - (b) Amenorrhoea
  - (c) Dysmenorrhoea
  - (d) Metrorrhagia
- 35. Bleeding from the uterus between periods is known as:**
- (a) Hypomenorrhoea
  - (b) Metrorrhagea
  - (c) Menorrhagia
  - (d) Dysmenorrhoea
- 36. Complete absence of menstruation is known as:**
- (a) Amenorrhoea
  - (b) Atresia
  - (c) Dysmenorrhoea
  - (d) Menorrhagia
- 37. Following ovulation, the remaining part of the graffian follicle turns into a temporary endocrine structure known as:**
- (a) Corpus hemorrhagicum
  - (b) Corpus luteum
  - (c) Corpus albicans
  - (d) Corpus spongiosum
- 38. Which day the ovulation does occur in a 28-day menstrual cycle?**
- (a) 12                      (b) 13
  - (c) 14                      (d) 28
- 39. Which of the following hormone surge brings about ovulation:**
- (a) LH                      (b) FSH
  - (c) Estrogen              (d) Progesterone
- 40. The layer of the uterine wall that is partially shed during the menstrual cycle is:**
- (a) Perimetrium
  - (b) Myometrium
  - (c) Endometrium
  - (d) None of the above

- 41. The arteries of the uterine wall that undergo disintegration during the menstrual cycle:**
- (a) Radial arteries
  - (b) Spiral arteries
  - (c) Circular arteries
  - (d) Longitudinal arteries
- 42. Which of the following cell organelles forms the acrosome:**
- (a) Mitochondrion
  - (b) Centriole
  - (c) Endoplasmic reticulum
  - (d) Golgi Complex
- 43. Find the mismatch:**
- (a) Acrosome-Dissolution
  - (b) Mitochondria-Energy supplement
  - (c) Tail-Nutrition
  - (d) Centriole-cleavage
- 44. The physiological changes that make the sperm competent to fertilize an oocyte are collectively known as :**
- (a) Capacitation
  - (b) Agglutination
  - (c) Proliferation
  - (d) None of the above
- 45. A reaction takes place in the head of a competent sperm that results in the formation of a tubule prior to penetration into the egg:**
- (a) Cortical reaction
  - (b) Agglutination
  - (c) Fertilizin-Antifertilizin reaction
  - (d) Acrosomal reaction
- 46. Prevention of polyspermy is the consequence of a reaction in the egg that results in the formation of a fertilization membrane:**
- (a) Cortical reaction
  - (b) Agglutination
  - (c) Acrosomal reaction
  - (d) Fertilizin-Antifertilizin reaction
- 47. The primary oocyte is arrested at which of the following cell division stages before puberty?**
- (a) Metaphase I
  - (b) Diplotene
  - (c) Diakinesis
  - (d) Metaphase II
- 48. The enzyme, secreted by the sperm head that dissolves the cementing substance of the corona radiata:**
- (a) Amylase
  - (b) Hyaluronidase
  - (c) Lipase
  - (d) Diesterase
- 49. Human oocyte is:**
- (a) Polylecithal
  - (b) Oligolecithal
  - (c) Alecithal
  - (d) Meiolecithal
- 50. The cleavage in human fertilized egg is:**
- (a) Meroblastic
  - (b) Holoblastic
  - (c) Radial
  - (d) Spiral
- 51. Milk ejection in the lactating mother is stimulated by:**
- (a) Lutenizing Hormone
  - (b) Prolactin
  - (c) Follicle Stimulating Hormone
  - (d) Oxytocin



**52. Human placenta is:**

- (a) Haemoendothelial
- (b) Syndesmochorial
- (c) Hamochorial
- (d) Epitheliochorial

**53. Uterine contraction and parturition is supplemented by:**

- (a) Oxytocin
- (b) Estrogen
- (c) Progesterone
- (d) Vasopressin

**54. Turner syndrome is characterized by the genotype:**

- (a) XO                      (b) XXX
- (c) XYY                  (d) XXY

**55. Klinefelter syndrome is characterized by the genotype:**

- (a) XXX                  (b) XYY
- (c) XO                    (d) XXY

**56. Gastrulation in human takes place by:**

- (a) Invagination
- (b) Involution
- (c) Primitive streak formation
- (d) Delamination

### ANSWER KEYS

- |         |         |         |         |
|---------|---------|---------|---------|
| 1. (a)  | 15. (b) | 29. (a) | 43. (c) |
| 2. (b)  | 16. (c) | 30. (c) | 44. (a) |
| 3. (c)  | 17. (a) | 31. (c) | 45. (d) |
| 4. (b)  | 18. (c) | 32. (c) | 46. (a) |
| 5. (d)  | 19. (c) | 33. (b) | 47. (b) |
| 6. (a)  | 20. (d) | 34. (c) | 48. (b) |
| 7. (b)  | 21. (a) | 35. (c) | 49. (c) |
| 8. (c)  | 22. (c) | 36. (a) | 50. (a) |
| 9. (c)  | 23. (b) | 37. (b) | 51. (d) |
| 10. (a) | 24. (d) | 38. (c) | 52. (c) |
| 11. (c) | 25. (a) | 39. (a) | 53. (a) |
| 12. (d) | 26. (a) | 40. (c) | 54. (a) |
| 13. (d) | 27. (b) | 41. (b) | 55. (d) |
| 14. (a) | 28. (c) | 42. (d) | 56. (c) |

## **II. DESCRIPTIVE QUESTIONS WITH ANSWERS**

### **1. Describe the male reproductive system in human.**

- Hints**
- (i) Testes: Gross structure, Histology and Endocrine functions
  - (ii) Excurrent ducts: Epididymis, Ductus deferens, Ejaculatory duct and Urethra
  - (iii) Glands: Prostate, Seminal vesicle and Bulbo-urethral gland
  - (iv) External genitalia
  - (v) Spermatogenesis and sperm maturation
  - (vi) Labeled diagrammatic presentation

### **2. Describe the female reproductive system in human**

- Hints**
- (i) Ovary: Gross structure, Histology and Endocrine functions
  - (ii) Fallopian tubes, Uterus and Cervix
  - (iii) External genitalia
  - (iv) Oogenesis, Release of mature egg, Fertilization, Implantation, Gestation and Parturition (Brief account)
  - (v) Labeled diagrammatic presentation

### **3. What is menstrual cycle? Describe the cycle in human with reference to cyclic changes in the ovary and uterine endometrium.**

- Hints**
- (i) Menstrual cycle-Definition
  - (ii) Ovarian cycle: Follicular phase, Ovulation and Luteal phase
  - (iii) Uterine cycle: Proliferative phase, Secretory phase and Menstrual phase
  - (iv) Cyclic changes in the breasts

### **4. Write notes on the following:**

#### **(a) Antimullerian Hormone (AMH):**

**Ans.** Antimullerian hormone (AMH), also known as Mullerian Inhibiting Hormone (MIH), inhibits the differentiation of the mullerian ducts in the early stage of the differentiation of reproductive ducts. Consequently, the male gonads and the duct system differentiate to their full status. It's a peptide hormone secreted by Sertoli cells of the testis, soon after the differentiation of the testes have commenced. The male reproductive system is thus, established.

**(b) Cryptorchidism:**

**Ans.** Embryonic testes are abdominal, i.e. retained in the abdomen. In 90% of the human male babies, these descend into the scrotum through the inguinal canal during the gestation period. The descent is stimulated by antimüllerian hormone secreted by the Sertoli cells of the testis. However, in 10% of the babies, the testes fail to descend into the scrotum and thus are retained in the abdomen. This phenomenon of retention of the testes in the abdomen is known as cryptorchidism or cryptorchism. This defect is rectified either by surgery or gonadotropin treatment.

**(c) Pampiniform plexus:**

**Ans.** Like every other organ, the testis is supplied by testicular artery and is drained by testicular vein. The veins draining the testis break up into capillaries that surround the testis and form a capillary plexus called pampiniform plexus. Blood that returns from the testis through the pampiniform plexus is cooler than the blood in the testicular artery. The arterial blood is cooled by the venous blood by a countercurrent heat exchange mechanism. This mechanism keeps the temperature of the testis 2° - 3° C lower than the normal body temperature. This is vital for spermatogenesis to continue.

**(d) Secondary sex characters:**

**Ans.** Secondary sexual characters constitute a set of external characters that are helpful in distinguishing the male individual from the female. These characters are not associated with the proliferation of the germ cells and conveyance of the gametes. These are only concerned with mating, birth and nourishment of the new-born. These start developing at the onset of puberty. Beard, coarse voice, broad shoulder, thick sebaceous gland secretion, etc. are among a few male secondary sexual characters. In the female, soft skin, less body hairs, soft voice, breasts, etc. constitute a few secondary sexual characters.

**(e) Accessory sex organs:**

**Ans.** The system of ducts for the conveyance of the gametes and the associated glands constitute accessory sex organs or structures. The multiple efferent ductules, paired epididymis, vasa deferentia, seminal vesicles, ejaculatory ducts, bulbo-urethral and prostate glands, urethra and the penis constitute the accessory sex organs in the male. The female accessories include fallopian tubes, uterus, vagina and glans clitoridis.

**(f) Seminiferous tubule:**

**Ans.** The testis is made up of many tubular structures called seminiferous tubules dispersed in a mass of interstitial matrix. In a cross section, the tubule is circular in outline. It is surrounded by a blood-testis barrier of basal lamina, muscle-like myoid cells and fibroblasts. Inner to the basal lamina are present large somatic cells called Sertoli Cells or sustentacular cells. Between these cells are present spermatogenic cells in different stages of spermatogenesis. At the centre are present numerous spermatozoa supported by Sertoli cells.

**(g) Interstitial cells of Leydig:**

**Ans.** The interstitial space among the seminiferous tubules is filled with an interstitial tissue and this tissue contains groups of cells called interstitial cells of Leydig. These cells have an endocrine function and secrete male steroid hormones, collectively known as androgens. The principal androgen is testosterone. It maintains male accessory sex organs, promotes the development of secondary sexual characters and controls spermatogenesis.

**(h) Sertoli cell:**

**Ans.** Sertoli (sustentacular) cells are large non-dividing somatic cells present in the seminiferous tubule. These cells are the target cells for follicle stimulating hormone (FSH). FSH stimulates Sertoli cells to synthesize and secrete androgen binding protein (ABP). ABP binds to androgens, especially testosterone, thus increasing its concentration in the tubule. It also secretes anti mullerian hormone (AMH) and inhibin. AMH inhibits the development of the Mullerian duct in the male. In addition, Sertoli cells support and nourish the differentiating spermatogenic cells.

**(i) Epididymis:**

**Ans.** Epididymis is a part of the duct system, through which spermatozoa are discharged. The seminiferous tubules discharge into the epididymis through an anastomosing network of tubules, the rete testis. The epididymis is a convoluted part of the duct system and consists of three parts: head, body and tail. The tail of the epididymis opens into the ejaculatory duct.

**(j) Seminal vesicle:**

**Ans.** There is a pair of seminal vesicles just posterior to the urinary bladder above the prostate. The duct of each vesicle discharges into the vas deferens at the base of a dilated part called ampulla, consequently forming an ejaculatory duct. The vesicles secrete a yellowish viscous fluid containing fructose as the chief source of energy for the developing spermatozoa. The seminal fluid accounts for 60% of the volume of the semen.

**(k) Prostate:**

**Ans.** There is a single prostate gland, just below the urinary bladder. The two ejaculatory ducts enter into the prostate and join to form a single prostatic urethra. The prostatic urethra receives small ducts from the prostate. The prostate secretes a thin watery fluid, which contains citric acid, calcium, coagulation proteins, prostate specific antigens and an enzyme, fibrinolysin. The coagulation proteins coagulate the semen following ejaculation. However, it assumes a liquid form by the action of fibrinolysin.

**(l) Bulbo-urethral gland (Cowper's gland):**

**Ans.** There is a pair of small spherical bulbo-urethral or Cowper's glands. Small ducts of the Cowper's glands discharge into the prostatic urethra. These glands secrete a clear mucous-like fluid that acts as a lubricant. Its secretion precedes the secretion of the semen.

**(m) Graafian follicle:**

**Ans.** The ovary of a mature human female is lined by a single layer of germinal epithelium and the inner content is a mass of dense irregular connective tissue divided into an outer cortex and an inner medulla or stroma. The cortex is seen to have ovarian follicles in different stages of maturation. One such follicle is a mature follicle or graafian follicle. It is a spherical in structure containing a secondary oocyte surrounded by layers of theca cells. The thecal cells are surrounded by layers of granulosa cells. There is a fluid-filled cavity called an antrum. Due to its presence of the antrum, the oocyte with its surrounding theca cells are displaced to one side of the follicle. The oocyte with the thecal cells remains connected with other cells by a thin cord of cells called cumulus oophorus.

**(n) Corpus luteum:**

**Ans.** The graafian follicle ruptures releasing the secondary oocyte and turns into a blood-filled structure called corpus haemorrhagicum. The theca and granulosa cells proliferate forming luteal cells. The blood is absorbed *in situ* and the structure turns into a corpus luteum. The luteal cells are the source of estrogens and progesterone and thus, corpus luteum is an endocrine structure. A peptide hormone, known as relaxin is also secreted by the corpus luteum. The corpus luteum persists as long as pregnancy continues. Soon after parturition, the structure disintegrates into a corpus albicans.

**(o) Spermatogenesis:**

**Ans.** Spermatogenesis is a process of spermatozoa formation from spermatogonia in the seminiferous tubules of the testis. It completes in two steps. In the first step, a diploid spermatogonium forms four spermatids in three phases: phase of multiplication, phase of

growth and phase of maturation. Phase of multiplication is equational, where-in each spermatogonium divides by repeated equational division forming a large number of spermatogonia. In the phase of growth, a spermatogonium grows in volume and forms a primary spermatocyte. The phase of maturation is significant. Each primary spermatocyte undergoes a meiosis. First meiosis is reductional forming two haploid secondary spermatocytes. Second meiosis is equational. Two haploid spermatids are formed from each secondary spermatocyte. Thus, four spermatids are formed from one spermatogonium. In the second step each spermatid metamorphoses into a motile spermatozoon through spermiogenesis.

**(p) Oogenesis:**

**Ans.** The process of oogenesis is essentially similar in sequence to that of spermatogenesis, except for, it occurs in the ovary. Another difference is that the phase of growth is little more prolonged and the first and second meiosis are unequal, such that at the end of each, an insignificantly small cell, named as polar body is formed. At the end, a single ootid and three polar bodies are formed. The ootid undergoes minor changes and forms a mature egg or ovum.

**(q) Menstrual cycle:**

**Ans.** Cyclic structural and functional changes in the ovary and uterus at an interval of 28 days in human sexually mature female is known as menstrual cycle. The cycle also occurs in apes and Old-World monkeys. The ovarian cycle is divided into follicular, ovulation and luteal phases. Ovulation or the release of a mature egg from the graafian follicle occurs at the day 14. Following ovulation, the graafian follicle recedes into a corpus luteum, which starts disintegrating by the day 22 and finally disappears to make way for another cycle. Concurrent with these changes, the uterine endometrium is sloughed off and the underlying arteries disintegrate. Consequently, the tissue debris and raw blood is discharged through the vagina towards the end of the cycle.

**(r) Blastocyst:**

**Ans.** Blastocyst is a multicellular spherical embryo that is formed following cleavage in human and other eutherian mammals. It is homologous to the blastula of other animals. It consists of an outer layer of cells called trophoblasts and an inner cell mass. There is a cavity, known as blastocoel between the trophoblast layer and the inner cell mass. The embryo develops from the inner cell mass, while the trophoblast layer helps in adhering to the uterine endometrium in a process called implantation.



**(s) Implantation:**

**Ans.** Implantation is the process of intimate attachment of the blastocyst to the uterine endometrium. The outer trophoblast layer helps attach the blastocyst. Following attachment, the endometrium proliferates and covers the entire embryo. The intimacy between the uterus and the implanted embryo is further increased by establishing a communication between the two through the blood vascular system. Implantation establishes pregnancy.

**(t) Placenta:**

**Ans.** Placenta is an organ formed by the apposition of the embryonic and uterine tissues for facilitating all kinds of exchanges between the embryo and uterus of the mother. Following implantation, the embryo forms the extra-embryonic membranes for its protection. Chorion and allantois (two of the four extra-embryonic membranes) in most mammals including human, vascularize and the chorion develops villi at the site of attachment. These villi interdigitate with the uterine tissue forming a placenta. The intimacy is further increased by the dissolution of one or a few tissues from both sides. Physiological exchange apart, the placenta is an endocrine structure, secreting estrogens, progesterone and relaxin.

**(u) Parturition:**

**Ans.** Parturition is the delivery of the fetus from the uterus to outside through the vaginal orifice at the end of gestation period. It is induced by a complex neuro-endocrine mechanism. The signal originates from the fetus and placenta, which induces mild contraction of the uterine muscle. This reflex is known as the fetal ejection reflex. This reflex triggers the release of oxytocin from the mother's pituitary gland. Oxytocin induces stronger contraction of the myometrium. The consequence is the expulsion of the fetus through the vaginal orifice.

**(v) Lactation:**

**Ans.** Human female has a pair of mammary glands, which develops and grows after puberty. These glands proliferate further during pregnancy and start secreting milk towards the end of pregnancy by a process known as lactation. Formation of milk is induced by prolactin (PRL). It is stored in the gland. When the baby suckles, there a reflex and this reflex induces the pituitary gland to secrete oxytocin. Oxytocin brings about the contraction of the smooth muscle of the gland and consequently milk is ejected. Mother's milk is the best nourishment for the neonatal. The first milk also contains an immunoglobulin, IgA that gives a kind of protection to the baby.

## CHAPTER - 4

# REPRODUCTIVE HEALTH

## MULTIPLE CHOICE QUESTIONS (MCQ)

### I. CHOOSE THE CORRECT ANSWER

1. **National Health Policy was enacted in:**  
(a) 1952                      (b) 1975  
(c) 1983                      (d) 2004
2. **National Family Planning Programme was launched in:**  
(a) 1951                      (b) 1983  
(c) 1985                      (d) 2002
3. **The Government of India redesignated the National Family Planning Programme as National Family Welfare Programme in:**  
(a) 1975                      (b) 1977  
(c) 1983                      (d) 2002
4. **National Health Mission was launched in:**  
(a) 2005                      (b) 2008  
(c) 2013                      (d) 2018
5. **The method of injecting a sperm directly into an ovum is an Assisted Reproductive Technology known as:**  
(a) Gamete Intra-Fallopian Transfer (GIFT)  
(b) Zygote Intra-Fallopian Transfer (ZIFT)  
(c) in vitro Fertilization (IVF)  
(d) Embryo Transfer (ET)
6. **Intensely lactating mothers generally do not conceive due to:**  
(a) Suppression of gonadotropins  
(b) Hypersecretion of gonadotropins  
(c) Suppression of gametic transport  
(d) Suppression of fertilization
7. **The technique of Gamete Intra-Fallopian Transfer (GIFT) is recommended for women, who:**  
(a) Can't produce ova  
(b) Can't retain the fetus in the uterus  
(c) Can't provide a suitable environment for fertilization  
(d) All of the above
8. **Which of the following may be used to overcome infertility, when the male partner has low sperm count and decreased sperm motility?**  
(a) Zygote Intra-Fallopian Transfer (ZIFT)  
(b) Gamete Intra-Fallopian Transfer (GIFT)  
(c) Intra-Uterine Insemination (IUI)  
(d) None of the above

9. Which of the following is not a spacing method of family planning?
- (a) Natural method
  - (b) Terminal method
  - (c) Chemical method
  - (d) Hormonal method
10. Which of the of two synthetic hormone combinations are present in oral contraceptives?
- (a) FSH & LH
  - (b) Estrogen & Progesterone
  - (c) LH & Estrogen
  - (d) LH & Progesterone
11. In which of the following spacing methods creams, jelly and foam tablets are used?
- (a) Barrier method
  - (b) Hormonal method
  - (c) Natural method
  - (d) Chemical method
12. Emergency contraceptives are effective, if used within:
- (a) 72 hour of coitus
  - (b) 72 hours of ovulation
  - (c) 72 hours of menstruation
  - (d) 72 hours of implantation
13. Which of the following is a sexually transmitted disease?
- (a) Tuberculosis
  - (b) Leishmaniasis
  - (c) Amoebiasis
  - (d) Trichomoniasis
14. Which of the following sexually transmitted diseases doesn't affect sex organs?
- (a) Syphilis
  - (b) AIDS
  - (c) Gonorrhea
  - (d) Genital warts
15. The terminal method of contraception is:
- (a) Ovariectomy
  - (b) Castration
  - (c) Vasectomy
  - (d) Hysterectomy
16. Which of the following sexually transmitted diseases is caused by a bacterium?
- (a) Chlamydia
  - (b) AIDS
  - (c) Hepatitis
  - (d) Genital Herpes
17. Genetic disorders of the developing fetus is determined by a method called:
- (a) Ultrasonography
  - (b) Computer Tomography
  - (c) Fetoscopy
  - (d) Amniocentesis

18. Which of the following can't be detected by amniocentesis?
- Jaundice
  - Cystic Fibrosis
  - Chromosomal Translocations
  - Down Syndrome
19. Amniocentesis is performed when a woman is between
- 5-10 weeks of gestation
  - 10-15 weeks of gestation
  - 15-20 weeks of gestation
  - More than 20 weeks of gestation
20. In which of the following weeks of pregnancy, chorionic villus sampling (CVS) is done:
- 5-10 weeks
  - 11-14 weeks
  - 15-20 weeks
  - More than 20 weeks
21. The first case of *in vitro* fertilization (IVF)-embryo transfer (ET) was successfully performed by:
- Robert Steptoe and Gilbert Brown
  - Louise Brown and Starling Taylor
  - Robert Brown and Thomas Gillman
  - Patrick Steptoe and Robert Edwards
22. Which of the following is a non-oral female contraceptive:
- Implant
  - Mala D pill
  - Saheli pill
  - Morning after pill
23. The rhythm method of contraception refers to:
- Withdrawal before ejaculation
  - Using condom during sexual intercourse
  - Avoidance of sexual intercourse during 48 hours following ovulation
  - Using cream, jelly or foam tablet during sexual intercourse

### ANSWER KEYS

- |        |         |         |         |
|--------|---------|---------|---------|
| 1. (c) | 7. (a)  | 13. (d) | 19. (c) |
| 2. (a) | 8. (c)  | 14. (b) | 20. (b) |
| 3. (b) | 9. (b)  | 15. (c) | 21. (d) |
| 4. (c) | 10. (b) | 16. (a) | 22. (a) |
| 5. (c) | 11. (d) | 17. (d) | 23. (c) |
| 6. (a) | 12. (a) | 18. (a) |         |

## **II. DESCRIPTIVE QUESTIONS WITH ANSWERS**

### **1. Notes on**

#### **(a) Sexually transmitted diseases (STDs):**

**Ans.** Infections, passed from one person to another by sexual contact are known as sexually transmitted diseases. World Health Organization (WHO) identifies these as sexually transmitted infections (STIs). The causative agents of STDs are viruses, bacteria or parasites. The contact is usually vaginal, anal or oral during sexual intercourse. However, some spread through intimate physical contact, like skin-to-skin contact (e.g. Herpes and Human Papilloma Virus). More than twenty types of STDs have so far been diagnosed. Some common ones are: Chlamydia (Bacteria), Genital herpes (Herpes simplex virus), Gonorrhoea (Bacteria), AIDS (HIV), Genital wart (Human Papilloma Virus), Syphilis (Bacteria), Hepatitis B (Hepatitis B Virus) and Trichomoniasis (Trichomonas, a protozoon). WHO has enlisted eight STDs as most prevalent, out of which four are bacterial and four others are viral.

#### **(b) Birth control:**

**Ans.** Birth control is a deliberate practice of control of birth of babies by couples through different recommended practices enforced by the Health and Family Welfare Department. Two common methods of birth control are: spacing method and terminal method. Spacing is a temporary method. In the spacing method, an appropriate gap is deliberately practiced between the births of babies. Spacing is practiced by barriers (by the use of condoms, diaphragm, fem shield, cervical cap, vault cap, etc.); intra-uterine devices (IUDs) like copper t and hormone releasing devices; chemicals like cream, jelly and foam tablet; hormones (hormones having contraceptive properties); and by natural method (safe period of intercourse, withdrawal before ejaculation and breast feeding). Terminal method is permanent. It involves surgical blocking of vas deferens and oviduct by vasectomy and tubectomy, respectively.

#### **(c) Contraception:**

**Ans.** Contraception is a hormonal birth control method that comes under the spacing method class. It is a temporary method, which uses hormones having contraceptive properties and is employed by women. Three types of contraceptives are in common practice: oral, non-oral and emergency contraceptives. Oral contraceptives are pills, which are taken for 21 days in a menstrual cycle starting from 5th day and ending on 25th day. Oral contraceptive pills contain a combination of synthetic estrogen and progesterone. Non-oral are either injectable or implants. Injectable ones contain a combination of synthetic

progesterone and oestadiol. Implants, too contain synthetic progesterone. An implant is placed sub-dermally for a long-term contraception. Emergency contraceptives are used for an unprotected sexual intercourse. Two of these pills are taken at the beginning and two after 12 hr. do the needful. Whatever may be case, the contraceptives use a combination of estrogen and progesterone or progesterone alone.

**(d) Medical termination of pregnancy (MTP):**

**Ans.** Unwanted pregnancy can be terminated medically early during the first trimester. A combination of a prostaglandin and an antiprogesterone is used for this purpose. This treatment is followed by a vacuum aspiration of the debris. The process is executed on the advice of a registered medical practitioner.

**(e) Terminal method of family planning:**

**Ans.** Terminal method is a permanent method of birth control. This method is based on surgical procedures, by which the discharge of semen in male and release of ovum in female are blocked. These techniques are more popularly known as sterilization processes. This comprises of vasectomy in the male and tubectomy in the female. Vasectomy is executed either by excising the vas deferens or by occluding it by ligation. Tubectomy is a surgical process, in which both the fallopian tubes are either excised or ligated to block the passage of ova.

**(f) Amniocentesis:**

**Ans.** Amniocentesis, also known as amniotic fluid test (AFT), is a medical procedure of prenatal diagnosis of chromosomal and biochemical abnormalities and fetal infections. In this procedure, a small amount of the amniotic fluid from the amniotic sac is aspirated preferably in the second trimester and sampled. The sample is centrifuged. Appropriate biochemical tests are undertaken on the supernatant to determine if there is any inborn error of metabolism. The sediment, containing fetal cells are cultured and the resultant cells are karyotyped to confirm if there is any chromosomal aberration. However, this test is misused to determine the gender of the fetus. This is an unethical and illegal practice, which invites punitive action as outlined in the penal code.

**(g) Infertility:**

**Ans.** Infertility refers to a biological inability of an individual, male or female, to contribute to conception. In many countries, this condition refers to a failure in conception after 12 months of regular sexual intercourse without the use of contraception. Possible causes of infertility in women are disorders in ovulation and problems in the fallopian tubes and uterus. Ovulation disorders may be treated with fertility drugs, while problems in the



fallopian tubes may be set right surgically. Infertility in men is caused by abnormal semen in 75% of the cases. Abnormal semen is caused by oligospermia (low sperm count), low sperm motility, abnormal sperms in the semen, etc. Other causes are erectile dysfunction and blockage in the duct system. Semen abnormality and erectile dysfunctions can be treated with appropriate medications, while blockages may be cleared by surgical procedures.

**(h) Assisted reproductive technology (ART):**

**Ans.** Due to infertility problems, there is a failure in conception. However, research and investigation have opened up new vistas in conception in infertile women. Several methods have successfully been practiced, which are collectively classed as assisted reproductive technology (ART). Some of the commonly practiced methods are intra-uterine insemination, *in vitro* fertilization (IVF) and embryo transfer, zygote intrafallopian transfer (ZIFT) and gamete intra-fallopian transfer (GIFT).

**(i) IVF and embryo transfer:**

**Ans.** *in vitro* fertilization (IVF) is a process of fertilization of an egg by a sperm outside the body under controlled laboratory conditions. It has become a method of choice for women, who can't conceive following regular unprotected sexual intercourse. The ovary is stimulated to undergo ovulation by administering hormones at an appropriate time. The eggs are retrieved fertilized *in vitro* and the fertilized eggs are cultured in a nutrient medium. In around 5 days, an embryo with actively dividing cells is formed. The embryo is then transferred into the uterus of a mother, made competent with hormonal treatment. Thus, pregnancy is established.

**(j) ZIFT :**

**Ans.** Zygote intra-fallopian transfer (ZIFT) is an assisted reproductive technology. It is used as a method of choice in women, whose fallopian tubes are blocked that prevents the migration of sperms. Eggs are retrieved from the ovaries of an ovulating woman. It's fertilized *in vitro* and the resulting zygote is transferred into the fallopian tube by laparoscopy.

**(k) GIFT:**

**Ans.** Gamete intra-fallopian transfer (GIFT) is an assisted reproductive technology. It's practiced to overcome infertility. Eggs are removed from the ovulating woman's ovaries and placed in one of the fallopian tubes along with the semen of man. Fertilization occurs in the fallopian tube and pregnancy is established.

## CHAPTER - 7

# EVOLUTION

## MULTIPLE CHOICE QUESTIONS (MCQ)

### I. CHOOSE THE CORRECT ANSWER

1. **Life originated on earth approximately about:**
  - (a) 2.5 billion years ago
  - (b) 3.5 billion years ago
  - (c) 4.5 billion years ago
  - (d) 5.5 billion years ago
2. **The theory of abiogenesis in the origin of life was proposed and advocated by:**
  - (a) Francesco Redi
  - (b) Spallanzani
  - (c) A.I. Oparin
  - (d) Louis Pasteur
3. **Which of the following is a correct sequence in the biological evolution?**
  - (a) Chemoautotroph, Chemoheterotroph and Photoautotroph
  - (b) Chemoheterotroph, Chemoautotroph and Photoautotroph
  - (c) Photoautotroph, Chemoautotroph and Chemoheterotroph
  - (d) Photoautotroph, Chemoheterotroph, and Chemoautotroph
4. **Which of the following compounds Miller and Urey used in the experimental synthesis of amino acids?**
  - (a)  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{CO}_2$  and  $\text{H}_2\text{O}$
  - (b)  $\text{CH}_4$ ,  $\text{CO}_2$ ,  $\text{H}_2$  and  $\text{H}_2\text{O}$
  - (c)  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2$  and  $\text{H}_2\text{O}$
  - (d)  $\text{CH}_4$ ,  $\text{N}_2$ ,  $\text{H}_2$  and  $\text{H}_2\text{O}$
5. **Hot ocean water containing concentrated prebiotic organic compounds is known as:**
  - (a) Colloid
  - (b) Crystalloid
  - (c) Gelatinous mixture
  - (d) Primordial soup
6. **Which of the following was first formed?**
  - (a) Virus
  - (b) Prokaryote
  - (c) Coacervate
  - (d) Microsphere
7. **Theory of natural selection was proposed by:**
  - (a) Charles Darwin
  - (b) J. B. Lamarck
  - (c) Hugo De Vries
  - (d) G. J. Mendel

8. **Darwin settled in an archipelago for observations on animals that led to the proposition of the theory of natural selection. Name the archipelago.**  
(a) Madagascar (b) Barbados  
(c) Falkland (d) Galapagos
9. **Finches, which were the main focus of Darwin's study are:**  
(a) Reptiles (b) Insects  
(c) Birds (d) Mammals
10. **Darwin apart, another naturalist came up with the theory of natural selection almost at the same time. Identify him:**  
(a) A. R. Wallace  
(b) J. B. Lamarck  
(c) Hugo DeVries  
(d) Robert Mc Malthus
11. **Which type of natural selection removes individuals from both ends of a phenotypic distribution so as to maintain a distribution average?**  
(a) Directional  
(b) Stabilizing  
(c) Disruptive  
(d) None of the above.
12. **Who among the following naturalists is not a proponent of the modern synthetic theory of evolution?**  
(a) Jullian Huxley  
(b) Ernst Meyer  
(c) Hugo DeVries  
(d) J.B.S. Haldane
13. **Which one of the following is not among the causative factors considered in the modern synthetic theory of evolution?**  
(a) Genetic recombination  
(b) Gene mutation  
(c) Chromosomal aberration  
(d) Genetic linkage
14. **Continuous genetic variation is the result of:**  
(a) Mutation  
(b) Isolation  
(c) Genetic recombination  
(d) Chromosomal aberration
15. **Discontinuous genetic variation appears by:**  
(a) Mutation  
(b) Isolation  
(c) Genetic recombination  
(d) Chromosomal aberration
16. **Homologous organs have:**  
(a) Different origin and similar functions  
(b) Similar origin and similar functions  
(c) Similar origin and different functions  
(d) Different origin and different functions
17. **Which of the following constitutes homologous organs?**  
(a) Fore limb of a frog and wing of a bird  
(b) Wing of a cockroach and wing of a bird  
(c) Wing of a bat and wing of a dragon fly  
(d) Leg of human and leg of a cockroach

- 18. Analogous organs have:**
- (a) Different origin and similar functions
  - (b) Similar origin and similar functions
  - (c) Similar origin and different functions
  - (d) Different origin and different functions
- 19. An example of analogous organs is:**
- (a) Fore limb of a frog and wing of a bird
  - (b) Wing of a cockroach and wing of a bat
  - (c) Fore limb of a frog and fore limb of a lizard
  - (d) Pectoral and pelvic fins of a fish
- 20. Which one of the following set of organs constitutes vestigial organs?**
- (a) Appendix, Pectoral girdle and Caecum
  - (b) Large intestine, Pectoral girdle and Caecum
  - (c) Large intestine, Coccyx and Ear muscle
  - (d) Appendix, Coccyx and Plica semilunaris
- 21. Study of fossil and fossil record is known as:**
- (a) Anatomy      (b) Paleontology
  - (c) Morphology   (d) Histology
- 22. Who is known as the Father of Modern Paleontology?**
- (a) Ernst Haeckel
  - (b) Karl Ernst von Baer
  - (c) Georges Cuvier
  - (d) Leonardo da Vinci
- 23. Direct evidences of organic evolution are obtained from:**
- (a) Morphology and Anatomy
  - (b) Embryology
  - (c) Fossil record
  - (d) Molecular Biology
- 24. Which one of the following eras is considered as the era of reptiles?**
- (a) Paleozoic
  - (b) Mesozoic
  - (c) Cenozoic
  - (d) Archaeozoic
- 25. Which one of the following eras is considered as the era of mammals?**
- (a) Paleozoic
  - (b) Mesozoic
  - (c) Cenozoic
  - (d) Archaeozoic
- 26. The age of a fossil is determined by:**
- (a) Radioactive dating
  - (b) Weighing the fossil
  - (c) Measuring its dimension
  - (d) Microscopic examination
- 27. *Archaeopteryx* is a fossil:**
- (a) Fish
  - (b) Amphibian
  - (c) Reptile
  - (d) Bird
- 28. Central Dogma constitutes an evidence of organic evolution from:**
- (a) Comparative Anatomy
  - (b) Embryology
  - (c) Molecular Biology
  - (d) Paleontology

- 29. The statement that ontogeny recapitulates phylogeny is an important evidence in favour of organic evolution from:**
- (a) Comparative Anatomy
  - (b) Embryology
  - (c) Molecular Biology
  - (d) Paleontology
- 30. Homologous organs, analogous organs and vestigial organs constitute evidences for organic evolution from:**
- (a) Comparative Anatomy
  - (b) Embryology
  - (c) Molecular Biology
  - (d) Paleontology
- 31. A random change in gene frequencies in a randomly breeding population is known as:**
- (a) Selection
  - (b) Genetic drift
  - (c) Isolation
  - (d) Genetic linkage
- 32. Industrial melanism is an example of:**
- (a) Genetic recombination
  - (b) Gene mutation
  - (c) Isolation
  - (d) Natural selection
- 33. The principle of genetic equilibrium was proposed by:**
- (a) Charles Darwin
  - (b) Hardy and Weinberg
  - (c) J. B. Lamarck
  - (d) Hugo DeVries
- 34. That gene frequencies of a population will remain constant, generation after generation unless evolutionary forces act on it, is known as:**
- (a) Law of genetic equilibrium
  - (b) Law of independent assortment
  - (c) Law of linkage
  - (d) Law of segregation
- 35. Find the odd match:**
- (a) Aerial - Flying
  - (b) Cursorial - Running
  - (c) Fossorial - Burrowing
  - (d) Arboreal - Swimming
- 36. Adaptive radiation in mammals centres around the adaptive modification of the basic structure of:**
- (a) Reproductive system
  - (b) Excretory patterns
  - (c) Pentadactyl limbs
  - (d) Respiratory system
- 37. Closest relative of modern human is:**
- (a) Gorilla
  - (b) Chimpanzee
  - (c) Orangutan
  - (d) Macaque
- 38. Which one of the following is not a great ape?**
- (a) Gorilla
  - (b) Chimpanzee
  - (c) Orangutan
  - (d) Macaque

**39. As per fossil record, it was inferred that the evolution of human occurred in:**

- (a) Asia                      (b) Europe  
(c) Africa                    (d) Australia

**40. Human evolution is evidenced to have commenced around:**

- (a) 3.0-3.5 billion years back  
(b) 4.0 billion years back  
(c) 4.5 billion years back  
(d) 5.0 billion years back

**41. Which one of the following is a correct sequence in hominid evolution?**

- (a) *Homo habilis*, *H. erectus*,  
*H. neanderthalensis* and *H. sapiens*  
(b) *Homo erectus*, *H. habilis*,  
*H. neanderthalensis* and *H. sapiens*  
(c) *Homo habilis*, *H. neanderthalensis*,  
*H. sapiens* and *H. erectus*  
(d) *Homo erectus*, *H. neanderthalensis*,  
*H. habilis* and *H. sapiens*

### ANSWER KEYS

- |         |         |         |         |
|---------|---------|---------|---------|
| 1. (b)  | 12. (c) | 23. (c) | 34. (a) |
| 2. (c)  | 13. (d) | 24. (b) | 35. (d) |
| 3. (b)  | 14. (c) | 25. (c) | 36. (c) |
| 4. (c)  | 15. (a) | 26. (a) | 37. (b) |
| 5. (d)  | 16. (c) | 27. (d) | 38. (d) |
| 6. (c)  | 17. (a) | 28. (c) | 39. (c) |
| 7. (a)  | 18. (a) | 29. (b) | 40. (a) |
| 8. (d)  | 19. (b) | 30. (a) | 41. (a) |
| 9. (c)  | 20. (d) | 31. (b) |         |
| 10. (a) | 21. (b) | 32. (d) |         |
| 11. (b) | 22. (d) | 33. (b) |         |



## **II. DESCRIPTIVE QUESTIONS WITH ANSWERS**

### **1. Give an account of the origin of life on earth.**

**Hints** (a) Origin of earth

(b) Cooling and crust formation

(c) Formation of an early reducing atmosphere with  $H_2$ ,  $N_2$ ,  $H_2O$ ,  $NH_3$ ,  $CH_4$ ,  $CO_2$  and HCN.

(d) A.I. Oparin's abiogenesis (Chemical evolution):

(i) Formation of simple organic molecules (Stanley Miller and Harold Urey's experiment)

(ii) Formation of complex organic molecules and then molecular aggregates like coacervates, microspheres, protocells and viruses

(e) Biological evolution:

(i) Evolution of prokaryotes (chemoheterotrophs, chemoautotrophs and photoautotrophs in a sequence)

(ii) Evolution of single-celled eukaryotes and then multicellular eukaryotes

(iii) Further evolution and diversification of the living world

### **2. Give an account of evidences of biological evolution.**

**Hints** **Evidences of organic evolution**

(a) Evidences from morphology and comparative anatomy - Homology, Analogy and Vestigial organs

(b) Evidences from embryology - Homology in early development and theory of recapitulation

(c) Evidences from paleontology - Fossils and fossil record, dating of fossil, geological time scale and evolution of horse as an example of complete fossil record through the time scale.

(d) Evidences from molecular biology - Cell (structure and chemical composition), genetic material and central dogma (flow of genetic information)

### **3. Describe Darwin's theory of natural selection and origin of species.**

**Hints** (a) Introduction - Origin of diversity through adaptations (adaptive modifications)

(b) Prodigality in reproduction - Laying of a large number of eggs, where there is a threat of destruction of eggs and hatched embryos

- (c) Limiting factors for survival
- (d) Struggle for existence - Competition for survival
- (e) Genetic variations through genetic recombination and mutation bring about adaptive structural changes. These changes enable the organisms to compete and survive.
- (f) Survival of the fittest
- (g) Natural selection and origin of new species
- (h) Natural selection in action - Industrial melanism
- (i) Criticism to Darwin's theory of natural selection

**4. Write notes on the following:**

**(a) Abiogenesis:**

**Ans.** Contrary to the idea of Francesco Redi (1668), Spallanzani (1767) and Louis Pasteur (1862) that life originated from preexisting life, abiogenesis refers to the origin of life from non-living matter. This idea was proposed by A.I. Oparin and J.B.S. Haldane (1923). This idea gained ground because of the question that where did life originate from, when there was no life on earth? Abiogenesis explains that life originated from simple inorganic matter, which is summed up as chemical evolution.

**(b) Coacervate:**

**Ans.** Complex organic molecules were formed from simple inorganic compounds by chemical evolution. Aggregates of such organic molecules were formed in the sea water. The sea water rich in the soluble organic matter was termed as primordial or prebiotic soup. Colloidal particles forming droplets originated from such aggregates, which could grow and divide. Oparin termed these as coacervates. `

**(c) Microsphere:**

**Ans.** Refer to the description at (b) and continue. Small spheres of complex organic molecules were next covered by external membranes. Such spheres were described as microspheres by Sydney Fox (1965).

**(d) Fossil:**

**Ans.** A fossil is any remain or impression of the entire body or parts of an animal or plant living in the remote past that has been preserved in the sedimentary rock deposit of the earth's crust. Fossils include hard parts like bones, teeth and shell; impressions or imprints of softer parts like feathers and leaves of plants; and casts or moulds of animals or plants

or parts thereof. Fossils are found in the sedimentary rock deposits. The older is the fossil, deeper it is present. The age of the fossil is determined by radioactive dating method. Fossils are considered as direct evidences in favour of organic evolution.

**(e) Dating of fossil:**

**Ans.** Dating of a fossil refers to determining the age of a fossil. This is done by radioactive dating. Among the better dating techniques are Uranium-Lead dating, Potassium-Argon dating and radiocarbon dating. A radioactive element disintegrates by emitting ionizing radiation to another lighter element and the time taken to disintegrate half of it is known as half-life period. The age of the fossil is determined by estimating the quantity of the element formed by disintegration from the initial radioactive element.

**(f) Geological time scale:**

**Ans.** A geological time scale is described as gradual evolutionary changes in the ascending order of time. The scale is divided primarily into five eras in an ascending order: Archaeozoic, Proterozoic, Paleozoic, Mesozoic and Cenozoic. Each era is divided into periods and each period into epochs. Archaeozoic is the most primitive era and is placed at the bottom, while the most recent, Cenozoic is placed at the top. It reflects an ascending order of evolution and biological diversity in an ascending order.

**(g) Homology:**

**Ans.** The organs, which have similar fundamental structure and origin, but different functions are known as homologous organs. Such a similarity is known as homology. Homology points at the fact that the animals possessing homologous organs have a common ancestry, i.e. they have descended from a common ancestor. For example, pentadactyl fore limbs of a diverse group of tetrapods have similar skeletal elements in a similar order. However, these have undergone adaptive modifications with the fundamental structure remaining similar.

**(h) Analogy:**

**Ans.** The organs having different structure and embryological origin, but have similar functions are known as analogous organs. This phenomenon of similarity is known as analogy. For example, the wings of an insect and the wings of a bird have completely different structure and origin. However, these carry out similar functions i.e. flight. Thus, the wings of an insect and those of a bird constitute analogous organs. Similarly, the pectoral fins of a fish and flippers of a whale are also analogous organs. This phenomenon also explains convergent evolution. It is therefore, inferred that animals possessing analogous organs have different ancestry.

**(i) Vestigial organs:**

**Ans.** Some structures in animals are present in reduced forms, but apparently do not perform any function. However, these structures correspond to well developed and functional structures of very closely related animals. Such organs are known as vestigial organs. These are considered as remnants of well-developed and useful structures, present in their ancestors that were essential for them. For example, the vermiform appendix in human is present in a reduced form. However, an enlarged appendix is present in ruminants (cow and buffalo). It harbours cellulose digesting bacteria that help digest cellulose. This apart, plica semilunaris, coccyx, nipples in male human, wisdom teeth, tonsils are other examples of vestigial organs.

**(j) Embryological evidences of evolution:**

**Ans.** The embryonic developmental pathways of animals and plants provide clues about their common ancestry. How-so-ever diverse the animal or plant is, there is a common pathway in the early development. For example, fertilization results in a zygote, which subsequently undergoes cleavage and forms a morula. This is followed by a stage known as blastula. The blastula undergoes gastrulation to form the primary plan of the body. More so, the early embryos of diverse animals are also similar in appearance. Karl E von Baer postulated that during the embryonic development, distantly related animals depart more and more than do more closely related animals. This idea was supported by Ernst Haeckel, who proposed the theory of recapitulation. It states that ontogeny recapitulates phylogeny. Alternately speaking, the developmental sequence of an organism remembers its evolutionary history.

**(k) Theory of recapitulation:**

**Ans.** Karl E von Baer postulated that during the embryonic development, distantly related animals depart more and more than do more closely related animals. This idea was supported by Ernst Haeckel, who proposed the theory of recapitulation. It states that ontogeny recapitulates phylogeny. Alternately speaking, the developmental sequence of an organism remembers its evolutionary history. The most outstanding example in this context is the anural tadpole larva. A toad is terrestrial. Like all amphibians, it returns to its ancestral habitat, water, for laying eggs, where the eggs hatch into fish-like tadpole larvae. These larvae then metamorphose into toadlets, which become terrestrial. This fact strengthens the fact that amphibians have originated from fish ancestors.

**(l) Central dogma:**

**Ans.** The genetic material in all eukaryotes is DNA, which is the store house of all genetic information. The transfer of genetic information occurs in two steps: transcription and translation. This information transfer pathway is known as central dogma, which is universal. However, in some RNA viruses the pathway is reversed i.e. the information stored in RNA is restored in DNA by reverse transcription and then to the proteins through transcription and translation as usual. The working of the central dogma reflects on the theory of common descent.

**(m) Genetic variation:**

**Ans.** Genetic variation is the raw material on which the force of natural selection acts and brings about the origin of new species. Variations are of two types: adaptive and non-adaptive. The adaptive variations are selected by nature and hence, are encouraged to survive and propagate to form future generation. Non-adaptive variations are eliminated by nature and such animal and plant populations become extinct. Genetic variation arises through genetic recombination during gamete formation and mutation. Genetic recombination is a continuous variation, while mutation is discontinuous and occurs once in a while.

**(n) Natural selection:**

**Ans.** Natural selection is a natural force acting on populations of organisms. The raw material for natural selection's action is genetic variation. Genetic variation in a population is caused by genetic recombination and mutation. Variation is of two types: adaptive and non-adaptive. The force of natural selection selects the organisms with adaptive variations only. Adaptive genetic variations express adaptive characters and enable the organism to survive and propagate to form future generation. Selection eliminates the organisms with non-adaptive variations from the population. Thus, natural selection guarantees the survival of the fit organisms only.

**(o) Industrial melanism:**

**Ans.** Industrial melanism is a ground reality of natural selection's operation. A characteristic non-pigmented moth (peppered moth) of the species, *Biston betularia* was prevalent in Manchester city before the onset of industrial revolution. However, a black pigmented moth of the same species was spotted in 1945 i.e. after industrial revolution. It was explained that the light body pigmentation changed to dark pigmentation so that they would not be identified by predators against the black sooty background. Natural selection selected the dark pigmented moths only, while eliminated the light pigmented moths. Thus, dark body pigmentation was an adaptive variation, while light pigmentation was a non-adaptive variation and hence, was eliminated from the population.

**(p) Neo-Darwinism:**

**Ans.** Darwin's theory considered natural selection as the main driving force of evolution. Nobody disagrees with this proposition. However, other factors like genetic recombination, mutation, isolation, random genetic drift, migration, etc. also play their due share of role in evolution. Considering their importance, Sewall Wright, R.A. Fischer, T. Dobzhansky, Julian Huxley, G.L. Stebbins and J.B.S. Haldane modified Darwin's theory, which is identified as Neo-Darwinism or synthetic theory of evolution.

**(q) Genetic drift:**

**Ans.** Sewall Wright recognized Genetic drift or more commonly, random genetic drift as the main driving force of evolution in a small randomly breeding population. In his honour, this phenomenon has been termed as Sewall Wright effect. It simply refers to a random change in the gene frequency. In a small population, the sum total number of genes (gene pool) is small. In the event of migration of an individual from one population to the small population, there will be random breeding. This changes the frequencies of some genes and hence, changes the structure of the gene pool. In this situation, genetic drift operates as the main driving force of evolution.

**(r) Hardy-Weinberg's law of genetic equilibrium:**

**Ans.** Hardy and Weinberg considered evolution as a population character. Evolutionary changes occur in a similar magnitude in all individuals of a population. They further proposed that allelic and genotypic frequencies in a population will remain unchanged generation after generation, if evolutionary forces do not operate on the population.

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## CHAPTER - 8

# HUMAN HEALTH AND DISEASES

## MULTIPLE CHOICE QUESTIONS (MCQ)

### I. CHOOSE THE CORRECT ANSWER

1. **Commensalism is a relationship between two organisms, in which:**
  - (a) There is a physiological relationship
  - (b) No one is benefited
  - (c) Both are benefited
  - (d) One is benefited and the other is harmed
2. **A butterfly visiting a flower is an example of:**
  - (a) Parasitism
  - (b) Symbiosis
  - (c) Commensalism
  - (d) None of the above
3. **Relationship between cattle and egret is an example of:**
  - (a) Parasitism
  - (b) Commensalism
  - (c) Symbiosis
  - (d) None of the above
4. **Which of the following statements on a parasite and a saprotroph is correct?**
  - (a) A parasite depends upon another organism for food
  - (b) a saprotroph depends upon dead organic matter for food
  - (c) A saprotroph doesn't depend upon other organisms
  - (d) All of the above
5. **A fungus is normally an example of:**
  - (a) A parasite
  - (b) A symbiont
  - (c) A saprotroph
  - (d) All of the above
6. **Pernicious malaria is caused by:**
  - (a) *Plasmodium falciparum*
  - (b) *Plasmodium vivax*
  - (c) *Plasmodium ovale*
  - (d) *Plasmodium malariae*
7. **In *Plasmodium vivax* infection, fever recurs every:**
  - (a) Third day
  - (b) Fourth day
  - (c) Everyday
  - (d) None of the above
8. **In *Plasmodium falciparum* infection, fever recurs every:**
  - (a) Second day
  - (b) Third day
  - (c) Continuously
  - (d) None of the above

9. **Which kind of malaria is most fatal:**
  - (a) Benign tertian
  - (b) Quartan
  - (c) Malignant tertian
  - (d) Mild tertian
10. **Life cycle of *Plasmodium*, completed in human host is:**
  - (a) Schizogony
  - (b) Gamogony
  - (c) Sporogony
  - (d) Gamogony and Sporogony
11. **What is the infective stage of malarial parasite known as:**
  - (a) Merozoite
  - (b) Sporozoite
  - (c) Trophozoite
  - (d) Cryptozoite
12. **Malarial parasite was discovered by:**
  - (a) Robert Koch
  - (b) Ronald Ross
  - (c) A. V. Leeuwenhoek
  - (d) Karl Landsteiner
13. **Malaria is spread by the vector:**
  - (a) Male Anopheles mosquito
  - (b) Female Anopheles mosquito
  - (c) Male Aedes mosquito
  - (d) Female Culex mosquito
14. **Steps to control malaria include:**
  - (a) Control of mosquito population
  - (b) Use of mosquito net
  - (c) Taking the drug containing quinine on the advice of the physician
  - (d) All of the above
15. **Dengue is caused by:**
  - (a) A bacterium
  - (b) A protozoon
  - (c) A virus
  - (d) A fungus
16. **Dengue virus was discovered by:**
  - (a) Ronald Ross
  - (b) Karl Landsteiner
  - (c) Ren Kimura and Susumu Hotta
  - (d) Robert Koch
17. **The genetic material of Dengue virus is:**
  - (a) DNA
  - (b) Negative sense RNA
  - (c) Positive sense RNA
  - (d) DNA-RNA hybrid
18. **The vector of Dengue is:**
  - (a) Anopheles mosquito
  - (b) Aedes mosquito
  - (c) Culex mosquito
  - (d) Housefly
19. **Dengue virus multiplies in:**
  - (a) Skin cells
  - (b) Lung alveolar cells
  - (c) Liver cells
  - (d) Blood cells
19. **The positive sense RNA of Dengue virus:**
  - (a) Acts as an mRNA
  - (b) Forms DNA by reverse transcription
  - (c) Directs the synthesis of viral proteins
  - (d) None of the above



- 20. Chikungunya is caused by a :**  
 (a) Bacterium (b) Virus  
 (c) Protozoon (d) Fungus
- 21. The genetic material of Chikungunya is:**  
 (a) DNA  
 (b) RNA  
 (c) Positive sense RNA  
 (d) Negative sense RNA
- 22. Zika virus was first reported from:**  
 (a) Egypt (b) Uganda  
 (c) Tanzania (d) Japan
- 23. The Zoological name of filarial worm is:**  
 (a) *Wuchereria bancrofti*  
 (b) *Dracunculus medinensis*  
 (c) *Trichinella spiralis*  
 (d) *Ascaris lumbricoides*
- 24. The filarial worm is normally present in :**  
 (a) Blood plasma  
 (b) Lymph vessel  
 (c) Venous blood  
 (d) Arterial blood
- 25. The infective stage of filarial worm is:**  
 (a) First stage microfilariae  
 (b) Second stage microfilariae  
 (c) Third stage microfilariae  
 (d) None of the above
- 26. The filarial worm belongs to the phylum:**  
 (a) Platyhelminthes  
 (b) Annelida  
 (c) Arthropoda  
 (d) Nematelminthes
- 27. Widal test is performed to detect:**  
 (a) Typhoid  
 (b) Scarlet fever  
 (c) Tuberculosis  
 (d) Cancer
- 28. Mantoux test is performed to diagnose:**  
 (a) Typhoid  
 (b) Scarlet fever  
 (c) Tuberculosis  
 (d) Cancer
- 29. Ascaris and Filarial worms are grouped together as:**  
 (a) Flat worms  
 (b) Round worms  
 (c) Ring worms  
 (d) None of the above
- 30. Which of the following is a bacterial disease?**  
 (a) Measles (b) Mumps  
 (c) Malaria (d) Typhoid
- 31. Which of the following is a viral disease?**  
 (a) Tetanus (b) Small pox  
 (c) Cholera (d) Typhoid

- 32. Which of the following causes tuberculosis?**
- (a) *Salmonella*
  - (b) *Streptococcus*
  - (c) *Mycobacterium*
  - (d) *Clostridium*
- 33. Amoebiasis is caused by:**
- (a) *Plasmodium vivax*
  - (b) *Entamoeba coli*
  - (c) *Entamoeba gingivalis*
  - (d) *Entamoeba histolytica*
- 34. Microfilariae are present in the peripheral blood of an infected person:**
- (a) During the day
  - (b) During afternoon
  - (c) During the night
  - (d) All the time
- 35. Which of the following diseases is caused by a nematode parasite?**
- (a) Elephantiasis
  - (b) Amoebiasis
  - (c) Leprosy
  - (d) Typhoid
- 36. Which of the following species of malarial parasite causes cerebral malaria?**
- (a) *Plasmodium vivax*
  - (b) *Plasmodium malariae*
  - (c) *Plasmodium falciparum*
  - (d) *Plasmodium ovale*
- 37. Which of the following is a non-communicable disease?**
- (a) Cholera
  - (b) Chicken pox
  - (c) Polio
  - (d) Rheumatoid fever
- 38. A drug, used to treat filariasis is :**
- (a) Albendazole
  - (b) Atovastatin
  - (c) Rosuvastatin
  - (d) Olmesartan
- 39. Typhoid fever is caused by:**
- (a) *Clostridium*
  - (b) *Mycobacterium*
  - (c) *Salmonella*
  - (d) *Diplococcus*
- 40. Minuta and Magna forms are found in the life cycle of:**
- (a) *Plasmodium vivax*
  - (b) *Entamoeba histolytica*
  - (c) *Wuchereria bancrofti*
  - (d) *Trypanosoma gambiense*
- 41. Ring worm is a :**
- (a) Nematode parasite
  - (b) Helminth parasite
  - (c) Fungal parasite
  - (d) Protozoon parasite
- 42. Ring worm infection is caused by:**
- (a) *Tinea corporis*
  - (b) *Entamoeba coli*
  - (c) *Plasmodium ovale*
  - (d) *Ascaris lumbricoides*

- 43. Dermatophytosis is an alternate name for:**
- (a) Leprosy
  - (b) Chicken pox
  - (c) Xerophthalmia
  - (d) Ring worm infection
- 44. Ring worm infection is diagnosed by:**
- (a) Black light illumination
  - (b) Fungal culture
  - (c) Skin biopsy
  - (d) All of the above
- 45. Ring worm infection spreads by:**
- (a) Blood transfusion
  - (b) Contact with pet animals
  - (c) Person to person contact
  - (d) Drinking contaminated water
- 46. What kind of virus most commonly causes common cold?**
- (a) Rhinovirus
  - (b) Retrovirus
  - (c) Adenovirus
  - (d) Rheovirus
- 47. Allergic cold is mainly due to:**
- (a) Bacteria
  - (b) Virus
  - (c) Overactive immune system
  - (d) None of the above
- 48. Which vitamin is used as a supplement in common cold?**
- (a) Vitamin A      (b) Vitamin B
  - (c) Vitamin C      (d) Vitamin D
- 49. Which of the following does not characterize innate immune system/**
- (a) Quick initiation
  - (b) Broad-based action
  - (c) Absence of memory
  - (d) Secretion of antibody
- 50. The leucocytes that turn into macrophages in the tissues are:**
- (a) Basophils      (b) Monocytes
  - (c) Eosinophils      (d) Neutrophils
- 51. The leucocytes that largely act as phagocytes are:**
- (a) Basophils      (b) Monocytes
  - (c) Neutrophils      (d) Eosinophils
- 52. The leucocytes that engulf helminth larvae are:**
- (a) Eosinophils
  - (b) Monocytes
  - (c) Neutrophils
  - (d) Basophils
- 53. Which of the following is not a lymphoid organ?**
- (a) Thymus
  - (b) Tonsil
  - (c) Peyer's patches
  - (d) Pancreas
- 54. Which of the following is a primary lymphoid organ?**
- (a) Lymph node
  - (b) Thymus
  - (c) Tonsil
  - (d) Spleen

- 55. Which of the following immunoglobulins is high during primary immune response?**
- (a) IgG                      (b) IgA  
(c) IgM                      (d) IgD
- 56. What is principal immunoglobulin in the serum of human ?**
- (a) IgG                      (b) IgA  
(c) IgM                      (d) IgE
- 57. Which of the following immunoglobulins is present in extracellular secretions?**
- (a) IgG                      (b) IgA  
(c) IgM                      (d) IgD
- 58. Which of the following immunoglobulins is involved in allergic reactions?**
- (a) IgG                      (b) IgA  
(c) IgM                      (d) IgE
- 59. Cellular communications during an immune response are executed by:**
- (a) Hormones  
(b) Cytokines  
(c) Carbohydrates  
(d) Nucleoproteins
- 60. Antigens are presented to the T-Helper cells by:**
- (a) Macrophage  
(b) Neutrophil  
(c) Natural killer cell  
(d) B-lymphocyte
- 61. Analogous lymphoid structure to the Bursa of Fabricius of birds in human is:**
- (a) Lymph node  
(b) Spleen  
(c) Thymus  
(d) GALT
- 62. Potential antibody secreting cells are called:**
- (a) T-lymphocytes  
(b) Plasma cells  
(c) Dendritic cells  
(d) Natural killer cells
- 63. Histamine that causes inflammation is secreted by:**
- (a) Neutrophils  
(b) Mast cells  
(c) B-lymphocytes  
(d) Macrophages
- 64. The complementary part of an antigen that binds to an antibody is known as:**
- (a) Paratope                      (b) Isotope  
(c) Epitope                      (d) Prototope
- 65. Immunoglobulins were discovered and characterized by:**
- (a) Gerald Edelman and Rodney Porter  
(b) Cesar Milstein and Georges Kohler  
(c) Paul Ehrlich  
(d) Linus Pauling

- 66. Antibody preparation of a single specificity is known as:**
- (a) Polyclonal antibody
  - (b) Non-specific antibody
  - (c) Membrane bound antibody
  - (d) Monoclonal antibody
- 67. Monoclonal antibody was discovered by:**
- (a) Gerald Edelman and Rodney Porter
  - (b) Cesar Milstein and Georges Kohler
  - (c) Paul Ehrlich
  - (d) Linus Pauling
- 68. MHC class I proteins, expressed on an infected cell surface binds to the T-cell receptor of:**
- (a) B-cell
  - (b) Helper T-cell
  - (c) Cytotoxic T-cell
  - (d) Suppressor T-cell
- 69. MHC class II proteins, expressed on antigen presenting cells and B-cells binds to the T-cell receptor of:**
- (a) Plasma cells
  - (b) Suppressor T-cell
  - (c) Cytotoxic T-cell
  - (d) Helper T-cell
- 70. Monoclonal antibodies are secreted by:**
- (a) Myeloma      (b) Lymphoma
  - (c) Hybridoma    (d) Sarcoma
- 71. An effective vaccine generates:**
- (a) Active acquired immunity
  - (b) Innate immunity
  - (c) Passive acquired immunity
  - (d) Non-adaptive immunity
- 72. Which of the following vaccines is a recombinant DNA vaccine?**
- (a) Polio              (b) Hepatitis B
  - (c) Diphtheria      (d) Pertussis
- 73. Measles, Mumps and Rubella vaccines contain:**
- (a) Viral coat protein
  - (b) Inactivated virus
  - (c) Virus conjugate
  - (d) Attenuated virus
- 74. Which of the following vaccines is a toxoid?**
- (a) Diphtheria      (b) Chicken pox
  - (c) Measles        (d) Polio
- 75. AIDS is due to:**
- (a) Reduction in the number of killer T-cells
  - (b) Autoimmunity
  - (c) Lack of interferon
  - (d) Reduction in the number of helper T-cells
- 76. The genetic material of Human Immunodeficiency Virus is:**
- (a) Double stranded DNA
  - (b) Single stranded DNA
  - (c) Single stranded RNA
  - (d) Double stranded RNA

**77. AIDS spreads through :**

- (a) Transfusion of contaminated blood
- (b) Infected needles and syringes
- (c) Unsafe sexual intercourse
- (d) All of the above

**78. The study of cancer biology is known as :**

- (a) Ethology
- (b) Cytology
- (c) Oncology
- (d) Immunology

**79. Sarcoma is a cancer of :**

- (a) Epithelial tissue
- (b) Connective tissue
- (c) Blood
- (d) Endodermal tissue

**80. Breast cancer is an example of :**

- (a) Adenoma      (b) Lymphoma
- (c) Carcinoma    (d) Sarcoma

**81. The affected cells in leukemia are :**

- (a) Plasma cells
- (b) Leucocytes
- (c) Thrombocytes
- (d) Erythrocytes

**82. Adenoma refers to the cancer of:**

- (a) Glands
- (b) Lymph node
- (c) Blood
- (d) Muscle

**83. The spreading of cancer cells to distant places in the body is known as :**

- (a) Metamorphosis
- (b) Metastasis
- (c) Metagenesis
- (d) Metachrosis

**84. Genes in normal cells that undergo mutation and cause abnormal cell growth and cancer, are known as:**

- (a) Oncogenes
- (b) Regulatory genes
- (c) Inhibitory genes
- (d) Initiation gene

**85. Genes, which counter the abnormal cell growth and tumor formation are known as:**

- (a) Viral protooncogenes
- (b) Tumor suppressor genes
- (c) Cellular protooncogenes
- (d) Structural genes

## ANSWER KEYS

1. (c)	23. (a)	45. (c)	67. (b)
2. (c)	24. (b)	46. (a)	68. (c)
3. (b)	25. (c)	47. (c)	69. (d)
4. (d)	26. (d)	48. (c)	70. (c)
5. (d)	27. (a)	49. (d)	71. (a)
6. (a)	28. (c)	50. (b)	72. (b)
7. (a)	29. (b)	51. (c)	73. (d)
8. (b)	30. (d)	52. (a)	74. (a)
9. (c)	31. (b)	53. (d)	75. (d)
10. (a)	32. (c)	54. (b)	76. (c)
11. (b)	33. (d)	55. (c)	77. (d)
12. (b)	34. (c)	56. (a)	78. (c)
13. (b)	35. (a)	57. (b)	79. (b)
14. (d)	36. (c)	58. (d)	80. (a)
15. (c)	37. (d)	59. (b)	81. (b)
16. (c)	38. (a)	60. (a)	82. (a)
17. (c)	39. (c)	61. (d)	83. (b)
18. (b)	40. (b)	62. (b)	84. (a)
19. (a)	41. (c)	63. (b)	85. (b)
20. (b)	42. (a)	64. (c)	
21. (c)	43. (d)	65. (a)	
22. (b)	44. (d)	66. (d)	

## II. DESCRIPTIVE QUESTIONS WITH ANSWERS

1. Write notes on the following within 50-60 words each:

(a) Cerebral malaria :

**Ans.** Malaria is a disease of the tropical and sub-tropical regions of the world. It's caused by a protozoon parasite, *Plasmodium* and is spread in the community by the vector, female *Anopheles* mosquito. Four species of *Plasmodium* infect human: *Plasmodium vivax*, *P. falciparum*, *P. malariae* and *P. ovale*. The one caused by *P. falciparum* is most life-threatening. This type of malaria is known as cerebral malaria or pernicious malaria. It's cerebral, since the erythrocytes tend to clump into masses in the blood capillaries of the brain, thus occluding the blood vessels and preventing blood drainage to and from the brain. It's again pernicious because the manifestations occur gradually and end up in a fatal consequence. There are neurological, renal and gastro-intestinal manifestations. If an appropriate diagnosis and treatment is not adopted at an appropriate time, the patient may die within 3-4 days.

(b) Dengue:

**Ans.** Dengue is a viral disease prevalent in the tropical regions of the world. It's spread by a mosquito vector, *Aedes aegypti* in the community. Dengue virus (DENV) is a single positive-stranded RNA virus. Symptoms begin to appear between 3-14 days after infection. Symptoms include high fever, head ache, vomiting, muscle and joint pain and skin rash. If a timely diagnosis and proper treatment is undertaken, the patient recovers in less than 7 days. However, in severe conditions, the disease develops into a dengue hemorrhagic fever, resulting in low levels of blood platelets and bleeding. Treatment of dengue is supportive, i.e. adequate fluid is administered through the mouth or intravenously. In acute cases, blood transfusion is undertaken to restore platelet normal number.

(c) Elephantiasis:

**Ans.** Elephantiasis is the enlargement and fibrosis of limbs, external genitalia and other body parts due to oedema, hypertrophy and tissue swelling. Body parts, especially the limbs are enlarged disproportionately by the development of warts. Such limbs are analogous to the limbs of an elephant and hence, the name, elephantiasis. The principal cause of these symptoms is due to obstruction of lymphatic vessels by microfilariae, a larva of a nematode parasite, the filarial worm of the species, *Wuchereria bancrofti* that infects human in the tropical regions of the world.

(d) Pneumonia:

**Ans.** Pneumonia is an infection of the lungs of human that causes an accumulation of fluid, thus obstructing the breathing process. Pneumonia is caused by viruses, bacteria and



fungi. Inflammation of the lining of the airways by allergens (air-borne droplets, spores and dust particles) also contribute to the infection. SARS-CoV-2 that caused the pandemic, Covid-19 has become the principal cause of pulmonary pneumonia in the recent time. *Streptococcus pneumoniae* is a bacterium species that causes bacterial pneumonia. Symptoms include fever, cough with mucous exudate, painful breathing, chest pain, feeling of tiredness and fatigue, loss of appetite and vomiting. Treatment options are antibiotics in mild cases, while severe cases may be treated with oxygen therapy.

**(e) Typhoid:**

**Ans.** Typhoid fever, also known as enteric fever is a disease caused by the bacterium, *Salmonella typhi*. The infection occurs by taking contaminated food and water. Symptoms are high fever, severe weakness, head ache, abdominal pain, vomiting and constipation or diarrhea. Fever starts slowly but increases daily reaching a high of 104 ° F. Diagnosis is made by Widal test. This test is confirmatory and is based on antigen antibody interaction. Typhoid fever is treated with an oral antibiotic, cefixime in combination with ofloxacin. It is prevented by following good hygienic practice, such as taking uncontaminated food and water.

**(f) Ascariasis:**

**Ans.** Ascariasis is caused by a large round worm (nematode) parasite of human, *Ascaris lumbricoides*. This infection is prevalent, where sanitation is poor. The parasite more often infects children than adults. It lives and reproduces in the small intestine of human. The common symptoms of this infection are, abdominal discomfort, intestinal ulcers, cough, fever and bloody sputum. There will be an increased percentage of eosinophils in the blood. Diagnosis is done by microscopic examination of stool. Treatment is undertaken by antiparasitic drugs, such as albendazole, ivermectin and mebendazole. It is prevented by practicing good hygiene sanitation.

**(g) Amoebic dysentery:**

**Ans.** Amoebic dysentery is caused by a protozoon parasite, *Entamoeba histolytica*. It lives in the intestine of human and feeds on the digested food and blood cells. It lays eggs in the intestine of the host. The eggs hatch into two different forms. One form lives in the intestine as usual and the other form bores through the epithelial lining and comes to lie in the connective tissue, where it feeds on tissue debris and blood cells oozing out from the ruptured blood vessels. It encysts there and the cysts are released through the stool of the host for another infection cycle. The symptoms are abdominal pain and bloody stool with mucous. Symptomatic cases are diagnosed and treated with simple medication. The disease is prevented by adopting a good sanitation practice and taking uncontaminated food and water.

**(h) Ringworm:**

**Ans.** Ringworm, also known as dermatophytosis or dermatophyte infection or tinea is a fungal infection that principally infects the skin and causes red or brown coloured ring-shaped rash. Although, the name is worm, it's not a worm, it's a pathogenic fungus. Ringworm infection is identified in accordance with the skin infection of the body part: skin of the body (tinea corporis), scalp (tinea capitis), groin (tinea cruris), etc. The infection causes red to brown itchy skin in a ring shape. It's highly contagious and spreads from place to place in the body of the same person and from person to person through skin contact. The principal treatment option is the use of an antifungal cream or spray.

**(i) Chikungunya:**

**Ans.** Chikungunya infection is caused by a virus (CHIKV) that is transmitted by Aedes sps. mosquito. It's prevalent in parts of the world, where mosquito control and sanitation practice are poor. Symptoms include fever, joint pain, muscle pain, head ache, joint swelling and rash, which are expressed between 2-14 days of exposure. Diagnosis is done by examining the blood sample for the presence of the viral RNA or antibodies formed against the virus. There is no proven treatment. Supportive care and symptomatic treatment improve the situation in a week's time. Best preventive method is the use of mosquito net and eliminating mosquito population.

**(j) Common cold:**

**Ans.** Common cold is a viral infectious disease of the upper respiratory tract, especially the mucosal lining of the nose, throat and larynx. It may also be caused by inhaling allergens that irritates the mucosa to secrete more mucous than normal. The symptoms are running nose, sore throat, coughing and sneezing, head ache and occasional fever. This infection is self-diagnosable and self-treatable. In acute cases, antihistaminic tablets, azithromycin and other broad-spectrum antibiotics are used as treatment options.

**(k) Innate immunity:**

**Ans.** Innate immunity is also known as inborn immunity or non-adaptive immunity or non-specific immunity. It's present right from the birth in all individuals. It is a broad-spectrum immunity that acts as the first line of defense in all individuals. This mechanism is non-specific in the sense that this can act against any invasion in a similar manner in all individuals. It is again, non-adaptive, i.e. it doesn't require a prior exposure to a pathogen for its operation. Alternately speaking, it does not restore any engagement in memory. General body surface, different types of leucocytes, hypersensitivity responses are among a few examples.

**(l) Acquired immunity:**

**Ans.** Acquired immunity is also known as adaptive immunity or specific immunity. It is the principal defense mechanism of the body. The immune system is triggered by the exposure of the body to a foreign substance or antigen. Different types of lymphocytes with specific structures and functions are formed from the common pool of lymphocytes. These are T- and B- lymphocytes, which have different functions. Along with these, memory lymphocytes are also formed, which preserve the memory of exposure to the foreign substance for a very long time period. In case of subsequent exposures, the system fixes the foreign substance in an electrifying speed. Acquired immunity is of two types: active and passive. In active acquired immunity, the system is made to learn about the defense mechanism from the exposure to the antigen. In the passive one, tailor-made defense molecules are administered to fix the foreign substance that enters into the body.

**(m) Humoral immunity:**

**Ans.** Humoral immunity is conferred by the antibodies synthesized by the plasma cells, which are differentiated from B-lymphocytes. B-lymphocytes (B for Bursa of Fabricius of birds) are named so because the bone marrow lymphocytes become competent only after passing through the Gut Associated Lymphoid Tissues (GALT / Peyer's patches), an analogous structure of Bursa of Fabricius of birds. Competence, in this context, refers to the ability of the B-lymphocytes to secrete complementary antibodies to the exposed antigen. The B-lymphocytes then differentiate into a potential antibody secreting cells, plasma cells. Plasma cells secrete antibodies having a complementarity to the antigen.

**(n) Cell-mediated immunity:**

**Ans.** Cell-mediated immunity refers to conferring of immunity by competent T-lymphocytes. The incompetent bone marrow lymphocytes choose one of the two routes for acquiring immunological competence. Those lymphocytes, which pass through the thymus turn into competent T-lymphocytes. These diversify functionally into two types: T<sub>HELPER</sub> lymphocytes (T<sub>H</sub>) and T<sub>KILLER</sub>/T<sub>CYTOTOXIC</sub> lymphocytes (T<sub>K</sub> / T<sub>C</sub>). T<sub>H</sub> cells patrol and detect the presence of foreign antigens, if any, and alert the immune system. It again cooperates with the B-lymphocytes for its differentiation into a potential antibody secreting plasma cell. T<sub>K</sub> / T<sub>C</sub> attack intruding cells directly, having evil intentions and destroy these by lysis.

**(o) T-helper lymphocyte (T<sub>H</sub>):**

Refer to the description at (n) for tips

**(p) T-killer lymphocyte (T<sub>K</sub>):**

Refer to the description at (n) for tips

**(q) Memory lymphocyte ( $T_M$ ):**

**Ans.** Memory is a distinguishing feature of the acquired immune system. Memory in this context refers to storing the first exposure information to a pathogen in a specific type of cell called memory cell and retrieving and sharing this information with the immunologically competent cells so as to engage the pathogen quickly and specifically. Humoral and cell-mediated immune systems store this vital information in the genetic material in the form of B-memory and T-memory lymphocytes, respectively. This is very crucial to the immune system because memory cells waste no time in the preparation of combat.

**(r) Vaccine:**

**Ans.** A vaccine is an agent or constituents of an agent, which on administration into the body of a subject confers a long term and specific immunity against an infectious disease. Application of vaccines to a population is known as vaccination or active immunization programme, which generates a long-term protection against a specific disease in the population. The experimental foundation of the concept of vaccine was laid by Edward Jenner in 1796. He demonstrated that people infected with cow pox virus induced a long-term protection against the deadly small pox virus. Vaccines are classed as: inactivated, live attenuated, toxoids, capsular polypeptides, sub-unit parts of a virus, recombinant vaccines, etc. The mass vaccination programme against Covid 19 could contain the pandemic. The Government undertakes such mass vaccination programmes, as a part of social welfare programme to contain and / or eradicate communicable diseases from the society

**(s) Cancer:**

**Ans.** Cancer is an uncontrolled cell growth in any part of the body that generates a tumor. It has been established that the regulation mechanism of the cell division process is lost by genetic changes through mutation. The turning on of a normal cell into a cancer cell is known as transformation. A cancer cell has specific property of loss of contact inhibition i.e. it loses contact with other cells, invades the connective tissue capsule and enters into the circulatory system. It's carried by the blood and forms a tumor, wherever it settles. This property is known as metastasis. All cells have specific genes called proto-oncogenes. These genes normally do not express. However, some agents turn the protooncogenes into oncogenes, which express specific proteins known as oncoproteins. The oncoproteins turn a normal cell into a cancer cell. This apart, there are some genes, known as tumor suppressor genes, which suppress a cell from becoming a cancer cell. A mutation in this gene encourages a normal cell to transform into a cancer cell. Some common cancers in human are sarcoma (cancer of connective tissue), Carcinoma (cancer of epithelial tissue), Lymphoma (cancer of lymphoid organs), Leukemia (cancer of blood), osteosarcoma (cancer of bone) and adenoma (cancer of glands).

**(t) HIV and AIDS:**

**Ans.** Human immunodeficiency virus (HIV) causes acquired immunodeficiency syndrome (AIDS) in human. It is a retrovirus with RNA as its genetic material. The immune system of the infected person is gradually compromised giving way to many opportunistic infections. T-helper lymphocyte population in persons with AIDS decreases to such a low that the functioning of the immune system is severely impaired. It's transmitted through unprotected sexual intercourse, blood transfusion, mother to the baby through placenta and mother's milk. There is no effective treatment. However, the progression from HIV to AIDS can be managed with antiviral drugs, such as inhibitors of viral binding to the cell (Dextran sulfate), reverse transcriptase inhibitor (Azidothymidine, Dioxycytosine and Phosphonoformate). Without an effective management, the average survival time with HIV infection is 9-11 years. It can be prevented by an appropriate education and awareness.

**(u) Adolescence:**

**Ans.** Adolescence is a crucial phase in human life between childhood and adulthood, i.e. between 10 and 19 years of age. This phase is characterized by distinct physical, physiological and psychological changes. It's an important transition in life that may lead to worst or best part of life later based on the degree of care and management given by the parents and the society.

**(v) Drug and Alcohol abuse:**

**Ans.** Drug intake and alcoholism has become a common social stigma in the present days. This problem has acquired a menacing dimension especially among the adolescents. The principal cause of this stigma is a change in the life style. People are bent upon for an easy-go life. It will be not wrong to say that a section of the population has used the youth power to act in its favour and in the bargain has made them addicted to drugs and alcohol. May be, they do not know the dreaded consequences of the addictions in the long run. When they know about the evil consequences, it's of no avail. The adolescents may be kept at a bay from this evil by a proper care and share act of the parents and the society and a proper moral education, which seems to be far reaching, since it has already acquired an epidemic dimension.

\*\*\*

## CHAPTER - 10

# MICROBES IN HUMAN WELFARE

## MULTIPLE CHOICE QUESTIONS (MCQ)

Choose the correct answer :

1. Yogurt is fermented from milk by:  
(a) *Streptococcus thermophilus*  
(b) *Leuconostoc citrovorum*  
(c) *Lactobacillus acidophilus*  
(d) *Streptococcus lactis*
2. Which of the following microorganisms is used in the production of blue cheese?  
(a) *Streptococcus thermophilus*  
(b) *Lactobacillus bulgaris*  
(c) *Penicillium roqueforti*  
(d) *Rhizopus stolonifer*
3. Which of the following products is produced from yeast cell crops harvested from vats?  
(a) Alcoholic beverages  
(b) Enzymes  
(c) Antibiotics  
(d) Organic acids
4. Which of the following microorganisms has high vitamin content?  
(a) Bacteria (b) Yeast  
(c) Algae (d) Protozoa
5. Which of the following produces citric acid?  
(a) *Aspergillus*  
(b) *Pseudomonas*  
(c) *Saccharomyces*  
(d) *Clostridium*
6. Which of the following microorganisms in symbiotic association with *Azolla* is nitrogen fixing?  
(a) *Frankia* (b) *Tolypothrix*  
(c) *Spirulina* (d) *Anabaena*
7. Which of the following is used as a biofertilizer in soya bean crop cultivation?  
(a) *Rhizobium* (b) *Azotobacter*  
(c) *Nostoc* (d) *Azospirillum*
8. A common biopesticide used for protecting plants from butterfly caterpillars is:  
(a) *Trichoderma*  
(b) *Baculovirus*  
(c) *Glomus*  
(d) *Bacillus thuringiensis*
9. Yeast is used for the production of:  
(a) Tetracycline (b) Butanol  
(c) Ethanol (d) Citric acid

10. Which of the following algae can be consumed by human as food?
- Chlorella*
  - Polysiphonia*
  - Ulothrix*
  - Spirogyra*
11. Which of the following microorganisms is not used as a biofertilizer?
- Rhizobium*
  - Nostoc*
  - Mycorrhiza*
  - Agrobacterium*
12. Find the incorrectly matched pair:
- Serratia* - Drug addiction
  - Spirulina* - Single cell protein
  - Rhizobium* - Biofertilizer
  - Streptomyces* - Antibiotic
13. *Trichoderma harzianum* is used for:
- Bioremediation of contaminated soil
  - Gene transfer in plants
  - Reclamation of wasteland
  - Biological control of soil-borne plant pathogens
14. Which of the following organisms is used in alcoholic fermentation?
- Pseudomonas*
  - Aspergillus*
  - Saccharomyces*
  - Penicillium*
15. Common food poisoning microorganisms are :
- Clostridium* and *Salmonella*
  - Clostridium* and *Escherichia coli*
  - Escherichia coli* and *Salmonella*
  - Clostridium* and *Streptococcus*
16. Prior to antibiotic discovery, a common antibacterial agent in use was:
- Penicillin
  - Prontosil
  - Streptomycin
  - Kanamycin
17. *Azolla pinnata* is a good biofertilizer for its symbiotic association with:
- Nitrogen fixing bacteria
  - Nitrogen fixing cyanobacteria
  - Mycorrhiza
  - Klebsiella
18. Which of the following is a non-symbiotic biofertilizer?
- Mycorrhiza*
  - Azotobacter*
  - Anabaena*
  - Rhizobium*
19. Nitrogen fixation in the root nodule of *Alnus* is brought about by:
- Frankia*
  - Azorhizobium*
  - Bradyrhizobium*
  - Clostridium*

20. Which of the following vitamin content increases following the conversion of milk into curd by lactic acid bacteria?
- (a) Vitamin A      (b) Vitamin B12  
(c) Vitamin C      (d) Vitamin D
21. Waste water treatment generates a large quantity of sludge, which is treated by:
- (a) Anaerobic digestion  
(b) Floe  
(c) Chemicals  
(d) Oxidation in oxidation pond
22. Methanogenic bacteria are not found in :
- (a) Rumen of cattle  
(b) Gobar gas plant  
(c) Bottom of water-logged paddy field  
(d) Activated sludge
23. The primary treatment of waste water involves the removal of:
- (a) Dissolved impurities  
(b) Suspended particles  
(c) Toxic substances  
(d) Harmful bacteria
24. BOD of waste water is measured by measuring the amount of:
- (a) Total organic matter  
(b) Biodegradable organic matter  
(c) Oxygen evolution  
(d) Oxygen consumption
25. The free-living fungus, *Trichoderma* can be used for:
- (a) Killing insects  
(b) Biological control of plant diseases  
(c) Controlling butterfly caterpillars  
(d) Producing antibiotics
26. Mycorrhiza does not help the host plant in :
- (a) Enhancing its phosphorus uptake capacity  
(b) Increasing its tolerance to drought  
(c) Enhancing its resistance to root pathogens  
(d) Enhancing its resistance to insects
27. Which one of the following is not a nitrogen fixing organism?
- (a) *Anaebena*  
(b) *Nostoc*  
(c) *Azotobacter*  
(d) *Pseudomonas*
28. Which of the following soil bacteria is phosphate solubilizing:
- (a) *Anaebena*  
(b) *Frankia*  
(c) *Pseudomonas sps*  
(d) *Azotobacter*
29. The microbiocidal biochemicals, synthesized and secreted by some microorganisms into the growth medium are known as:
- (a) Antiseptics      (b) Antibiotics  
(c) Antacids      (d) Antibodies



- 30. Streptomycin is obtained from:**
- (a) *Streptomyces griseus*
  - (b) *Streptomyces rimosus*
  - (c) *Streptomyces venezuelae*
  - (d) *Streptomyces coelicolor*
- 31. Chloramphenicol is isolated from a culture of:**
- (a) *Streptomyces griseus*
  - (b) *Streptomyces venezuelae*
  - (c) *Streptomyces rimosus*
  - (d) *Streptomyces albidoflavus*
- 32. Which of the following does not have biopesticide property?**
- (a) *Trichoderma harzianum*
  - (b) *Bacillus thuringiensis*
  - (c) *Xanthomonas campestris*
  - (d) *Baculovirus*
- 33. Statins for lowering blood cholesterol level are extracted from:**
- (a) Algae                      (b) Bacteria
  - (c) Virus                      (d) Yeast
- 34. *Monascus purpureus*, a species of yeast is commercially used for the extraction of:**
- (a) Citric acid
  - (b) Ethanol
  - (c) Statin
  - (d) Streptokinase
- 35. The purpose of biological treatment of waste water is to:**
- (a) Decrease BOD
  - (b) Increase BOD
  - (c) Reduce sedimentation
  - (d) Increase sedimentation
- 36. The mass of bacteria held together by slime and fungal filaments is known as:**
- (a) Primary sludge
  - (b) Floe
  - (c) Activated sludge
  - (d) Anaerobic sludge
- 37. Biogas production is:**
- (a) Aerobic                      (b) Anaerobic
  - (c) Oxidative                      (d) Conjugative
- 38. Methanogenic microorganisms, growing anaerobically on cellulosic material, produce:**
- (a) Methane
  - (b) Methane and Carbon Dioxide
  - (c) Methane and Hydrogen
  - (d) Methane, Carbon Dioxide and Hydrogen
- 39. Biogas is produced by:**
- (a) Aerobic breakdown of biomass
  - (b) Anaerobic breakdown of biomass
  - (c) Burning of biomass
  - (d) Extreme pressure of the topsoil on the buried biomass

40. **Nif genes occur in:**
- (a) *Penicillium*
  - (b) *Aspergillus*
  - (c) *Rhizobium*
  - (d) *Streptococcus*
41. **The term antibiotic was introduced by:**
- (a) Alexander Fleming
  - (b) Louis Pasteur
  - (c) Joseph Lister
  - (d) Selman Waksman
42. **Usnic acid, an antibiotic is derived from:**
- (a) Fungi                      (b) Bacteria
  - (c) Lichens                      (d) Algae
43. **Which of the following compounds is produced by *Arabia gossopae* :**
- (a) Riboflavin      (b) Steroid
  - (c) Statin              (d) Lycin
44. **In the industrial production of Streptomycin, the secondary metabolite is:**
- (a) Vitamin B12      (b) Vitamin C
  - (c) Vitamin B6      (d) Ethanol
45. **Penicillin is commercially produced by:**
- (a) *Penicillium notatum*
  - (b) *Penicillium chrysogenum*
  - (c) *Penicillium citrinum*
  - (d) *Penicillium roqueforti*
46. **Thermoresistant bacteria are used in the preservation of food by:**
- (a) Freezing
  - (b) Canning
  - (c) Using chemical preservatives
  - (d) Irradiation
47. **Vitamin B12 can be estimated by using the microorganism:**
- (a) *Pseudomonas sps.*
  - (b) *Lactobacillus leichmanni*
  - (c) *Bacillus subtilis*
  - (d) *Escherichia coli*
48. **In commercial production of ethanol, the raw material used is:**
- (a) Molasses
  - (b) Cellulose
  - (c) Sulfite waste liquor
  - (d) Paddy waste
49. **L-Lysine is produced from:**
- (a) *Corynebacterium glutamicum*
  - (b) *Agrobacterium sps*
  - (c) *Mycobacterium sps*
  - (d) *Phosphobacteria*
50. **Which of the following microorganisms is used in Amylase production:**
- (a) *Bacillus subtilis*
  - (b) *Saccharomyces cerevieae*
  - (c) *Aspergillus niger*
  - (d) *Mucor fragilis*

- 51. Pectinase is commercially produced from:**
- (a) *Saccharomyces cerevisiae*
  - (b) *Trichoderma koningi*
  - (c) *Aspergillus niger*
  - (d) *Corynebacterium glutamicum*
- 52. Cellulase is produced from :**
- (a) *Saccharomyces cerevisiae*
  - (b) *Trichoderma koningi*
  - (c) *Aspergillus niger*
  - (d) *Corynebacterium glutamicum*
- 53. Vitamin B12 is produced industrially from:**
- (a) *Propionibacterium sps*
  - (b) *Pseudomonas sps*
  - (c) Both (a) & (b)
  - (d) None of the above
- 54. Citric acid is produced under aerobic condition from:**
- (a) *Aspergillus*
  - (b) *Penicillium*
  - (c) *Mucor*
  - (d) All of the above
- 55. *Clostridium acetobutylicum* is used for the production of:**
- (a) Acetone and Butanol
  - (b) Ethanol
  - (c) Vitamin B12
  - (d) Citric acid
- 56. *Spirulina* is:**
- (a) Edible fungus
  - (b) Biofertilizer
  - (c) Single cell protein
  - (d) Biopesticide
- 57. The weed that can be used in biogas production is:**
- (a) *Hydrilla*
  - (b) *Solanum nigrum*
  - (c) *Eichhornia crassipes*
  - (d) *Parthenium hysterophorus*
- 58. The insecticidal crystalline protein that kills insect pest larvae is produced by:**
- (a) *Bacillus thuringiensis*
  - (b) *Pseudomonas syringae*
  - (c) *Aspergillus niger*
  - (d) *Saccharomyces cerevisiae*
- 59. Lactic acid bacteria convert milk into curd and improves its nutritional value by enhancing:**
- (a) Vitamin A      (b) Vitamin B
  - (c) Vitamin C      (d) Vitamin D
- 60. Which of the following is produced by the action of anaerobic bacteria on sewage:**
- (a) Mustard gas
  - (b) Marsh gas
  - (c) Laughing gas
  - (d) Propane

## ANSWER KEYS

- |         |         |         |
|---------|---------|---------|
| 1. (a)  | 21. (a) | 41. (d) |
| 2. (c)  | 22. (d) | 42. (c) |
| 3. (a)  | 23. (b) | 43. (a) |
| 4. (b)  | 24. (d) | 44. (a) |
| 5. (a)  | 25. (b) | 45. (b) |
| 6. (d)  | 26. (a) | 46. (b) |
| 7. (a)  | 27. (d) | 47. (b) |
| 8. (d)  | 28. (c) | 48. (c) |
| 9. (c)  | 29. (b) | 49. (a) |
| 10. (a) | 30. (a) | 50. (a) |
| 11. (d) | 31. (b) | 51. (c) |
| 12. (a) | 32. (c) | 52. (b) |
| 13. (d) | 33. (d) | 53. (c) |
| 14. (c) | 34. (c) | 54. (d) |
| 15. (a) | 35. (a) | 55. (b) |
| 16. (b) | 36. (b) | 56. (c) |
| 17. (b) | 37. (b) | 57. (b) |
| 18. (b) | 38. (d) | 58. (a) |
| 19. (a) | 39. (b) | 59. (b) |
| 20. (b) | 40. (c) | 60. (b) |

## II. DESCRIPTIVE QUESTIONS WITH ANSWERS

1. Write notes on the following within 50-60 words each:

(a) Microbes in food processing:

**Ans.** Food processing is a process of making food from raw food ingredients by physical and chemical processes. Food is processed in every households as well as in industry for commercial benefits. Where-ever the food is processed, microbes play an important role in it. Microbes are used in the fermentation process. Mankind has been using yeast, moulds and bacteria in making food products, such as bread, beer, wine, vinegar, yoghurt and cheese. *Lactobacillus bulgaricus* is used in fermenting curd from milk. Microbes are also used to process fish, meat and vegetables.

(b) Microbes in industrial production:

**Ans.** Microbes are used in the industrial production of a score of beneficial products. Antibiotics like penicillin (from *Penicillium notatum*), streptomycin (from *Streptomyces griseus*), tetracycline (from *Streptomyces auriofaciens*), chloramphenicol (from *Streptomyces venezuelae*) and many more are industrially produced by using microorganisms. Curd, cheese and yoghurt are produced commercially by using microorganisms. Many organic acids, like lactic acid, citric acid, gluconic acid and fumaric acid are produced by microbial fermentation. Enzymes, like amylase, protease, pectinase, lipase and cellulase are industrially produced by using microorganisms.

(c) Microbes in sewage treatment:

**Ans.** A large volume of waste water, known as sewage is generated everyday from the cities, towns and urban settlements. It is one of the causes of environmental pollution in urban areas. Conventional treatment of the sewage is less effective. Sewage contains many biodegradable organic compounds. Many species of bacteria and protists have the ability to break down these compounds into simpler and harmless ones. In large urban areas, these microbes are supplied with nutrients, oxygen and other essential elements in a large container, known as a bioreactor containing sewage and stirred continuously. The harmful dissolved compounds degrade and precipitate out. The precipitate is separated from the water and the water is subjected to another treatment releasing comparatively less harmful water that may be reused in several activities.

**(d) Microbes in energy generation:**

**Ans.** Energy is at the centerstage of all life processes. Mankind has been using two energy resources: conventional (non-renewable) and non-conventional (renewable). Non-conventional (renewable) energy sources will be the energy sources of the future. One such source is biogas. Energy in the form of biogas is generated from urban waste and cow dung by using methane producing (methanogenic) bacteria in large vessels called bioreactors. Man has been using biogas for over 200 years now. However, modern practice using methanogenic bacteria in bioreactors is profit-effective. Another technology, known as land-fill technology is adopted in large urban areas, where the volume of solid waste is very large. The waste is dumped in a shallow abandoned land and is covered by soil on top. Anaerobic bacteria undertake digestion of complex organic compounds and generate biogas, which is released and collected through a vent made at the top of the soil cover.

**(e) Biocontrol agents:**

**Ans.** Several microorganisms have an intrinsic ability to act on crop pests and kill them. *Bacillus thuringiensis*, a soil bacterium synthesizes a crystalline protein, known as *Bt* protein that acts on some insect pests and kills them. This finding has inspired to create transgenic crop plants containing *Bt* protein gene. These transgenic plants are resistant to the attack of some insect pests. Baculoviruses are rod-shaped DNA viruses that can infect and kill the larval stages of some insect pests. These biological agents are known as biocontrol agents or biopesticides.

**(f) Biofertilizer:**

**Ans.** Biofertilizers are biologically active products, including microorganisms (bacteria, algae and fungi), which provide nutrients to plants. Most biofertilizers belong to one of the two categories of microorganisms: nitrogen fixing and phosphate solubilizing. Nitrogen fixing bacteria, such as *Rhizobium*, *Frankia*, *Azotobacter*, *Azospirillum*, *Klebsiella* and blue-green algae (BGA or Cyanobacteria) and phosphate solubilizing bacteria of the class, phosphobacteria, such as *Pseudomonas putida* and *Bacillus megaterium* are packaged in a carrier material, preferably sterile soil and sold in the market as a biofertilizer.

**(g) Antibiotic production:**

Refer to the description at (b).

\*\*\*

## CHAPTER - 11 & 12

# BIOTECHNOLOGY AND ITS APPLICATIONS

## MULTIPLE CHOICE QUESTIONS (MCQ)

Choose the correct answer :

1. **The resultant DNA formed by a method of combining DNA of two species is known as:**
  - (a) Gene Amplification
  - (b) Recombinant DNA Technology
  - (c) Crossingover
  - (d) Genetic Counseling
2. **Construction of recombinant DNA involves:**
  - (a) Cleavage and rejoining of DNA fragments with restriction endonuclease.
  - (b) Cleavage of DNA into fragments with restriction endonuclease and then rejoining the fragments with DNA ligase.
  - (c) Cleavage and rejoining of DNA fragments with DNA ligase.
  - (d) Cleavage of DNA into fragments with DNA ligase and then rejoining the fragments with restriction endonuclease.
3. **Technique of synthesizing polydeoxyribonucleotide was developed by:**
  - (a) Barbera McClintock
  - (b) J. D. Watson
  - (c) Frederick Sanger
  - (d) Har Gobind Khorana
4. **Which of the following functional gene was synthesized by Har Gobind Khorana:**
  - (a) *E. coli* tyrosine tRNA gene
  - (b) Yeast alanine tRNA gene
  - (c) Yeast alanine mRNA gene
  - (d) *E. coli* tyrosine mRNA gene
5. **The first-ever recombinant DNA was constructed by:**
  - (a) Boliver and Rodriguez
  - (b) Werner Arber and Hamilton Smith
  - (c) O. T. Avery and MacLeod
  - (d) Herbert Boyer and Stanley Cohen
6. **The first-ever recombinant DNA was constructed in:**
  - (a) 1962
  - (b) 1972
  - (c) 1982
  - (d) 1992
7. **Which of the following observations was made by Avery, MacLeod and Mc Carty?**
  - (a) DNA is a duplex molecule
  - (b) DNA can be taken up by cells from the medium
  - (c) DNA can denature at higher temperature
  - (d) DNA is more stable than RNA

8. **Manipulation of DNA to change its nucleotide sequence is known as:**
- (a) Genetic Engineering
  - (b) Genetic Counseling
  - (c) Genetic Fingerprinting
  - (d) Genetic Sequencing
9. **Nucleic acid fragments of differing lengths are separated from each other by a technique, known as:**
- (a) Chromatography
  - (b) Colorimetry
  - (c) Electrophoresis
  - (d) Spectrophotometry
10. **The technique of transfer of DNA fragments from an agarose gel slab on to a nylon membrane is known as:**
- (a) Northorn Blotting
  - (b) Eastern Blotting
  - (c) Western Blotting
  - (d) Southern Blotting
11. **The technique of transfer of protein molecules from a polyacrylamide gel slab on to a membrane is known as :**
- (a) Northorn Blotting
  - (b) Southern Blotting
  - (c) Western Blotting
  - (d) Dot Blotting
12. **Which of the following enzymes is identified as molecular scissors:**
- (a) Polymerases
  - (b) Endonucleases
  - (c) Ligases
  - (d) Exonucleases
13. **Which of the following enzymes is identified as molecular glue:**
- (a) Polymerases
  - (b) Endonucleases
  - (c) Ligases
  - (d) Exonucleases
14. **The principal function of DNA polymerase I is:**
- (a) Proofreading following DNA replication
  - (b) Joining of two DNA fragments
  - (c) Excision of one by one nucleotides from one prime end of DNA
  - (d) Extension of DNA in replication
15. **Class II restriction endonucleases recognize and cut palindromic sequences generating:**
- (a) Cohesive ends only
  - (b) Overhanging complementary ends only
  - (c) Flush ends only
  - (d) All of the above
16. **The first restriction endonuclease, Hind II was isolated and characterized by:**
- (a) Hamilton O. Smith, Thomas Kelly and Kent Wilcox
  - (b) Werner Arber
  - (c) Daniel Nathans
  - (d) Herbert Boyer



17. **The restriction endonucleases used in molecular cloning process recognize short nucleotide sequences, known as :**
- (a) Palindromic sequence
  - (b) Repetitive sequence
  - (c) Minisatellite sequence
  - (d) Microsatellite sequence
18. **A pair of Class II restriction endonucleases that recognize similar palindromic sequences but cut at different sites are known as:**
- (a) Isocaudomers
  - (b) Neoschizomers
  - (c) Isoschizomers
  - (d) Isodimers
19. **The breaking of the hydrogen bonds holding two complementary strands of a DNA so as to form single polynucleotide strands is known as:**
- (a) Renaturation
  - (b) Regeneration
  - (c) Reassociation
  - (d) Denaturation
20. **Circular Prokaryotic vector DNA for carrying donor DNA inserts for cloning are known as:**
- (a) Chromosomal DNA
  - (b) Plasmid DNA
  - (c) Mitochondrial DNA
  - (d) Chloroplast DNA
21. **A suitable vector DNA for carrying a donor DNA insert needs to have:**
- (a) An origin of replication only
  - (b) Marker genes only
  - (c) One or many restriction sites only
  - (d) All of the above
22. **Restriction endonucleases are named so because these:**
- (a) Restrict the replication and growth of external DNA following its entry
  - (b) Restrict the entry of external DNA
  - (c) Restrict the release of external DNA following its entry
  - (d) All of the above
23. **The genomic DNA of the prokaryotic cell is protected from the destructive action of its own restriction endonucleases by:**
- (a) Methylation of specific nucleotides in the recognition sequence
  - (b) Acetylation of specific nucleotides in the recognition sequence
  - (c) Hydroxylation of specific nucleotides in the recognition sequence
  - (d) Hydrogenation of specific nucleotides in the recognition sequence

**24. Restriction modification system of bacteria consists of:**

- (a) Restriction endonuclease and DNA Ligase
- (b) Restriction endonuclease and DNA Polymerase
- (c) Restriction endonuclease and Methyl Transferase
- (d) Restriction endonuclease and RNA Polymerase

**25. Nucleotide elongating enzymes are known as:**

- (a) Ligases
- (b) Endonucleases
- (c) Exonucleases
- (d) Polymerases

**26. The genetically engineered cloning vector, pBR322 was constructed by:**

- (a) Werner Arber and Stuart Linn
- (b) J. D. Watson and F. H. C. Crick
- (c) Boliver and Rodriguez
- (d) Hamilton O. Smith and Daniel Nathans

**27. The principal DNA replicating enzyme in *Escherichia coli* is:**

- (a) DNA Polymerase I
- (b) DNA Polymerase II
- (c) DNA Polymerase III
- (d) RNA dependent DNA Polymerase

**28. Which of the following enzymes catalyzes DNA synthesis on an RNA template?**

- (a) DNA dependent RNA Polymerase
- (b) DNA dependent DNA Polymerase
- (c) RNA dependent RNA Polymerase
- (d) RNA dependent DNA Polymerase

**29. Reverse transcriptase was isolated and characterized by:**

- (a) David Baltimore and Howard Temin
- (b) J.D. Watson and F. H. C. Crick
- (c) Paul Berg and Stanley Cohen
- (d) Werner Arber and Hamilton O. Smith

**30. The resultant cloning vector formed by the integration of the cohesive site of lambda bacteriophage DNA into a plasmid is known as bacterial:**

- (a) Cosmid      (b) Phasmid
- (c) Phagemid    (d) Ti plasmid

**31. Plasmids that can integrate into bacterial genomic DNA are called:**

- (a) Cosmids
- (b) Episomes
- (c) Phagemids
- (d) Phage

**32. A cloning vector that can be used in both *E.coli* and yeast host cells:**

- (a) Lambda bacteriophage
- (b) Cosmid
- (c) Shuttle vector
- (d) Artificial chromosome

- 33. The expression plasmid vector is characterized by the presence of:**
- (a) Promotor and Terminator sequences
  - (b) Promoter sequence only
  - (c) Terminator sequence only
  - (d) None of the above
- 34. The uptake of recombinant plasmids by bacterial host cells is known as:**
- (a) Transfection
  - (b) Transfusion
  - (c) Transduction
  - (d) Transformation
- 35. The uptake of viral DNA by mammalian host cells is known as:**
- (a) Transfection
  - (b) Transfusion
  - (c) Transduction
  - (d) Transformation
- 36. Polymerase Chain Reaction was discovered by :**
- (a) Daniel Nathan
  - (b) Karry Mullis
  - (c) Hamilton Smith
  - (d) Herbert Boyer
- 37. The mechanical device that is used to amplify a DNA fragment by PCR is:**
- (a) Colorimeter
  - (b) Transilluminator
  - (c) Thermocycler
  - (d) Spectrophotometer
- 38. The thermostable DNA Polymerase used in Polymerase Chain Reaction is isolated from:**
- (a) *Thermus aquaticus*
  - (b) *Saccharomyces cerevisiae*
  - (c) *Escherichia coli*
  - (d) *Pseudomonas syringae*
- 39. Transfer of a DNA fragment into a host cell with a glass micropipette is known as:**
- (a) Electroporation
  - (b) Lipofection
  - (c) Microinjection
  - (d) Biolistic
- 40. Transfer of a donor DNA fragment into a plant cell protoplast by short pulses of electric current is known as:**
- (a) Electroporation
  - (b) Lipofection
  - (c) Microinjection
  - (d) Transfection
- 41. Transferring a DNA fragment into a host cell by a gene gun is known as:**
- (a) Electroporation
  - (b) Lipofection
  - (c) Microinjection
  - (d) Biolistic
- 42. The plasmid that is generally used for gene manipulation in plant cells is:**
- (a) Resistance plasmid
  - (b) Tumor inducing plasmid
  - (c) Colicinogenic plasmid
  - (d) pBR322

- 43. Which of the following bacterium is a natural genetic engineer?**
- (a) *Escherichia coli*
  - (b) *Clostridium titani*
  - (c) *Mycobacterium leprae*
  - (d) *Agrobacterium tumefaciens*
- 44. A gene library that represents all genes of a cell is:**
- (a) Genomic DNA library
  - (b) cDNA library
  - (c) Replicated gene library
  - (d) Junk DNA library
- 45. The gene library that represents all the expressed genes of a cell is:**
- (a) Genomic DNA library
  - (b) cDNA library
  - (c) Replicated gene library
  - (d) Junk DNA library
- 46. The first recombinant therapeutic molecule approved for human use is :**
- (a) Growth hormone
  - (b) Hirudin
  - (c) Parathyroid hormone
  - (d) Insulin
- 47. The biotechnological firm that manufactured first human insulin :**
- (a) Aventis            (b) EliLily Corpn.
  - (c) Monsanto        (d) DuPont
- 48. A plant cell product whose cell wall is digested is known as:**
- (a) Protoplast
  - (b) Nucleus
  - (c) Cytoplasm
  - (d) Plasma membrane
- 49. A laboratory technique, by which a meristematic part of a plant develops root and shoot forming a plantlet.**
- (a) Fertilization
  - (b) Mutation
  - (c) Transformation
  - (d) Micropropagation
- 50. The mass of undifferentiated plant cells formed in a plant tissue culture media is known as :**
- (a) Callus            (b) Protoplast
  - (c) Plantlet        (d) Meristem
- 51. Golden rice is produced by engineering a gene into rice plant cells:**
- (a) Cholecalciferol
  - (b) Nicotinamide
  - (c) Ascorbic acid
  - (d)  $\beta$  Carotene
- 52. Antibody preparation of a single specificity is known as:**
- (a) Primary antibody
  - (b) Polyclonal antibody
  - (c) Monoclonal antibody
  - (d) Secondary antibody

53. A plant or animal, generated by transferring a beneficial foreign gene into a cell is :
- Transfecting
  - Transducing
  - Transgenic
  - Transacting
54. Deficiency of the enzyme, adenosine deaminase causes a genetic disorder:
- SCID
  - DMD
  - Cystic Fibrosis
  - Familial Hypercholesterolemia
55. *Bt* protein is used as a:
- Biofertilizer
  - Biopesticide
  - Bioactivator
  - Biotransformer
56. The prefix *Bt* in *Bt* protein is synonymous with :
- Bacillus thuringiensis*
  - Biotechnology
  - Biotransformation
  - Biological technique
57. The delayed ripening variety of tomato is raised by:
- Ribozyme technology
  - Induced mutation
  - Antisense RNA technology
  - Polyploidy
58. Recombinant Hepatitis B vaccine is produced by:
- Cloning of DNA
  - Cloning of RNA
  - Cloning of the whole virus
  - Cloning of coat protein of the virus
59. The first Covid-19 DNA vaccine manufactured by recombinant DNA technology and approved for human use is:
- Covishield
  - Coronavac
  - ZyCov-D
  - Covaxin
60. A vaccine that contains purified parts of a pathogenic organism, which act as antigens is known as:
- DNA vaccine
  - Sub-unit vaccine
  - RNA vaccine
  - Attenuated vaccine
61. The blue-green alga, *Anabaena* associates symbiotically with a tiny water fern, *Azolla* and thus acts as a :
- Biofertilizer
  - Biopesticide
  - Biotransformer
  - Biotransducer
62. Which of the following microorganisms is not used as a biofertilizer?
- Rhizobium*
  - Azotobacter*
  - Azospirillum*
  - Pseudomonas*

- 63. The first genetically modified (transgenic) animal, a super mouse was created by transferring another animal's gene into the fertilized egg of mouse. What is the gene?**
- (a) Rat growth hormone gene
  - (b) Human leptin gene
  - (c) Fish follicle stimulating hormone gene
  - (d) plant growth regulator gene
- 64. Which of the following diazotrophic bacterium's nitrogen fixing genes (*nif* genes) were first cloned and transferred to cells of non-nitrogen fixing plants :**
- (a) *Azotobacter* (b) *Azospirillum*
  - (c) *Rhizobium* (d) *Klebsiella*
- 65. Which of the following is not covered by laws governing intellectual property right?**
- (a) Trade mark (b) Trade secret
  - (c) Copyright (d) Trade license
- 66. Patent is not granted for:**
- (a) A novel invention
  - (b) An invention having an industrial application
  - (c) A discovery made by using a previously existing knowledge
  - (d) An invention having an inventive step
- 67. Which of the following is not related to biosafety issues?**
- (a) UNESCO
  - (b) Convention on Biological Diversity
  - (c) Cartagena Protocol
  - (d) World Trade Organization
- 68. Chakraborty patent case is known for a legal battle for grant of a patent on:**
- (a) Neem
  - (b) Turmeric
  - (c) An oil eating bacterium
  - (d) Basamati rice
- 69. Illegal trade of biological resources of a sovereign country by anyone for profit without the permission of the country is known as:**
- (a) Biosafety
  - (b) Biopiracy
  - (c) Bioprospecting
  - (d) Bioassessment
- 70. Which of the following patent cases, India is not directly or indirectly connected with?**
- (a) Soya bean patent case
  - (b) Neem patent case
  - (c) Turmeric patent case
  - (d) Basamati rice patent case

## ANSWER KEYS

1. (b)	19. (d)	37. (c)	55. (b)
2. (b)	20. (b)	38. (a)	56. (a)
3. (d)	21. (d)	39. (c)	57. (c)
4. (b)	22. (a)	40. (a)	58. (d)
5. (d)	23. (a)	41. (d)	59. (c)
6. (b)	24. (c)	42. (b)	60. (b)
7. (b)	25. (d)	43. (d)	61. (a)
8. (a)	26. (c)	44. (a)	62. (d)
9. (c)	27. (c)	45. (b)	63. (a)
10. (d)	28. (d)	46. (d)	64. (c)
11. (c)	29. (a)	47. (b)	65. (d)
12. (b)	30. (a)	48. (a)	66. (c)
13. (c)	31. (b)	49. (d)	67. (a)
14. (a)	32. (c)	50. (a)	68. (c)
15. (d)	33. (a)	51. (d)	69. (b)
16. (a)	34. (d)	52. (c)	70. (a)
17. (a)	35. (a)	53. (c)	
18. (c)	36. (b)	54. (a)	

## **II. DESCRIPTIVE QUESTIONS WITH ANSWERS**

### **1. Describe the process of construction of a recombinant DNA.**

- Hints**
- (i) Brief history and definition of a recombinant DNA
  - (ii) Major steps in its construction
    - (a) Isolation and purification of the donor and vector DNA
    - (b) Cutting of both with a suitable restriction endonuclease
    - (c) Separation of the donor DNA fragment by agarose gel electrophoresis
    - (d) Southern blotting and denaturation of the donor DNA fragment
    - (e) Molecular hybridization with a probe and autoradiography
    - (f) Separation of the donor DNA duplex fragment calibrating with the autoradiogram
    - (g) Joining of the donor DNA duplex with the cut vector DNA by complementary base pairing.
    - (h) Sealing with polynucleotide DNA ligase.

### **2. Give an account of different tools and techniques in the construction of a recombinant DNA.**

- Hints**
- (i) Two main tools execute the recombinant DNA construction process : Enzymes and Vectors
  - (ii) Enzymes
    - (a) Nucleases: Endonucleases and Exonucleases
    - (b) Polymerases: DNA and RNA polymerases and Reverse transcriptase
    - (c) Polynucleotide DNA Ligases
    - (d) End modifying enzymes:
  - (iii) Vectors
    - (a) Vectors compatible with prokaryotic host cells, plasmids with special reference to pBR322
    - (b) Lambda bacteriophage vector
    - (c) Hybrid vectors such as cosmid



**3. Give an account of agarose gel electrophoresis and describe the principle of separation and resolution of DNA fragments following fragmentation by restriction endonucleases.**

**Ans.** (i) Principle  
(ii) The apparatus  
(iii) DNA sample preparation and loading  
(iv) Operation  
(v) Resolution by ethidium bromide fluorescens

**4. Give an account of restriction endonucleases used in cutting DNA in recombinant DNA technology.**

**Hints** (i) Endonuclease, the cutting enzyme  
(ii) Restriction! Why this class of endonucleases is named so?  
(iii) Restriction modification system of the host cell (*E. coli*)  
(iv) Classes of restriction endonucleases: I, II and III  
(v) Why class II enzymes are suitable?  
(vi) Mechanism of cutting generating cohesive and flush (blunt) ends

**5. Describe the structure of pBR322 and discuss how the antibiotic resistance marker genes help in the selection of recombinant clones.**

**Hints** (i) Fundamental structure of a plasmid  
(ii) Bare minimum requirements for being a suitable plasmid vector  
(iii) pBR322-Its structure  
(iv) Insertion of the donor DNA and sealing by polynucleotide DNA ligase  
(v) Selection and screening of the recombinant pBR322 by using the antibiotic resistance marker genes

**6. Discuss about blotting techniques used in the construction of recombinant DNA.**

**Hints** (i) What is blotting?  
(ii) Types of blotting: Southern, Northern and Western  
(iii) Process of blotting for each  
(iv) As a step in recombinant DNA construction

**7. Describe the role played by different classes enzymes in recombinant DNA technology.**

- Hints**
- (i) Different classes of enzymes : Nucleases, Polymerases, Ligases and End modifying Enzymes
  - (ii) Nucleases: Endonucleases and Exonucleases
    - (a) Restriction endonucleases, especially of class II
  - (iii) Polymerases: DNA polymerase, RNA polymerase and Reverse transcriptase
  - (iv) Polynucleotide DNA ligase
  - (v) End modifying enzymes: Terminal transferase

**8. Describe different steps in the polymerase chain reaction.**

- Hints**
- (i) Polymerase chain reaction-Definition and brief history
  - (ii) The enzyme - *Taq* DNA polymerase
  - (iii) The equipment-Thermocycler
  - (iv) The process
    - (a) Denaturation of the target sequence
    - (b) Oligonucleotide probe annealing
    - (c) Elongation by *Taq* DNA polymerase

**9. Write notes on the following each within 50-60 words:**

**(a) Genetic engineering:**

**Ans.** Genetic engineering is engineering or manipulation of genes towards a beneficial end. It's very much similar to a tailor, who cuts the cloth according to the coat size. A gene is cut and removed from its location and is made to replicate into a number of copies by replication by analytical techniques of molecular biology. These genes are then expressed in a suitable environment to form a beneficial product for human use. Similarly, a defective gene may be removed from its location and a correct gene may be inserted into the same location for restoring normal status. Thus, genes are tailor-made towards beneficial ends.

**(b) Recombinant DNA:**

**Ans.** DNA constructed by combining DNA from two heterogeneous sources is known as recombinant DNA. Human genome is isolated and purified. A beneficial gene is cut from its location by an enzyme, called restriction endonuclease. It is then isolated and inserted into another DNA, known as a carrier or vector DNA. Bacterial plasmids act as excellent vectors. However, these can't accommodate large human genes. There are suitable vectors for accommodating human gene inserts. The human gene and the vector gene combine constitutes a recombinant DNA.

**(c) Restriction endonuclease:**

**Ans.** Restriction endonuclease is a class of enzymes, used in the genetic engineering practice. It's an endonuclease class of enzyme and present in bacteria. It catalyzes the breaking of a phosphodiester bond holding two nucleotides. This mechanism is used to restrict the growth of a foreign DNA, especially viral DNA that may enter into it and hence, the name is restriction endonuclease. The host bacterium's DNA is protected from the harmful effects of its own restriction endonuclease by methylation of target nitrogenous bases. These enzymes are of three classes: I, II and III. Enzymes of Class II are suitable for genetic engineering practice, since these recognize 4-6 base pair palindromic sequences and make cuts symmetrically around the line of symmetry. In doing so, two cohesive or sticky ends are generated. Another class makes cuts on the line of symmetry, thus generating two blunt or flush ends.

**(d) Agarose gel electrophoresis:**

**Ans.** Separation of molecules through a solid or semisolid medium based on their size and electric charge in an electric field is known as electrophoresis. In agarose gel electrophoresis, a porous (gel particles adhere onto each other with very narrow passages among them) agarose gel is used as a semisolid medium. Nucleic acid fragments (RNA or DNA) of differing molecular weights are separated from each other in the electric field. An alkaline buffer is used to impart negative charges to the nucleic acid fragments, such that these negatively charged fragments migrate from cathode to anode, when a potential difference between the two electrodes is created.

**(e) Cloning vector:**

**Ans.** Cloning literally means, formation of multiple copies of something. When this applies to a DNA or a gene, it's known as DNA or gene cloning. Cloning of DNA refers to its replication. Replication is a complex process requiring several factors. A DNA fragment can't replicate itself. A cloning vector fulfils all the requirements. Bacterial plasmids are suitable cloning vectors for DNA cloning. It's a small and autonomously replicating circular DNA possessing an origin of replication, a site of integration of the DNA fragment into it and one or two genetic markers for screening and identification of whether a DNA fragment has integrated into it or not. All bacterial plasmids are not suitable cloning plasmids. These are genetically engineered looking at the bare minimum requirements for cloning. Besides plasmids, lambda bacteriophage DNA, cosmid, artificial chromosomes are also used as cloning vectors, based on the size of the DNA fragment to be cloned.

**(f) Plasmid:**

**Ans.** A plasmid is a small, circular, double stranded and autonomously replicating DNA present in bacteria. Autonomous replication property is acquired by the presence of an origin of replication. It can replicate independent of the genomic DNA. Plasmids are used as cloning vectors in the genetic engineering practice. A bacterial plasmid is genetically engineered to make it suitable for the cloning of genes. One to many restriction sites are integrated into the plasmid DNA by engineering for the insertion of the DNA fragment.

**(g) pBR322:**

**Ans.** pBR322 is a widely used cloning plasmid engineered by Boliver and Rodriguez. It is a small, circular, double-stranded DNA possessing an origin of replication. There are two genetic marker genes, such as ampicillin resistance and tetracycline resistance marker genes (*Amp<sup>r</sup>* and *Tet<sup>r</sup>*) for screening of the recombinant plasmids. One or a few restriction sites are integrated into one of the two marker genes to facilitate in the process of screening of recombinants.

**(h) Cosmid:**

**Ans.** Cosmid is a hybrid cloning vector that is formed by integrating the cos (cohesive sites) of the lambda bacteriophage into a bacterial plasmid. It's used as a cloning vector for cloning larger DNA fragments (around 45 kb in size). A restriction site is integrated into the cos site and this combine is integrated into a genetic marker gene of a plasmid. When the cos is opened, a larger DNA fragment (45 kb) may integrate into it. The genetic marker helps in the screening of the recombinants and the origin of replication of the plasmid vests an autonomous replication property of the vector.

**(i) DNA ligase:**

**Ans.** Polynucleotide DNA ligase or simply DNA ligase is an enzyme that catalyzes the joining of the ends of two DNA fragments by forming a new phosphodiester bond. It's, therefore, known as molecular glue. It's used in joining of a DNA fragment to a cloning vector so as to form a recombinant DNA.

**(j) Microinjection:**

**Ans.** Microinjection is a process of introduction of a beneficial DNA fragment into a eukaryotic cell. It's a subtle process, in which the target DNA fragment is sucked into a glass micropipette and injected into a target cell with precision. The target cell is held in position by suction so as to complete the transfer. Microinjection is a common practice of introducing foreign genes (transgenes) into target cells and in the process of generating transgenic animals. Brinster and his coworkers created a super mouse by transferring a rat growth hormone gene into the fertilized egg of a mouse by this process.

**(k) Electroporation:**

**Ans.** Electroporation is a process of transferring a foreign gene into a plant cell. The recombinant plant cell, by somatic embryogenesis develops into a callus and then into a transgenic plantlet. In this process, high voltage electric current is passed intermittently through a medium containing the plant protoplasts and the target foreign gene. In doing so, transient openings are formed in the plasma membrane of the protoplasts, through which the foreign DNA enters into the cytoplasm and then into the nucleus to undergo recombination. Cellulose cell wall is then regenerated and the recombinant plant cells are cultured in a plant nutrient media to form a callus and then a transgenic plantlet.

**(l) *Ti* plasmid:**

**Ans.** *Ti* plasmid is a plasmid present in the soil bacterium *Agrobacterium tumefaciens*. The acronym *Ti* is used for tumor inducing, since, this plasmid induces tumors in its host plants. The host plant is tobacco plant and the tumors are known as crown gall tumors. This plasmid is compatible with plant cells and is engineered and is used in generating transgenic plants.

**(m) Biofertilizer:**

**Ans.** Biofertilizers are biologically active products, including microorganisms (bacteria, algae and fungi), which provide nutrients to plants. Most biofertilizers belong to one of the two categories of microorganisms: nitrogen fixing and phosphate solubilizing. Nitrogen fixing bacteria, such as *Rhizobium*, *Frankia*, *Azotobacter*, *Azospirillum*, *Klebsiella* and blue-green algae (cyanobacteria) and phosphate solubilizing bacteria of the class, phosphobacteria, such as *Pseudomonas putida* and *Bacillus megaterium* are packaged in a carrier material, preferably sterile soil and sold in the market.

**(n) Biopesticide:**

**Ans.** *Bt* protein gene of the soil bacterium, *Bacillus thuringiensis* expresses a protein, insecticidal crystalline protein (ICP) or *Bt* protein that has insecticidal properties. It kills caterpillar larvae of moths and butterflies and beetles, such as potato beetle and boll weevil. This protein has been used as a biopesticide considering its insecticidal properties. Two strategies have been employed. In the first strategy, the *Bt* gene is isolated and is inserted into *Escherichia coli* or *Pseudomonas fluorescens*. These transformed bacteria are sprayed at the root of the beneficiary plant. In the second strategy, plant cells are transformed by recombinant *Ti* plasmid containing the *Bt* protein gene. The transformed plant cells are cultured *in vitro* to generate transgenic plants having endogenous *Bt* protein gene.

**(o) *Bt* crop:**

**Ans.** Refer to the description at (n) and continue reading.

*Bt* crops are transgenic crops. The plants have endogenous *Bt* protein gene and are resistant to a number of insect pests. Many *Bt* crop plants have been successfully raised and given dividend. Some of these are *Bt* cotton by Monsanto, Star Link corn by Aventis and *Bt* brinjal. Despite partial success of these crops, the complete safety of its users has not been guaranteed. Many safety issues have to be addressed before their wide-spread use.

**(p) Recombinant vaccine:**

**Ans.** Refer to the description at (r) of Chapter: 8, Health and Diseases and continue reading.

A recombinant vaccine is produced through recombinant DNA technology. The basic principle is the insertion of the gene encoding an antigen into a suitable vector DNA, consequently forming a recombinant DNA. A bacterial host cell is transformed by this recombinant DNA. The antigen gene is cloned and expressed to form a large number of antigen molecules. These are purified and used as a vaccine. Hepatitis B and Human Papilloma Virus vaccines are two examples of recombinant vaccines, which are in use currently.

**(q) Gene therapy:**

**Ans.** Treatment of a genetic disorder by replacing a defective gene with a normal gene in the cells of a tissue of an affected person is known as gene therapy or more appropriately gene replacement therapy. Germ cell gene therapy is more fruitful than somatic therapy because the correction will perpetuate through generations. The first attempt was made on a child who was suffering from an inherited immunodeficiency disorder, severe combined immunodeficiency (SCID). SCID was expressed due to the deficiency of an enzyme, adenosine deaminase. The bone marrow stem cells were transformed by a correct form of the gene and then returned back to the bone marrow. There was a partial success, but this Familial Hypercholesterolemia (FH) method is not widely used was also tried with some success.

**(r) Stem cell technology:**

**Ans.** In multicellular organisms, stem cells are undifferentiated or partially differentiated cells that can differentiate into several cell types and divide indefinitely to produce more stem cells. Stem cells are of two types: embryonic and adult. The cells of the inner cell mass of the blastocyst are embryonic stem cells. These cells have the ability to differentiate into

all of the body's cell types and have an indefinite proliferation, when cultured *in vitro*. These are pluripotent stem cells. Adult stem cells, also known as somatic stem cells, occur in varied locations: haematopoietic stem cells (bone marrow and umbilical cord), mesenchymal stem cells, neural crest stem cells, testicular cells, etc. Adult stem cells are either multipotent or unipotent. Transplantation of stem cells is promising in the therapy of many disorders, which can't be cured by conventional therapy

**(s) Transgenic animals:**

**Ans.** A transgenic animal bears a beneficial gene (transgene) from across the species barrier. This is achieved by transferring a beneficial gene of one species into the fertilized egg of another species. The transferred gene is from across the species and hence, is known as a transgene. By the usual recombination process, the transgene becomes an integral part of the host cell genome. By the progress of further development, the embryo turns into a transgenic animal. The transgene is expressed and a beneficial product is formed. Brinster and his coworkers created a super mouse by transferring rat growth hormone gene into the fertilized egg of a mouse by microinjection. The transgenic mouse was bulkier and it was believed that the growth hormone transgene expressed more growth hormone that made the mouse bulkier. Many transgenic fishes, birds and mammals have been created by employing this technology.

**(t) Polymerase Chain Reaction:**

**Ans.** Polymerase Chain Reaction (PCR) is an extracellular amplification (replication) of DNA in an equipment, specially designed for it. The equipment is known as a thermocycler with a programmed cooling and heating cycle. The process was discovered by Kary Mullis. The DNA sample with the DNA polymerase enzyme and a complementary primer are loaded into the thermocycler with the programming done and the amplification process is taken care of by the equipment. The entire process is completed in three steps: Denaturation; Primer annealing; and Extension. Denaturation is the separation of two DNA fragments by the hydrolysis of hydrogen bonds at a temperature of 94-95°C for 0.5 min. In the next step, complementary primer annealing is undertaken at the 3' ends of the fragments at 55°C for 1.5 min. In the last step, the DNA polymerase undertakes the extension in a 5' → 3' direction at a temperature of 72°C for 1 min. DNA polymerase enzyme that is used is extracted from a hot sulfur spring bacterium, *Thermus aquaticus*. This enzyme, *Taq* polymerase is a thermostable enzyme and therefore, doesn't lose its functional integrity at a temperature, as high as 95°C.

**(u) Patent in Biotechnology:**

**Ans.** Patent is a legal right, privilege and authority granted by a sovereign state to a person or institution for a limited period of time for an invention using scientific and technical knowledge. The Patent Act was enacted in 1970 in India and since then, it has undergone several amendments. A patent is granted for an invention and not for a discovery. An invention involves the application of new knowledge, while a discovery is an application of an existing knowledge. Other prerequisites for a patent are: the invention must have an inventive step; the invention must have an industrial application and the invention must be described in sufficient details. Most of us are aware of India's victory in neem, turmeric and basmati rice patent cases.

**(v) Biopiracy:**

**Ans.** The patent law is enforceable for inventions, which are made on microorganisms, plants and animals as the source material. Therefore, there is a need to survey the source material for expanding the horizon of research and investigation. This survey with a good intention is known as bioprospecting. However, there is a fear that scientists may transfer a biological resource for monetary benefits which they may consider as novel. Convention on Biological Diversity has recognized the sovereign rights of a country over its biological resource. Illegal transfer of the biological resource of a sovereign country is known as biopiracy.

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