(1)

Q.P. Code: 31306.

F.Y.B.Sc. Biotechnology Semester II Examination
Model Answers
Life Sciences -II: Genetics

Q. 1 Do as directed (Any fifteen) 15

1. Genetic constitution of an individual
2. **Essential** genes
3. The ratio for dominant epistasis is 12:3:1
4. True.
5. Trait which express itself in the immediate next generation.
6. Heterozygous.
7. Alleles.
8. 'Transductant': Bacterial recombinant formed due to transduction/ transfer of genes through bacteriophages.
9. In a HFr X F- cross the frequency of recombination is low. False
10. Give the term for : Extra-chromosomal self-replicating circular DNA in bacteria. : plasmid
11. Bacterial transposon : IS element/Tn3/Tn10
12. Griffith's experiment on transforming principle was conducted using virulent and non virulent strains of Pneumococci .
13. Bacterial transposable elements have <u>inverted repeats</u> at the ends.
14. Gene flow is the transfer of alleles or genes from one population to another due to migration leading to change in allele frequencies.
15. Forward mutation.
16. 10/25= 0.4
17. Agarose Gel Electrophoresis.
18. Any one correct example such as EcoRI etc.
19. True
20. Founder effect

Q. 2 A 08

P generation	**Parent 1**	**Parent 2**
Parental phenotype	Purple flowers with round seeds	White flowers with wrinkled seeds
Diploid parental	PPRR	pprr

genotype		
Haploid gametes	PR	pr

PR X pr

F1 generation: **PpRr (F1 genotype)**

Purple round (F1 phenotype)

Selfing or interbreeding of F1 generations: PpRr X PpRr

phenotypes	Purple round	Purple round
genotypes	PpRr	PpRr
gametes	PR, Pr, pR, pr	PR, Pr, pR, pr

Punnette square for the cross PpRr X PpRr

		Pr	pR	pr
PR	PPRR	PPRr	PpRR	PpRr
Pr	PPRr	PPrr	PpRr	Pprr
pR	PpRR	PpRr	ppRR	ppRr
pr	PpRr	Pprr	ppRr	pprr

Genotypic ratio : PPRR (1), PPRr (2), PpRR (2), PpRr (4), PPrr(1), Pprr (2), ppRR (1), ppRr (2), pprr (1).

Phenotypic ratio : purple round (9), purple wrinkled (3), white round (3), white wrinkled (1).

Q. 2 B Elaborate on Dominant epistasis. **07**

[redacted]

$F_1 \times F_1$ — $W/w\ Y/y$ white fruit × $W/w\ Y/y$ white fruit

F_2 ratio for $W/w \times W/w$	F_2 ratio for $Y/y \times Y/y$	Combined F_2 ratios	F_2 phenotypic proportions	
$^3/_4\ W/-$	$^3/_4\ Y/-$	$^9/_{16}\ W/-\ Y/-$	$^9/_{16}$ white	$^{12}/_{16}$ white
	$^1/_4\ y/y$	$^3/_{16}\ W/-\ y/y$	$^3/_{16}$ white	
$^1/_4\ w/w$	$^3/_4\ Y/-$	$^3/_{16}\ w/w\ Y/-$	$^3/_{16}$ yellow	
	$^1/_4\ y/y$	$^1/_{16}\ w/w\ y/y$	$^1/_{16}$ green	

OR

Q. 2 C What are multiple alleles? Discuss briefly on the inheritance of ABO blood group in man. **08**

In a population of individuals, however, a given gene may have several alleles (often one wild type and the rest mutant), not just two. Such genes are said to have multiple alleles, and the alleles are said to constitutea *multiple allelic series.*

Although a gene may have multiple alleles in a given population of individuals, *a single diploid individual can have only a maximum of twoof these alleles, one on each of the two homologous chromosomescarrying the gene locus.*

An example of multiple alleles of a gene is found in thehuman ABO blood group series, which was discovered byKarl Landsteiner in the early 1900s.

O, A, B, and AB are the four blood group phenotypesin the ABO system. Different combinations of three allelesof the ABO blood group gene I^A, I^B and i—give rise to the four phenotypes.

Table showing the different alleles that determine ABO Blood Groups In Humans

Phenotype		

(Blood Group)	Genotype	
O	i/i	
A	I^A/I^A	or I^A/i
B	I^B/I^B	or I^B/i
AB	I^A/I^B	

Blood typing (determining an individual's bloodgroup) and analyzing blood group inheritance sometimesare used in cases of disputed paternity or maternity.

ABO alleles and RBC antigen: TheI^A allele of the ABO blood group gene encodes aproduct that is needed for the biosynthesis of the A antigenbut that is not involved in the biosynthesis of the B antigen.People of blood type A (genotype I^A/I^A or I^A/i) have onlythe A antigen on their red blood cells and therefore the Bantigen is foreign to them.

The I^Ballele of the ABO blood group gene encodes aproduct needed for biosynthesis of the B antigen, but it isnot involved in biosynthesis of the A antigen. Therefore,people of blood type B (genotype I^B/I^B or I^B/ior) have theB antigen on their red blood cells, and their blood serumcontains naturally occurring anti-A antibodies but noanti-B antibodies.

People of AB blood type (genotype I^A/I^B)have both A and B antigens on the blood cells and neitheranti-A nor anti-B antibodies in their blood serum.

Lastly, the *i*allele encodes no functional productsinvolved in the biosynthesis of either the A or the Bantigen. Therefore, in people with blood type O (*i/i*), thered blood cells have neither A nor B antigen, and theirblood serum contains both anti-A and anti-B antibodies.

The relationship between the ABO multiple alleles andthe antigens on the red blood cells is as follows: The I^A allele encodesa glycosyltransferase enzyme that adds a particular type ofsugar to the H antigen to produce the A antigen. The I^Ballele encodes a different glycosyltransferase, which adds adifferent sugar to the H antigen to produce the B antigen. In an I^A/I^B heterozygote, both enzymes are producedand, therefore, some H antigen is converted to the A antigenand some is converted to the B antigen. The redblood cell has both antigens on the surface, so the personis of blood group AB.

People who are homozygous for the *i*allele produceno enzymes to convert the H antigen glycolipid. Therefore,their red blood cells carry only the H antigen. The H antigen is encoded by the dominant *H* allele oflocus distinct from the ABO blood group gene.

People who are homozygous for the recessive mutant allele, *h*,do not make the H antigentherefore, regardless of the presence of or alleles at the ABO blood group gene,no A or B antigens can be produced. These very rare *h*/*h*people are like blood group O people in the sense that hey lack A and B antigens; they are said to have the Bombay blood type.

Q. 2 D Explain the phenomenon of modification of law of dominance with a suitable example. **07**

Incomplete dominance and codomiance – 1 mark

Incomplete dominance definition- 1 mark example 2 mark

Codominace definition – 1 mark example 2 Marks

Q. 3 A F factor (fertility factor/ sex factor) **08**

- extra-chromosomal, circular, double stranded plasmid DNA responsible for sexual differentiation in bacteria- [Cells with F factor- F^+ male ; without F factor- F^- female]
- F factor initiates the process of gene transfer from donor (male) cell to recipient (female) bacterial cell in the process of conjugation (F^+ and F^- cross); transfer of F factor is independent
- It can get integrated in/ recombined with bacterial chromosome to form HFr (High frequency of recombination) strain , F factor can carry bacterial genes when Hfr reverts to form F' (F prime) which transfers bacterial genes efficiently

Sex pili

`Conjugation': Progressive gene transfer by physical contact or mating between F+ (donor) & F^- (recipient) strains through sex pilus or conjugation tub

Q. 3 B

- Restricted (Specialized) transduction :Process by which only certain bacterial genes can be transduced to another bacterium by viruses e.g. gal and bio genes by λ phage in Escherichia coli. **07**
- Specialized transduction occurs when the prophage (viral DNA integrated into the bacterial chromosome) is excised from the chromosome and carry the donor bacterial genes packaged into the virus particle and injects into another recipient host bacterium.
- Appropriate diagram

OR

Q. 3 C Similarities: **08**

- Processes of gene transfer in bacteria
- Bothe lead to genetic recombination and used for mapping

Differences

Transduction	Transformation
Gene transfer through bacteriophages	Uptake of naked DNA
Process: Generalized and specialized	Process: No types, DNA taken up by competent cells

Q. 3 D Interrupted Mating Experiment: Jacob and Wollman demonstrated the mechanisms of gene transfer by conjugation in *Escherichia Coli* **07**

Technique: mating/conjugation between *Hfr* donor cell with F^- recipient cell genotypes

Donor – HfrH: thr^+ leu^+ azi^r ton^r lac^+ gal^+ str^s

Recipient – F^-: thr^- leu^- azi^s ton^s lac^- gal^- str^r

The process of conjugation involves gene transfer from donor and recipient cells by physically contact through a sex pilus is interrupted by use of a kitchen blender to break the matting cell apart at various times after the beginning of conjugation.

The resulting recombinants are studied for analysis of order transfer of genes

Diagram

Q. 4 A Discuss with example the theory of Natural Selection. **08**

1. Explain natural selection
2. effect of genetic drift, mutations on natural selection
3. e.g. for the selection in natural population
4. Carbonaria species and industrial revolution.

Q. 4 B Discuss Speciation with suitable examples. **07**

1. What is speciation

2. Causes of speciation
3. Types of speciation
4. Examples.

OR

Q. 4 C Give full form of PAGE? How PAGE is used by geneticist in measuring genetic variations at the protein level in a population? **08**

1. PAGE- Poly acrylamide gel electrophoresis.
2. Genetic variation
3. Existence of Neutral model of genetic variation

Q. 4 D Elaborate on Hardy Weinberg law and its assumptions. **07**

Hardy Weinberg's law states that in an infinitely large and randomly mating population free from the mutations, migrations and natural selection the frequencies of the alleles do not change over time and as long as the genotypic frequencies remain in the proportion, the sum of the genotypic frequencies equals one.
Assumptions of the Hardy Weinberg's law:
1. Infinitely large populations
2. Random mating
3. Free from mutations, natural selection, migration.
Each assumption has to be explained.

Q 5 Write Short notes on **any three** of the following **15**

a. Monohybrid cross. – suitable example and phenotype and genotype ratio.

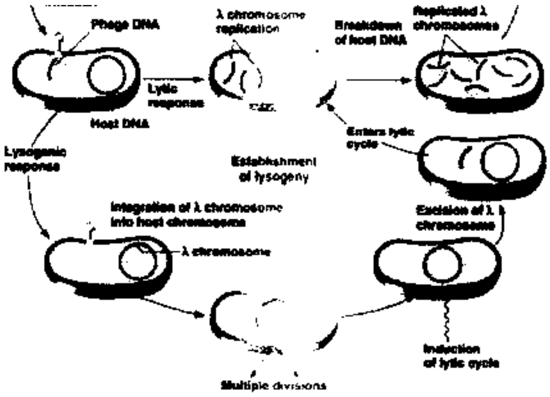
b. Recessive epistasis.- suitable example and phenotype ratio.

c. Generalized transduction

- process by which any bacterial gene may be transferred to another bacterium via a bacteriophage
- Transduction by the bacteriophages in lytic cycle as follows:
- Infection of the donor bacterium, replication of viral DNA, viral protein synthesis, assembly of viral particles , bacterial chromosomal DNA is inserted into the viral capsid by chance and transferred to the recipient bacterium leading to generalized transduction and genetic recombination

d. Lysogeny in bacteriophages

Lysogeny: Insertion of viral chromosome , Integration of viral chromosome into bacterial chromosome-prophage, Replication of prophages with bacterial replication , Induction Any one example of



e. Computation of Allelic frequencies.

What are allelic frequencies, Formula and example.