BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
ADVANCED & APPLIED MICROBIOLOGY (BIO G523)
FIRST SEMESTER 2016-17 COMPREHENSIVE EXAM

Max Time: 3 hours **Date: 09.12.2016**
Max Marks: 80 (Close Book: 25 + Open Book: 55)

Note: 1. *Answer briefly, to the point and in the format asked.*
2. *You have a maximum of 1h to answer Close Book paper, but you can turn in any time after 30 minutes to the invigilator to collect Open Book paper.*
3. *Answer all parts of the same question together, in sequence.*

Section A (Close Book)

Q1. Identify the following. **[1 x 6=6]**

(a) A novel target for antibiotics which prevents cell division.
(b) First synthetic chemical to be used as an antibiotic.
(c) A phytohormone whose elevated level during abiotic stress inhibits root/shoot proliferation.
(d) Name of differentiated rhizobial cell specialized for nitrogen fixation.
(e) A slender projection of parasitic fungi which is inserted to plants to take nutrition.
(f) Protein on plant surface required for adhesion of rhizobial cells.

Q2. Answer the following questions with appropriate justification. **[2 x 3=6]**

(a) What is principle of bacterial fight club with reference to identification of therapeutic compound?

(b) You have been given following four compounds having antimicrobial property. Based on given information, identify best antimicrobial compound to be used for therapy. Write order of chemicals (A to D) starting from most potential drug. Answer the question with suitable justification.

Criteria/Compound	**A**	**B**	**C**	**D**
Therapeutic dose (µg/mg)	50	30	25	100
Toxic dose (µg/mg)	125	170	100	125

(c) What are SAR and ISR? Differentiate them.

Q3. It is known that the microbiota governs various aspects of an organism. Answer the following questions dealing with the same.

(a) Microbiota composition of female changes with gestational age. State the changes that occur mentioning the advantages associated with each change. [5]

(b) CDC's Division of Nutrition, Physical Activity, and Obesity is committed to increasing breastfeeding rates considering its health benefits for the baby. How does the baby gain the benefits? [2]

Q4. Represent schematically the basic components of microbial biosensor. Provide proper label and detection principle(s). [3]

Q5. Explain the mechanism of genome editing using CRISPR/Cas system. [3]

Section B (Open Book)

Q1. Each of the following questions carries equal marks. **[5 x 3=15]**

(a) The discoverer of Teixobactin, a recently discovered drug, claims that it is difficult to obtain resistance to this antibiotic in gram-positive bacteria. What is the basis of this claim? What was the novelty and principle used for the isolation of this antibiotic? However, similar claim was made for other drug against which some bacteria developed resistance. Mention name of that drug and write mechanism of resistance.

(b) Like animals, plants do have immune system. Compare immunity in animals with plants and highlight similarity and differences with suitable example or justification.

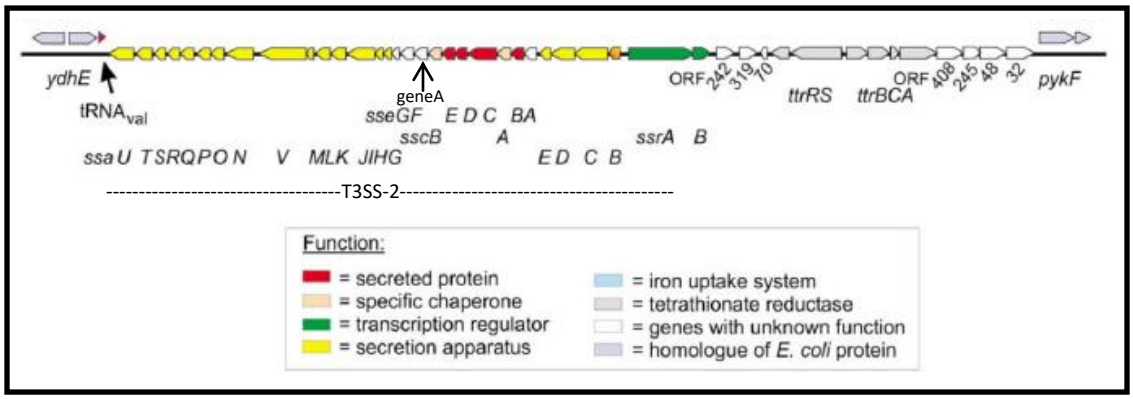
(c) Most of us have general understanding that *archea* are most primitive life form among bacteria, archea, and eukarya. Do you agree with the statement? Justify your answer. Explain theories of evolution of cellular life.

Q2. **(a)** How do different hormones play role in plant-rhizobia interaction? **[2]**

(b) How can a bacteriophage be better alternative than that of antibiotics for treatment of bacterial diseases? Explain with suitable examples. **[3]**

Q3. BCG vaccine was developed by successive *in-vitro* subculturing every three weeks for 230 times. Suppose there is a outbreak of novel disease in which the bacteria resides majorly in the blood of the patient. Considering that you choose to develop a vaccine strain in a manner similar to BCG as a part of your Ph. D. thesis you start subculturing the strain in blood-agar every 3rd week. You find that even after 500 subcultures the virulence of the strain did not go down. Explain what might be the probable reason for the same. How would you tackle the problem? **[3]**

Q4. One of your colleagues used transposon-based mutagenesis to identify the virulent proteins of the Salmonella. One such mutant is highly attenuated. When tested, he found that the transposon got integrated only in geneA (see below the part of the pathogen genome). It is known through literature that the geneA is not essential for virulence. Can you help your colleague to find the probable reason for the same? Justify. **[3]**



Q5.(a) It is known that the T3SS system knockout strain of Salmonella is attenuated in causing diarrhea in normal mice/human. However, in patients with inflammatory bowel disease it causes severe diarrhea. How would you explain this observation? **[3]**

(b) The competitive index (CI) of wild-type: T3SS knockout strain when grown in LB is ~1 while CI under *in-vivo* (mouse gut) condition is significantly less than 1. Why there is a difference in CI under the two conditions mentioned? Identify the phenomenon linked to this behaviour. **[4]**

Q6. A novel chemical isolated from plant A has anti-microbial activity against *in vitro* grown bacteria and has cell membrane stabilizing property. Your supervisor asked you to test the efficacy of this drug against the disease caused by different intracellular bacterial pathogens. Design experiments for the same stating the pathogens you would consider. Would you obtain similar results for all the pathogens? Justify your results. (Answer considering the intracellular niche of the bacteria). **[5+3]**

Q7. Consider there is an outbreak of a disease caused by a novel pathogen which is highly human specific. Government plans to develop a sub-unit vaccine and approaches you (employed as senior scientist at CDC) for help. Which method would you consider for identifying a potent antigen of the pathogen? Justify. **[2]**

Q8. Schematically represent the functioning of gut-brain axis. **[3]**

Q9. Different strains were isolated from industrial sewage and whole genome sequencing performed. The pairwise genome calculations were performed with reference genomes (Spp. I - VIII) from the database to obtain average nucleotide identity (ANI). Following table represents the pairwise ANI values. Using this information state which strains (A-O) may belong to same species (Spp. I - VIII) and strain(s), if any, that could not be matched to referenced strains. Provide justification for the observations made. **[5]**

Strain	Spp. I	Spp. II	Spp. III	Spp. IV	Spp. V	Spp. VI	Spp. VII	Spp. VIII
A	90.97	91.09	91.56	91.33	96.73	94.24	86.33	81.45
B	99.48	91.28	91.38	91.49	90.58	90.64	89.36	81.41
C	91.75	96.05	95.85	92.77	91.04	91.21	90.56	81.32
D	98.72	90.97	90.9	91.12	90.15	90.23	89.36	80.98
E	91.73	–	96.68	93.25	91.08	91.31	89.64	81.3
F	91.76	99.67	96.66	96.35	91.07	91.33	89.97	81.32
G	99	90.87	90.99	91.02	90.05	90.2	89.36	80.86
H	91.71	96.13	95.81	–	91.03	91.18	90.36	81.29
I	90.85	91.08	91.71	91.24	94.95	98.64	85.74	81.46
J	91	91.05	91.53	91.24	97.15	94.36	86.14	81.39
K	–	90.35	90.95	90.87	89.61	90.00	89.53	81.1
L	90.98	90.94	91.51	91.18	97.02	94.26	86.14	81.42
M	90.78	90.84	97.5	91.16	94.71	91.08	86.04	81.44
N	80.89	80.47	80.92	80.88	80.82	80.98	74.88	–
O	90.81	91.03	91.65	91.17	94.92	99.94	85.74	81.45

Q10. A microbiologist is troubleshooting a batch of home-brewed ale (beer) that did not ferment properly. She noticed that the alcohol content was only 2%, which is well below the desired level. Microscopic examination showed that yeast were healthy and numerous. Chemical analysis of the beer showed low levels of sugar, high levels of CO_2, and large amounts of protein in the liquid. What did the microbiologist conclude as the probable cause of the beer not coming out properly? Justify your answer.

[4]

**********All the best**********