Bacterial and viral genetics

1. What is conjugation?
   Genetic exchange by the transfer of one chromosome from one cell into another and then crossing over between donor and recipient chromosome.

2. What is the difference between an F+ cell, and F- cell, and an Hfr cell?
   F+ has the F factor and donates, while F- does not have the F factor and receives. The Hfr has integrated the F factor into its chromosome.

3. An interrupted-mating experiments was performed using three different Hfr strains (A, B, and C). Alleles were transferred (from last to first) in the following order:
   - strain A: thi his gal lac pro
   - strain B: act leu thr thi his
   - strain C: lac gal his thr
   How are the F factor sequences integrated into the chromosomes of these strains oriented relative to each other?
   A and B are in the same orientation.

4. What is transformation?
   Free, fragmented DNA is taken up by the cell and then integrated into the chromosome via crossing over.

5. What is co-transformation? Is co-transformation more likely to happen if two genes are close together or far apart?
   Transfer of 2 or more genes during a single uptake event and is more likely to happen if the genes are close together.

6. What is transduction?
   Virus incorporates part of host genome into the viral particle for the next infection cycle and then gets integrated into a new host cell, along with the piece from the old host.

7. What is the difference between a viral lytic and lysogenic cycle?
   In the lytic life cycle, the virus genome never integrates into the host cell genome, but in the lysogenic cycle it does integrate.

8. What is a retrovirus? Give an example of a retrovirus.
   Virus is RNA but uses reverse transcriptase to generate dsDNA to be integrated into host genome. HIV is an example.

Translation

9. What is a ribosome?
   Protein + tRNA with 2 subunits that assemble the polypeptide chain using the mRNA code during translation.

10. What are the two main differences between translation in prokaryotes vs. translation in eukaryotes?
    - Initiation: Prokaryotes end AUG start site, eukaryotes it first binds to the 5' cap than scans for the AUG
    - Separation of transcription and translation: prokaryotes - simultaneously, eukaryotes must complete transcription + RNA processing, export to cytoplasm, and then translation can happen.

Chromosomal variation

11. Describe the four types of chromosomal rearrangements (drawing pictures is a good idea.)
   
   [Diagram showing duplication, deletion, inversion, and translocation]
12. What is aneuploidy?
Change in number of individual chromosomes

13. What is polyploidy?
More than 2 complete sets of all the chromosomes, so like 2N to 3N

14. What is gene regulation?
Process that determines whether or not a gene is expressed and to what level of expression

15. How do you distinguish between a repressible control system and an inducible control system? How do you distinguish between a positive control system and a negative control system?
Positive - normally on, Inducible - normally off

16. Draw the regulator protein and signal response for each of the four control systems and explain how each system responds to a signal. Indicate if they system is on or off in normal state and response to signal.

- **Negative inducible**
  - Normal state: off
  - Response to signal: on

- **Negative repressible**
  - Normal state: on
  - Response to signal: off

- **Positive inducible**
  - Normal state: off
  - Response to signal: on

- **Positive repressible**
  - Normal state: on
  - Response to signal: off
17. What is attenuation?

Premature termination of transcription/translation

18. What happens with attenuation when tryptophan is low?

- **trp**-**E. coli** is low and ribosome stalls on the codons so the ribosome covers region 1 when 3 is being transcribed, and then a 2+3 hairpin forms and this does not terminate translation.

19. What happens with attenuation when tryptophan is high?

- **trp**-**E. coli** is high and the ribosome does not stall on the codons so the ribosome covers region 2 when region 3 is being transcribed and then a 3+4 hairpin forms that terminates translation.
20. What does histone acetylation do? How does it work? Draw out the process including the enzymes and how the amino acid on the histone changes.

21. What is cytosine methylation? Is this associated with higher or lower levels of gene expression? Which group is a cytosine that can inhibit gene expression if activator binding site one methylated and also several others.

22. Outline the steps of the GAL4 system when galactose is absent and when galactose is present.
- No galactose ⇒ GAL4 binds to GAL3 from starting transcription
- Galactose present ⇒ galactose binds to GAL4 ⇒ GAL4 interacts with GAL80 to bring about a structural change so that it no longer binds GAL4 ⇒ GAL4 interacts with basal transcription apparatus to stimulate transcription

23. What are the functions of enhancers and insulators?
- Enhancer: transcriptional regulator protein binding site that stimulates transcription from a distance
- Insulator: blocks enhancer activity, is located between enhancers.

24. Explain each of the three gene regulation mechanisms after transcription.
- Transcriptional silencing: allele exchange is paused, regulated by protein phosphorylation
- Alternative splicing: different proteins can arise from different splicing
- mRNA degradation: siRNAs and miRNAs

25. Outline how to recognize if a single nucleotide mutation is a transition or transversion mutation.
- Purine: A and G are pyrimidines: T and C
- Transition: purine for purine or pyrimidine for pyrimidine
- Transversion: purine for pyrimidine or pyrimidine for purine

26. List and explain the three possible codon mutations that can arise from a single nucleotide mutation.
- Missense: change in 1 amino acid = site
- Nonsense: mutation creates stop codon = site
- Silent: no change in amino acid

27. What type of codon mutation happens from an addition or deletion of one or two nucleotides? What is the typical effect of this mutation?
- Frameshift mutation, usually leads to a nonfunctional protein

28. How does a gain-of-function mutation happen?
- Binding site of a repressor or negative regulator factor is prevented

29. What is a suppressor mutation? What is the difference between an intragenic suppressor and an intergenic suppressor?
- The mutation "undoes" the previous mutation to revert back to wildtype
- Intragenic: 2nd mutation is in same gene as first mutation
- Intergenic: 2nd mutation is in different gene than 1st mutation

30. What are the three spontaneous ways a single nucleotide mutation can arise? Explain the process of how each one yields a single nucleotide mutation.
- frame shift: sometimes exists in rare form due to a protein shift and this causes it to base pair differently
- Deamination: spontaneous hydrolysis of N-glycoside bond removes base from sugar, so then during replication, polymerase just randomly puts on a base
- Deamination: converts C to U (which pairs with A) or 3-methyl cytosine (methylated C) into T, which also pairs with A