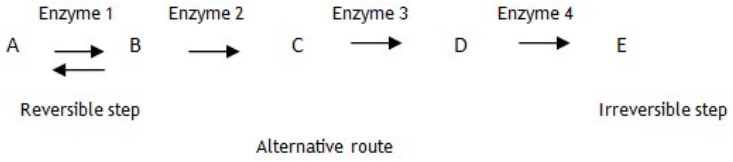
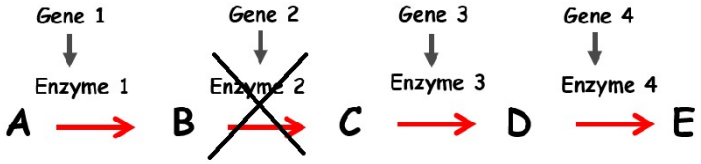
Metabolism

1. **Define metabolism.**
   - All the reactions that occur inside the cell.
2. **Name the molecule that controls each step in a metabolic pathway.**
   - Enzyme
3. **Draw a metabolic pathway and label the 3 possible steps involved in a metabolic pathway.**



4. **In the following metabolic pathway state the following if enzyme 2 is inhibited.**



   (i) **Concentration of B**
   increases
   (ii) **Concentration of C/D/E**
   decreases
   (iii) **Concentration of A**
   stays constant
   (iv) **Which enzyme would require to be inhibited to ensure accumulation of metabolite D**
   Enzyme 4
5. **Name the two types of metabolic pathways.**
   - Catabolic and anabolic
6. **What metabolic pathway releases energy**
   - Catabolic
7. **Are reactions involving biosynthesis anabolic or catabolic**
   - Anabolic
8. **Are the following reactions catabolic or anabolic**

   (i) ATP being converted to ADP
   - catabolic

   (ii) Glycolysis
   - Catabolic

   (iii) Proteins being produced from amino acids
   - anabolic

   (iv) Producing glucose from glycogen
   - catabolic

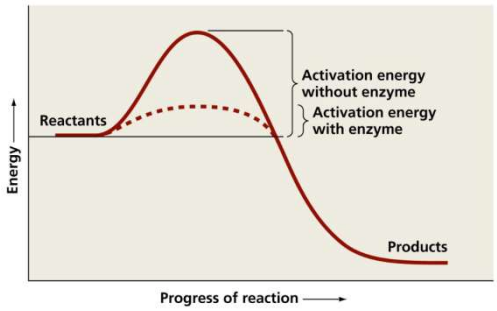
Compartmentalised membranes & proteins

9. **State two examples of compartmentalised membranes**
   - Mitochondria or chloroplasts
10. **State the effect of compartmentalised membranes on the surface area: volume ratio**
    - Increases surface area: volume ratio
11. **State the effect of compartmentalised membranes on reaction rate.**
    - Increase reaction rate

12. **Name the three types of protein found in the membrane**
    - Pores, pumps and enzymes
13. **What type of protein is involved in active transport**
    - Pumps

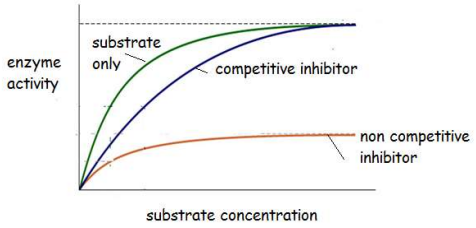
Enzymes

14. **Define induced fit in terms of enzymes and substrates (2 marks).**
    - Active site changes shape after substrate has bound to active site.
15. **State the effect of enzymes on activation energy and draw a graph to summarise this.**

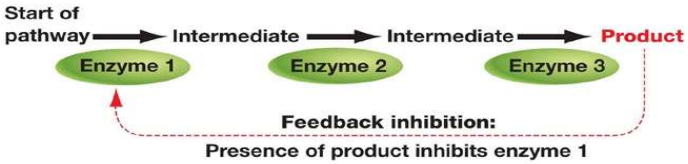


16. **State the affinity the substrate and product has for the active site.**
    - Substrate high affinity
    - Product low affinity
17. **Explain how the enzyme ensures correct orientation of the substrate.**
    - Active site
18. **Does a high concentration of product promote the forward or backward reaction.**
    - Backward reaction
19. **Do inhibitors increase or decrease enzyme activity.**
    - Decrease enzyme activity
20. **Name the three types of enzyme inhibitors.**
    - Competitive inhibitor
    - Non competitive inhibitor
    - Feedback inhibition
21. **Define a competitive inhibitor.**
    - Binds at the active site instead of the substrate.
22. **Define a non competitive inhibitor.**
    - Binds away from the active site changing the shape of the active site preventing substrate from binding.
23. **Which type of inhibitor is reversible.**
    - Competitive inhibitor
24. **Explain how this type of inhibitor's effect is reversed.**
    - Increasing substrate concentration

25. **Draw a graph of enzyme activity against substrate concentration for a control/competitive inhibitor and non competitive inhibitor.**

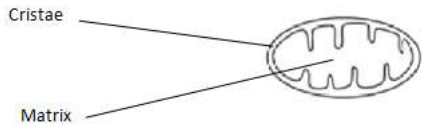


26. **Are heavy metals such as lead or mercury competitive or non competitive inhibitors.**
    - Non competitive inhibitors
27. **What substance is inhibited during feedback inhibition.**
    - First enzyme in pathway
28. **Draw a metabolic pathway diagram summarising feedback inhibition.**



Respiration

29. **Name the three stages of respiration and state their location inside the cell.**
    - Glycolysis in the cytoplasm
    - Citric Acid Cycle in the matrix of mitochondria
    - Electron Transport Chain in the Cristae of mitochondria
30. **State the stage of respiration that produces the most ATP**
    - Electron transport chain
31. **State the stage of respiration that produces carbon dioxide**
    - Citric Acid Cycle
32. **State the stage of respiration that produces water.**
    - Electron Transport Chain
33. **Draw a mitochondria and label the matrix and cristae (inner mitochondrial membrane).**



34. **Explain why some cells have more mitochondria than other cells and give an example of a cell with lots of mitochondria.**
    - Cells require more ATP to be produced
    - Active cells such as sperm/muscle/brain cells have more mitochondria
35. **Explain why cells such as muscles also have more folds in their many mitochondri than other cells such as skin which have less folds. (2 marks)**

    - More cristae in muscle cells = more ATP synthase in electron transport chain
    - More ATP produced for <u>muscle contraction</u>

36. **What name is given to the conversion of glucose to pyruvate via an intermediate.**
    - Glycolysis
37. **Explain what is meant by the energy investment stage of glycolysis**
    - 2 ATP needed to phosphorylate the intermediate
38. **Explain what is meant by the energy payoff stage**
    - 2 ATP in but 4 ATP produced OR net gain of 2 ATP
39. **State what is produced during fermentation in muscle cells and yeast/plant cells.**
    - Muscles produce lactic acid
    - Yeast/plant cells produce alcohol and CO_2
40. **State which type of fermentation is reversible and irreversible in animals or plants/yeast.**
    - Animals reversible fermentation
    - Plants/yeast irreversible fermentation
41. **State the fate of yeast during fermentation.**
    - Killed by alcohol
42. **State the role of dehydrogenase**
    - Removes H ions and electrons and passes to NAD to make NADH.
43. **State the role of co enzymes**
    - Accepts H ions and electrons and pass to the electron transport chain.

44. Name two co enzymes and state which stage (s) of respiration they occur.

- NAD – glycolysis and Citric Acid Cycle
- FAD – Citric Acid Cycle

45. State the number of carbons on

(i) Glucose

- 6C

(ii) Acetyl

- 2C

(iii) Citric acid

- 6C

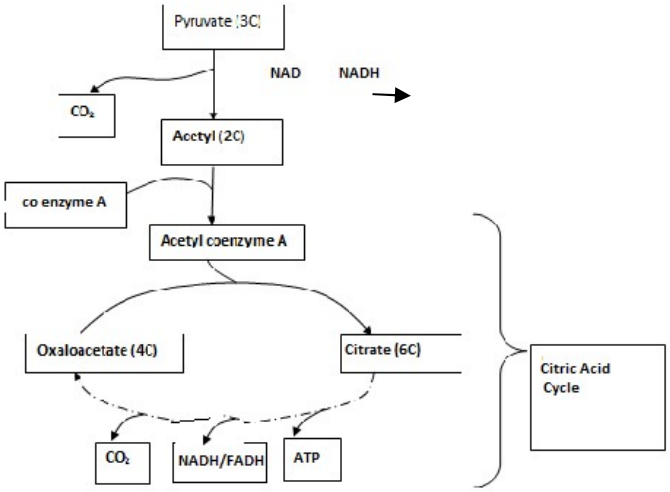
(iv) Pyruvate

- 3C

46. Name the substance required to proceed beyond pyruvate in the aerobic pathway.

- oxygen

47. Draw the metabolic pathway from pyruvate into the Citric Acid Cycle.



48. State three products produced by the Citric Acid Cycle

- CO_2
- ATP
- NADH/FADH

49. Name the molecule regenerated during the Citric Acid Cycle

- Oxaloacetate

50. Define the electron transport chain

- Collection of proteins in the inner mitochondrial membrane**.**

51. State the molecule that allows H to be pumped across the membrane.

- Electrons

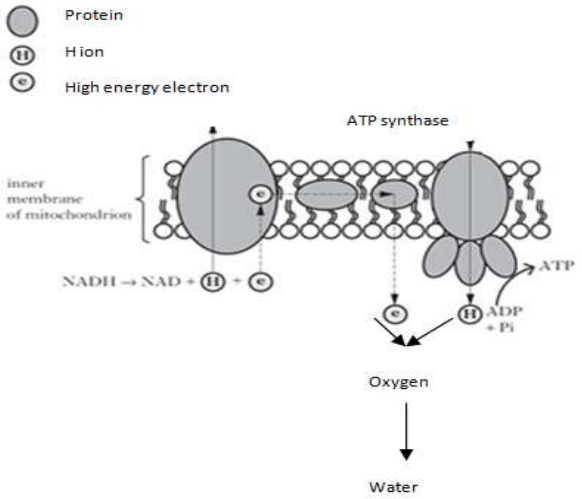
52. State the role of oxygen in the electron transport chain

- Final H and electron acceptor (that produces water).

53. Explain the role of H in the synthesis of ATP (2 marks)

- Flows across ATP synthase
- This causes ATP synthase to rotate making ATP from ADP & Pi

54. Draw a labelled diagram of the electron transport chain



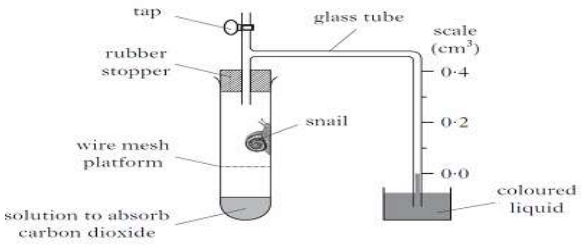
55. State two alternative respiratory substrates

- Proteins/amino acids/ fatty acids/ fat/glycogen/starch

56. State the stages that proteins, fats and carbohydrates feed into.

- Proteins & fats – Glycolysis and Citric Acid Cycle
- Carbohydrates (starch/glycogen) – Glycolysis

57. Draw a labelled diagram of a respirometer



58. An investigation was carried out to determine the effect of the number of worms on the rate of respiration. Identify the independent and dependent variable.

- Independent variable – number of worms
- Dependent variable – rate of respiration

59. Explain how the reliability of the results could be improved in the experiment above.

- Repeat experiment with another group of worms

60. State why the respirometer was left for 10 minutes before measuring the results.

- To ensure worms adjust to temperature

61. Describe how temperature can be controlled in the experiment

- Use of a water bath

62. State the control of the respirometer experiment described in Q55.

- Exact same set up but without worms

63. Explain why a control is necessary

- To prove the worm is causing the liquid to move up tube.

64. Explain how liquid is drawn up the tube in the respirometer (2 marks)

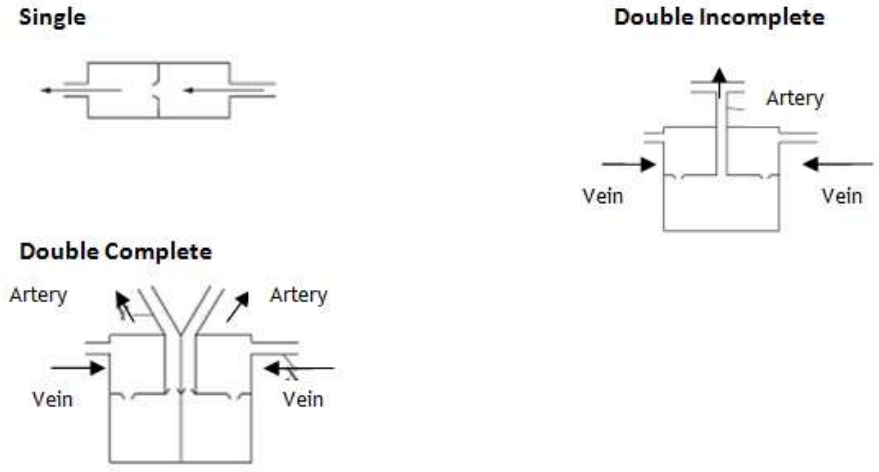
- Oxygen taken in and carbon dioxide absorbed by chemical.
- Less volume of air in tube causes more air/dye to be forced up tube.

Metabolism & Circulatory systems

65. **Name two ways of measuring metabolic rate.**
    - Oxygen produced per minute
    - Carbon dioxide taken in per minute
    - Change in temperature per minute
66. **Rank the following animals from highest to lowest metabolic rate: fish, bird, amphibian/reptile, mammals.**

    Highest metabolic rate
    - Bird
    - Mammal
    - Amphibian/reptile
    - Fish

    Lowest metabolic rate
67. **State the type of circulatory system for birds, amphibians, fish, mammals, reptiles.**
    - Bird & mammal double complete circulatory system
    - Amphibian/reptile double incomplete circulatory system
    - Fish single circulatory system
68. **State the number of atria and ventricles in a double complete, single and double incomplete circulatory system.**
    - Double complete – 2 atria and 2 ventricles
    - Double incomplete – 2 atria and 1 ventricle
    - Single – 1 atrium and 1 ventricle
69. **Draw a diagram of a double complete, incomplete and single circulatory system and label arteries and veins as well as the direction of blood flow in arteries and veins.**



70. **Explain why double complete circulatory systems are more efficient than double incomplete circulatory systems (2 marks).**
    - Double complete prevent mixing of oxygenated and deoxygenated blood
    - Increased oxygen delivered to tissues for respiration
71. **State two features of the lungs that makes birds respiratory system more efficient than mammals and reptiles.**
    - 1 way circulatory system
    - Parabronchi
72. **Explain why parabronchi are advantageous over mammalian alveoli.**
    - Alveoli are dead end but parabronchi allow continuous gas exchange.

73. Describe the respiratory system of amphibians.

- Very simplistic with just a trachea and 2 air sacs for gas exchange during exercise.

Low Oxygen Niche, VO2 max & Terrestrial Body Size

74. Describe the relationship between oxygen concentration and terrestrial body size.

- As oxygen concentration has increased so too has terrestrial body size.

75. Explain why oxygen concentration limits the size of terrestrial animals on earth.

- Limits rate of metabolism so animals are limited in size due to only 20% oxygen in air.

76. State two examples of low oxygen niches.

- High altitude
- Deep ocean

77. State an adaptation of deep diving mammals and of being at high altitude.

- Deep diving mammals – lower heart rate/ partially deflate lungs so oxygen demand is less.
- High altitude – produce more red blood cells per ml of blood.

78. Explain what VO_2 max is a measure of

- Cardiovascular fitness

79. Explain how VO_2 max indicates fitness

- The higher the oxygen consumed the fitter the individual

80. If individual A produces 40ml of oxygen in 10 minutes and weighs 55kg and individual B produces 45ml of oxygen and weighs 60kg which individual is fitter. Work this out per minute per kg.

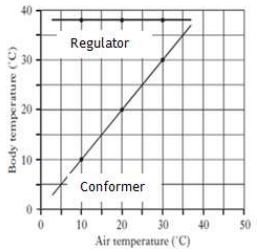
- A 40ml divided by 10 minutes divided by 55kg = 0.073 ml/min/kg
- B 45ml divided by 10 minutes divided by 60kg = 0.075ml/min/kg
- Individual B is fitter

81. Explain why it is necessary to measure VO2 max per kg

- As individuals weights are different the per kg calculation allows a valid (fair) comparison of their relative fitness.

Regulators, Conformers & Extremophiles

82. Draw a graph of internal versus external temperature for regulators and conformers.



83. Define a regulator.
- Internal environment remains constant despite changes to external environment

84. Define a conformer.
- Internal environment changes with external environment

85. State two abiotic factors that regulators can control.
- Salinity
- Temperature
- pH

86. State whether regulators or conformers have a high or low metabolic rate.
- Regulators high metabolic costs
- Conformers low metabolic costs

87. Explain why regulators have high metabolic costs.
- Regulate metabolism by homeostasis which costs energy

88. State whether regulators or conformers have a wide or narrow niche.
- Regulators wider niche
- Conformers narrower niche

89. State whether regulators or conformers do homeostasis
- Regulators = homeostasis
- Conformers = no homeostasis

90. State what type of organisms undergo behavioural adaptations to control their metabolism
- Conformers (as they cannot undertake homeostasis)

91. Explain why mammals thermoregulate (2 marks).
- To keep enzymes at their optimum
- To maintain high diffusion rates

92. Name the temperature monitoring centre in mammals.
- Hypothalamus

93. Name the effector where corrective responses occur during thermoregulation.
- Skin

94. State how information is communicated between the temperature monitoring centre and effector.
- Nerve (impulses)

95. Name 4 corrective responses to being too hot in regulators
- Vasodilate blood vessels
- Hair erector muscles relax
- Sweating increases
- Lower metabolic rate

96. Name 4 corrective responses to being too cold in regulators
- Vasoconstrict blood vessels
- Hair erector muscles contract
- Shivering increases
- Higher metabolic rate

97. Explain the process of vasodilation.

- Increased blood flow
- Increased heat loss by radiation

98. Explain why hair erector muscles contract.

- Hairs stand up
- Air trapped by insulation

99. Explain why animals sweat.

- Increases evaporation of water to cool body.

100. Explain why animals shiver.

- Increased muscle contraction to generate heat

101. Explain why metabolism increases during winter.

- Increased heat generated.

102. Define an extremophile.

- An organism that can live in an environment that others cannot survive.

103. Give an example of where thermophilic bacteria live.

- Hot springs/sea bed vents/volcanoes

104. Explain why thermophilic bacteria survive high temperatures.

- The bacteria's enzymes e do not denature at high temperatures
- (e.g taq polymerase which is used in PCR)

105. Another type of extremophile lives in sea bed vents and is not a thermophile but instead is able to generate ATP from which other type of molecule.

- Inorganic molecules (hydrogen sulphide)

Surviving and Avoiding adverse conditions

106.State the technique that survives adverse conditions.

- Dormancy

107.State the technique that avoids adverse conditions.

- Migration

108.Define dormancy.

- Lowered metabolic rate

109.State one observable physiological measure of lowered metabolic rate.

- Lower heart rate
- Lower breathing rate
- Lower body temperature

110.Animals undergo dormancy when environmental conditions vary beyond

- Tolerable limits

111.Name one problem with environmental conditions going beyond that which can be tolerated by animals.

- Cannot sustain high metabolic rate

112.Define predictive or consequential dormancy.

- Predictive dormancy when metabolic rate is reduced BEFORE onset of adverse conditions
- Consequential dormancy when metabolic rate is reduced AFTER onset of adverse conditions

113.Which type of dormancy occurs during unpredictable conditions?

- Consequential as can occur at any time

114.State the 3 types of dormancy.

- Aestivation Hibernation (daily) torpor

115.Which type of dormancy occurs in hummingbirds?

- Daily torpor

116.Which type of dormancy occurs in crocodiles after the onset of adverse conditions.

- Consequential aestivation

117.Which type of dormancy occurs in bears before the onset of winter.

- Predictive hibernation

118.Define hibernation

- Reduced metabolic rate in low temperatures/winter

119. Define aestivation

- Reduced metabolic rate during drought/very high temperatures

120. Define daily torpor

- Reduced metabolic rate in animals with high metabolic rates

121.State an advantage of undergoing dormancy

- Saves energy

122.Define migration

- Avoiding metabolic adversity by relocation

123.Name the two components to migration.

- Innate
- learned

124.State a vertebrate example of migration

- Salmon move from fresh water to sea water.
- Birds move from UK to Europe in winter

125.Describe an invertebrate example of migration

- Monarch Butterfly moves from Canada to Mexico in Winter

126.State a disadvantage of migration

- Costs energy to migrate

127.State one way of tracking migration.

- Electronic tags/mark and recapture/GP

Microbe growth & Fermenters

128. State two different substances needed for microbe growth.

- Energy source
- Raw material

129. Give an example of an energy source.

- Light (photosynthetic bacteria)
- carbohydrates

130. Give an example of a simple and complex raw material.

- Simple raw material = amino acid
- Complex raw material = beef extract/fatty acids/vitamins

131. What process do microbes need simple raw materials for.

- Protein synthesis

132. State the 4 environmental conditions that need to be controlled inside a fermenter.

- Sterility/temperature/oxygen/pH

133. Explain why sterile conditions are required.

- To prevent contamination by other microbes that can cause disease/use up raw materials

134. Describe how sterile conditions are achieved in the fermenter.

- Air filter/boiling water to kill other microbes

135. Explain why temperature and pH require to be controlled.

- To keep microbe enzymes at their optimum

136. State 2 ways temperature is controlled in a fermenter.

- Water jacket
- thermostat

137. Describe how pH is controlled in a fermenter.

- Use of buffers

138. Explain why oxygen concentration requires to be controlled in a fermenter.

- For aerobic respiration

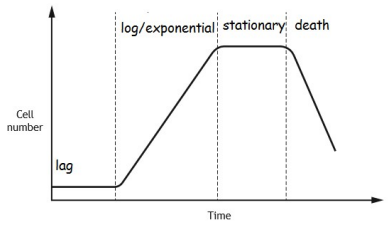
139. Describe 2 ways oxygen concentration is maintained in the fermenter.

- Air inlet
- Use of paddles for aeration

140. State two other molecules that need to be added to a fermenter when the desired product is not the end product in the metabolic pathway.

- Inducers/inhibitors/precursors

141. Draw a graph of the four stages of microbe growth.



142. Explain what happens during the lag phase.

- Takes time for enzymes to be induced/produced

143. Why are enzymes being induced?

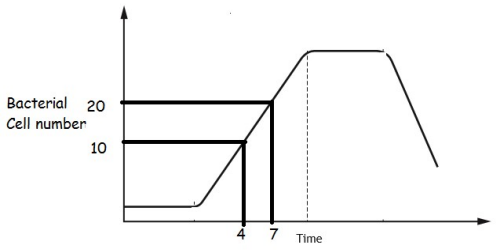
- Needed for primary metabolism to allow cell numbers to increase

144.Explain how to calculate mean generation/doubling time via a graph diagram.

- Using the exponential/log phase find a time period on the Y axis and read off the time on the X axis.
- Then double the bacteria cell number on the Y axis and read off the time on the X axis.
- The difference in time taken to double the bacterial number is the mean generation/doubling time

Worked Example

- In the example below the intial bacterial number is 10 and this was at 4 hours.
- The bacterial number at 20 (double 10) was 7 hours.
- Therefore the mean generation time would be 7-4 = <u>3 hours</u>



145.Define the exponential/log phase of microbe growth

- Rapid bacterial growth due to cell count doubling with each round of mitosis

146.Explain why a logarithmic scale is required when plotting microbe growth graphs

- As microbe growth is exponential/too rapid to be plotted on normal scale

147.State what phase the birth rate equals the death rate

- Stationary phase

148.Explain why there is a stationary phase of microbe growth

- Lack of nutrients in culture medium
- Toxic metabolites start to be produced

149.Explain why a death phase occurs

- Toxic metabolites accumulate

150.State the stages of microbe growth that are involved in primary metabolism

- Lag and log/exponential

151. Explain what happens during primary growth

- Microbes prepare to and actually increase in cell number

152.State the stages of microbe growth that are involved in secondary metabolism

- Only stationary phase

153.Name a secondary metabolite

- antibiotics

154.Explain why secondary metabolites are produced by bacteria.

- To outcompete other bacteria (to gain an ecological advantage) when competition is fierce.

Altering Wild Microbes

155.State two ways of altering wild microbes.
- Mutagenesis/selective breeding/recombinant DNA technology

156.If wild bacteria are exposed to UV radiation this is an example of?
- Mutagenesis

157.Explain how you selectively breed bacteria
- Plasmid chosen and passed from 1 bacteria to another in SAME generation/horizontal gene transfer

158.Explain how you selectively breed yeast
- Specific Yeast selected and reproduce sexually via gametes

159.Define recombinant DNA technology.
- Animal/plant genes inserted into microbe to produce animal/plant protein.

160.Which type of vector bacteria or yeast can produce inactive forms of protein.
- Bacteria

161.Explain your choice.
- Bacteria cannot fold protein correctly/cannot undergo post translational modifications

162.State why in some proteins bacterial vectors are used.
- Bacteria multiply faster/very rapidly compared to yeast

163.What are the two roles of endonuclease.
- Cut plasmids open
- Cut gene out of chromosome

164.State why the same endonuclease is used for both processes.
- To create matching/complementary sticky ends

165.State the role of ligase in recombinant DNA technology.
- Seals gene into plasmid

166.Name the 6 genes found on a vector.
- ORI sequence/regulatory sequence/safety genes/antibiotic resistance genes/genes to increase yield/restriction site

167.Name the genes responsible for self replication/future copying of plasmids
- ORI sequence/Origin of Replication

168.Name the genes where endonuclease cuts on plasmid
- Restriction site

169.Name the genes which turn certain genes ON or OFF (control gene expression)
- Regulatory sequence

170.Explain how genes work that increase yield of product.
- Amplify certain steps in a metabolic pathway/inhibit other steps in metabolic pathway

171.Explain how antibiotic resistance genes work. (2 marks)
- Expose all GM bacteria to antibiotic
- Only those bacteria that have taken up plasmid successful (transformed bacteria) will be resistant to antibiotic and survive.

172.Explain why antibiotic resistance genes are necessary.
- Plasmids being inserted into bacteria is not very successful. This process is called transforming bacteria.

173.Name an ethical consideration when working with GM micro organisms.
- GM bacterias will pass on antibiotic resistance to wild microbes in external environment by escaping lab

174.Describe how scientists prevent this ethical issue with GM microbes.
- GM bacteria have genes that prevent survival in external environments