SL Matura Vorbereitungsstunden [75 marks]

1a. *[4 marks]* **Organisms have evolved a great diversity of cell types.**

Describe the endosymbiotic theory.

Markscheme

a. theory that eukaryotic cells evolved from prokaryotes
OR
origin of eukaryotic organisms based on some organisms living inside/engulfed by other organisms
OR
prokaryotic cell engulfed another prokaryote including it in cytoplasm without digesting it;
b. mitochondria/chloroplasts have double membranes;
c. mitochondria/chloroplasts have their own DNA/loop of DNA/naked DNA;
d. mitochondria/chloroplasts have similar size to prokaryotes;
e. mitochondria/chloroplasts can reproduce by binary fission;
f. mitochondria/chloroplasts have 70S ribosomes (same as prokaryotes);

1b. ***[7 marks]***

Explain the need for halving the chromosome number during a sexual life cycle and how this is done.

Markscheme

a. chromosome number is halved so the zygote/offspring has same number as the parent / so that chromosome number is not doubled;
b. process is meiosis;
c. DNA/chromosomes replicate (so each chromosome consists of two chromatids);
d. homologous chromosomes pair in prophase I;
e. (these) separate in anaphase I into two cells;
f. (after meiosis I) cells are haploid;
g. in meiosis II chromatids are separated;
h. result is four haploid cells/gametes;
i. each gamete is genetically unique;
j. (uniqueness) is due to crossing over/independent assortment/random alignment of chromosomes;
k. fertilization results in the formation of a diploid zygote;
l. (fertilization) results in variation in a population

1c. ***[4 marks]***

Outline the binomial system of classification.

Markscheme

a. the binomial system of names for species is universal among biologists
OR
named according to a globally recognized scheme;
b. allows to classify organisms into groups based on similar characteristics/common ancestry/DNA;
c. every species is given a binomial name;
d. members of the same species can mate and reproduce fertile offspring
e. genus is written first, followed by species;
f. genus is capitalized, (followed by) species is lower case
OR
an underlined correct example/stated that it must be underlined or italicized;

2a. ***[3 marks]***

Outline the structure of proteins.

Markscheme

a. protein formed from amino acids
OR
20 different amino acids ✓

b. linked together by peptide bonds ✓

c. may consist of one or more polypeptides linked together ✓

d. have a specific shape/conformation/folding ✓

e. shape determines function ✓

2b. ***[7 marks]***

Cells produce a large variety of proteins with different sequences of amino acids. Explain how this is done.

Markscheme

a. protein is produced when a gene is expressed / switched on ✓

b. genetic code/codons consists of three nucleotides/bases/base triplet ✓

c. genetic code in DNA is transcribed/transcription (to mRNA) ✓

d. mRNA exits the nucleus ✓

e. mRNA (code) is translated/translation into a polypeptide/protein ✓

f. amino acid sequence/polypeptide formation occurs at a ribosome ✓

g. one codon translates to one amino acid ✓

h. tRNA carries code for specific amino acids ✓

i. tRNA anticodon matches with specific codon in mRNA ✓

j. amino acids joined (by peptide bonds) to form polypeptide ✓

k. sequence of amino acids determined by order of bases/nucleotides/codons in DNA/mRNA ✓

l. proteins vary based on which amino acids are used and their order
OR
protein variety increases by mutations to DNA ✓

2c. ***[5 marks]***

Outline the range of functions of proteins in cells.

Markscheme

a. enzymes that catalyse/speed up/control (the rate and direction of) metabolic reactions ✓

b. proteins can be hormones which are chemical messengers to cells ✓

c. proteins that transport through the membrane such as channel/carrier/pumps / that regulate what enters/leaves the cell ✓

d. hemoglobin in red blood cells that transports/ binds oxygen ✓

e. membrane proteins for cell/tissue recognition/cell adhesion/communication ✓

f. structural elements of muscle fibre/actin/myosin for movement
OR
spindle fibres move chromosomes ✓

g. histones condense DNA into chromosomes ✓

The question requires answer that the function is in cells.

3a. ***[3 marks]***

Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*.

Outline the structures in *M. tuberculosis* that are not present in a human cell.

Markscheme

a. cell wall ✓

b. pili/flagella ✓

c. 70S ribosomes ✓

d. nucleoid / circular DNA
OR
naked DNA ✓

e. plasmids ✓

As candidates do not need to know the structure of Mycobacterium tuberculosis, all prokaryotic structures are accepted.

Ignore references to membrane bound organelles.

3b. ***[7 marks]***

Explain the production of antibodies when a patient is infected with the TB bacterium.

Markscheme

a. phagocytes/lymphocytes are white blood cells ✓

b. TB bacterium has a specific antigen ✓

c. this antigen is recognised by white blood cells ✓

d. a clone of lymphocytes/plasma cells/B cells are produced ✓

e. antibodies are produced by lymphocytes ✓

f. each lymphocyte produces just one type of antibody ✓

g. (this is) specific immunity ✓

h. (part of the) antibody/immunoglobulin binds to the antigen / specific antibody binds to the specific antigen ✓

i. antibodies are proteins/immunoglobulins ✓

j. (some) plasma cells become memory cells ✓

k. memory cells reproduce quickly ✓

l. memory cells prevent infection in the future ✓

Allow annotated diagrams to explain the process.

3c. ***[5 marks]***

Describe the risk to the human population of indiscriminate use of antibiotics.

Markscheme

a. antibiotics block bacterial processes ✓

b. example of bacterial process ✓ e.g. *cell wall formation*

c. variations exist naturally in a population / some are naturally resistant to the antibiotic ✓

d. bacteria that are not resistant to this antibiotic will die / only resistant will survive (when antibiotic given) ✓

e. this characteristic could be passed to next generation ✓

f. (natural selection) leads to changes in the proportions/frequency in the population ✓

g. human population will be exposed to antibiotic resistant bacteria and will not have antibiotic to kill them ✓

h. (antibiotic resistant bacteria) may pass resistance to other bacteria species/types by means of plasmids (so other bacteria species turn resistant too) ✓

4a. ***[4 marks]***

Draw a section of the Singer-Nicolson model of an animal cell membrane.

Markscheme

a. bilayer of phospholipids with both "tails" towards the inside «of the bilayer» ✓ *This can be taken unlabeled from diagram*.

b. hydrophilic/polar **and** hydrophobic/non-polar annotation ✓

c. cholesterol between phospholipid tails ✓

d. glycoprotein ✓

e. integral proteins/channel proteins ✓

f. peripheral proteins ✓ *Allow this if it does not extend across the membrane*

Elements should be clearly drawn, correctly positioned and annotated.

4b. ***[4 marks]***

Outline the principles used by scientists to classify organisms.

Markscheme

a. use of the binomial system ✓

b. agreed/developed by scientists / *OWTTE* ✓

c. hierarchy of taxa used ✓ *Names of the seven taxa not required*.

d. three domains used/three domain names ✓ *OWTTE*

e. genome/DNA sequence similarities
OR
amino acid sequence of specific proteins ✓

f. species from a common ancestor are grouped together
OR
included in the same clade/branch in cladogram ✓

g. use evidence of evolutionary origin ✓ Allow example *e.g.* fossil record comparison

h. shared characteristics within a group
OR
similar embryonic development ✓

4c. ***[7 marks]***

Explain the movement of energy and inorganic nutrients in an ecosystem.

Markscheme

a. autotrophs/producers/plants obtain inorganic nutrients from the «abiotic» environment ✓

b. energy provided «mainly» by sunlight ✓

c. light energy converted «to chemical energy» through photosynthesis ✓

d. photosynthesis/producers/autotrophs convert inorganic carbon/carbon dioxide and water into carbon/organic compounds ✓

e. «these» carbon compounds/foods contain/are a source of «useable» energy «for life» ✓

f. carbon compounds/energy are transferred along food chains when eaten by consumers/heterotrophs ✓ *Allow OWTTE for mpf for passed up trophic levels*.

g. respiration returns carbon «dioxide» to the environment ✓

h. respiration releases stored/chemical energy as ATP/heat ✓

i. energy/ATP is used to carry out life functions/synthesis/growth/movement ✓

j. energy is lost/not recycled ✓

k. nutrients are recycled / example of recycled nutrient *e.g.* carbon ✓

l. decomposers recycle minerals/inorganic nutrients ✓

5a. ***[4 marks]***

Outline the stages in the production of mRNA by transcription.

Markscheme

a. DNA is unwound/strands are separated «by RNA polymerase» ✓

b. new nucleotides attached to template strand «by RNA polymerase» ✓

c. complementary base pairing/base pairing with an example
OR
adenine with thymine/uracil with adenine/cytosine with guanine/guanine with cytosine ✓

d. mRNA detaches from template ✓

e. DNA rewinds ✓

5b. ***[4 marks]***

Describe the functions of proteins in cell membranes.

Markscheme

a. facilitated diffusion by channel proteins ✓

b. active transport by protein pumps
OR
protein pumps *eg* sodium-potassium ✓

c. cell recognition by glycoproteins/protein receptors ✓

d. communication/receptors for hormones/signal molecules ✓

e. cell adhesion ✓

f. allow up to one additional mark for AHL material ✓

5c. ***[7 marks]***

Explain how natural selection can lead to speciation.

Markscheme

a. natural selection is caused by selection pressures in the environment
OR
example of a selection pressure ✓

b. natural selection requires that variation exists within a species ✓

c. variation arises randomly due to mutation
OR
variation is enhanced by meiosis/sexual reproduction ✓

d. over-production of offspring promotes selection
OR
natural selection occurs when there is competition/overpopulation/predators/environmental changes/changes in selection pressures ✓

e. well adapted individuals/individuals with best variations survive to reproduce/survival of fittest ✓

f. «frequency of» genes/alleles conferring an advantage are selected for
OR
genes/alleles conferring a disadvantage are selected against ✓

g. genetic divergence/difference increases
OR
natural selection «genetically» isolates members of a species so eventually they can no longer produce fertile offspring ✓

h. genetic divergence» leads to reproductive isolation ✓

i. geographical/behavioural/ecological factors may lead to «reproductive» isolation ✓

j. prolonged «reproductive» isolation leads to speciation ✓

k. up to one additional mark for AHL information ✓