M12/4/BIOLO/SP3/ENG/TZ1/XX/M

International Baccalaureate®
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MARKSCHEME

May 2012

BIOLOGY

Standard Level

Paper 3

20 pages

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through Scoris™, by e-mail or telephone – if through Scoris™ or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through Scoris™ or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of Scoris™, please contact emarking@ibo.org.

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1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use Scoris™ annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, enter a zero in the mark panel on the right-hand side of the screen. Where an answer to a part question is worth no marks because the candidate has not attempted the part question, enter an "NR" in the mark panel on the right-hand side of the screen.

7. If a candidate has attempted more than the required number of options within a paper or section of a paper, mark all the answers. Scoris™ will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp "seen" on any additional sheet that contains no other annotation.

9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the "CON" stamp.

Subject Details: Biology SL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options **[2 × 18 marks]**.
Maximum total = **[36 marks]**.

1. A markscheme often has more marking points than the total allows. This is intentional.

2. Each marking point has a separate line and the end is shown by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking indicate this by adding **ECF** (error carried forward) on the script.

10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Option A — Human nutrition and health

A1. (a) iron *[1]*

(b) 21– 40-year-old males *[1]*

(c) a. more females than males have iron deficiency (55 %/25 %);
b. very small difference / 2 % difference between males and females for vitamin B12 deficiency and folic acid deficiency; *[2]*
Allow valid numerical comparisons.
Accept reverse argument for first point.

(d) a. females lose blood while menstruating;
b. extra nutrients needed while pregnant;
c. extra nutrients needed while breastfeeding;
d. differences in diet/vegetarian/vegan / low ferretin levels;
e. males receive more food than females/perceived to have greater need/status; *[2 max]*

A2. (a) a. fibre/cellulose cannot be digested;
b. aids peristalsis/helps to prevent constipation/adds bulk;
c. prevents obesity by increasing bulk in the stomach;
d. reduces the risk of appendicitis/cancer/hemorrhoids;
e. slows the rate of sugar absorption/helps prevent diabetes; *[3 max]*

(b) a. minerals are inorganic elements (simple compounds from elements in ionic form) and vitamins are organic compounds (which cannot be synthesised by the body);
b. minerals are all water soluble but only some vitamins are water soluble (others are lipid soluble);
c. some vitamins are destroyed by exposure to oxygen, minerals are not; *[1 max]*

(c) a. PKU caused by deficiency/ lack of enzyme (tyrosine hydroxylase);
b. phenylalanine cannot be converted/metabolized (to tyrosine) so builds up in blood and tissues/remains high;
c. so extra sources of phenylalanine in the diet must be controlled/reduced;
d. diet should include fruit/grain/vegetables/special formula milk;
e. diet must be undertaken very early in life;
f. to reduce brain damage/mental retardation;
g. symptoms occur from three/four months; *[3 max]*
Do not credit any references to genes.

A3. (a) a. human milk contains lactose while artificial milk contains glucose;
b. human milk protein (65 % whey protein, 35 % casein) different from proteins in artificial milk (18 % bovine whey, 82 % bovine casein, soya protein);
c. differences in fatty acid composition (human butterfat *versus* palm, coconut, soy or safflower oils);
d. human milk has less iron/Ca/P than artificial milk;
e. human milk has antibodies (in colostrum) while artificial milk does not; ***[2 max]***

Statements must be ***comparative*** *to gain a mark.*

(b) a. babies more able to resist infection/gives passive immunity (to the baby);
b. all necessary nutritional ingredients in the right amounts / properly balanced diet/more easily digested (by the baby);
c. lower mortality rates of breastfed babies;
d. no risk of allergic reaction to proteins in cow's milk/soya;
e. reinforces close bond (emotional/social) between mother and child;
f. (may) act as natural birth control method;
g. naturally sterile;
h. energy required to produce milk / milk production helps mothers lose weight; ***[3 max]***

Option B — Physiology of exercise

B1. (a) 20 (%) *(units not required)* ***[1]***

(b) (i) a. sprinters have (slightly) more muscle injuries than hurdlers;
b. hurdlers have more (×2) injuries to joints than sprinters;
c. sprinters have (slightly) more tendon injuries than hurdlers;
d. sprinters and hurdlers have very similar levels of other injuries / both have (about) 26 % other injuries; ***[2 max]***

(ii) sprinting because the pattern of injuries more closely matches that of sprinters / specific example of match *e.g.* muscle injuries close to 50 % in both ***[1]***

(c) a. gentle stretching of tendons/ligaments may make them less vulnerable to injuries;
b. warm-up routines improve blood flow to muscles, making muscles warmer and less prone to injury;
c. evidence for the effectiveness of warm-up routines is thin and anecdotal / some athletes compete successfully after little or no warming up; ***[2 max]***
*Do **not** accept psychological effects/mental preparation – this does not relate to injuries.*

B2. (a) a. knee joint is hinge joint while hip joint is ball and socket;
b. knee joint allows movement in one plane only while hip joint allows movement in all planes;
c. knee joint allows flexion/bending/straightening/extension while hip joint allows protraction/retraction/abduction/adduction/rotation; ***[2 max]***
***N.B.** Answers must make comparisons.*

(b) a. blood flow to brain unchanged during exercise;
b. blood flow to heart wall/skeletal muscles/skin increased during exercise;
c. blood flow to kidneys/stomach/intestines/abdominal organs/liver reduced during exercise; ***[2 max]***

(c) a. EPO produced by kidneys/stimulate red blood cell production in bone marrow;
b. (six week) treatment with EPO can give (12 %) increase in hemoglobin so more oxygen carried;
c. EPO not detected in urine/blood/same as natural hormone;
d. increase in blood viscosity is potentially life threatening/increased risk of strokes/heart attacks/pulmonary edema;
e. may lead to exclusion/banning from competitions/has ethical implications/fairness *etc.*; ***[2 max]***

B3. (a) *Award **[1]** for each structure clearly drawn and correctly labeled.*

a. Z lines;
b. thin actin filaments shown attached to Z lines;
c. thick myosin filaments with heads;
d. light and dark bands; ***[3 max]***

*Award **[2 max]** for poorly drawn/inaccurate diagram.*

(b)
a. action potential arrives at the neuromuscular junction/depolarizes muscle cells;
b. release of calcium ions from the sarcoplasmic reticulum;
c. (calcium binding to troponin exposes actin) to form cross-bridges;
d. heads push actin filament towards centre of sarcomere (so sarcomere becomes shorter);
e. use of ATP to break cross-bridges/re-set myosin heads; ***[3 max]***

Option C — Cells and energy

C1. (a) (255–184/183 =) 71/72 $mg\,CO_2\,m^{-2}\,hr^{-1}$ *(units required)* ***[1]***

(b) respiration (in tree root cells/mycorrhizal fungi/bacteria/other microorganisms) ***[1]***

(c) (i) a. as nitrogen addition increases, release of CO_2 decreases;
b. greater decrease from zero to 50 $kg\,ha^{-1}\,yr^{-1}$ than from 50–150 $kg\,ha^{-1}\,yr^{-1}$ / from zero to 50 $kg\,ha^{-1}\,yr^{-1}$ decrease is 43 $mg\,CO_2\,m^{-2}\,hr^{-1}$, from 50–150 $kg\,ha^{-1}\,yr^{-1}$ decrease is 28 mg $CO_2\,m^{-2}\,hr^{-1}$; ***[2]***

(ii) increased nitrogen addition leads to less root/fungal/bacterial growth/alters pH/osmotic potential of soil so affecting/decreasing respiration of organisms resulting in less CO_2 production ***[1]***

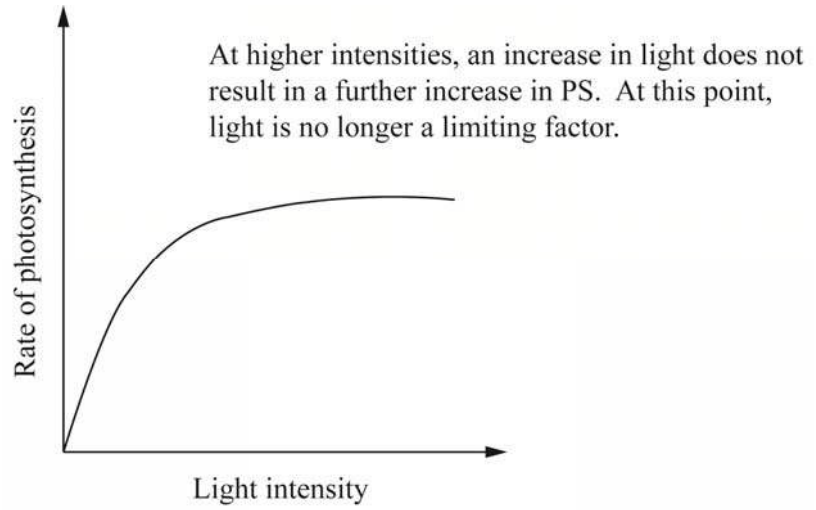
(d) a. as nitrogen addition treatment increases, release of CO_2 from soil decreases in the hardwood area whereas there is no significant change in the softwood area;
b. release of CO_2 from soil is higher in hardwood area than in softwood area at all nitrogen addition treatments;
c. at nitrogen addition treatment of 50 $kg\ ha^{-1}\ yr^{-1}$ hardwood shows (large) decrease in CO_2 release from zero treatment whereas softwood shows (slight) increase / other valid numerical comparison; ***[2 max]***

C2. (a) a. oxidation is loss of electrons, reduction is gain of electrons;
b. oxidation frequently involves gaining oxygen, reduction is losing oxygen;
c. oxidation is losing hydrogen, reduction is gaining hydrogen;
d. oxidation increases oxidation state / number of elements, reduction lowers it; ***[2 max]***

(b) a. takes place in cytoplasm;
b. glucose is phosphorylated/two molecules of ATP are used;
c. one hexose sugar/glucose is converted into two three-carbon/3C molecules/hydrolysis;
d. pyruvate is formed/oxidation of glucose to pyruvate;
e. small yield/net gain of two ATP;
f. net gain of two NADH + H^+;
g. does not require/use oxygen/anaerobic process; ***[3 max]***

(c) a. limiting factors can determine the rate of photosynthesis / if the level of a factor is changed the rate of photosynthesis changes;
b. only changes to one factor will affect rate of photosynthesis at a particular time;
c. light intensity affects the light-dependent reactions/production of ATP/NADPH;
d. at low light levels the rate of photosynthesis is directly proportional to light intensity/light is limiting;
e. at high light levels there is no further increase in the rate of photosynthesis/some other factor is limiting (*e.g.* CO_2/temperature); ***[3 max]***

Accept the above points illustrated by a suitable correctly sketched graph with both axes labelled and correct shape (see example below).



C3. a. polar amino acids are water soluble/hydrophilic, non-polar amino acids are not/hydrophobic;
b. distribution of amino acids influences the position of proteins (in membranes);
c. polar amino acids often found on outside of protein, non polar orientate themselves away from water/ in core of protein;
d. polar amino acids create hydrophilic channels through membranes;
e. non-polar amino acids interact with lipid bi-layer/stabilize proteins in membranes;
f. polarity of amino acids determines the specificity of active sites in enzymes;
g. polar and non-polar amino acids affect the tertiary and quaternary/3D structure of proteins; ***[3 max]***

Option D — Evolution

D1. (a) 1972 ***[1]***

(b) 32 *(units not required) (Allow answers in the range 31–33)* ***[1]***

(c) (i) *Award **[2 max]** if at least 1 similarity and 1 difference not given.*

Similarities:
a. in all species, melanics show a decline / non-melanics an increase in frequency;
b. up to 1987 percentage of melanics stable/slight decline for all three species;

*Differences: Both parts of comparision required for **[1].***
c. after 1987 percentage of *B. betularia* melanics declines sharply whereas percentage for the other species declines slowly;
d. at start of investigation/1969/up to 1987 (very) few (less than 10%) non-melanic forms of *B. betularia* whereas the percentage much higher (more than 20%) for the other two species / converse;
e. melanic forms of *B. betularia* and *O. bidentata* drop below 50% (by 1996) but *A. crenata* does not; ***[3 max]***

(ii) a. change from polluted (industrial) environment to clean (post-industrial);
b. change in tree species allowing different habitats for resting moths;
c. change in predators as climate/habitats change;
d. changing selection pressures/mutation/migration/genetic drift;
e. grass grows quickly/colour not influenced by pollution so least change in/less selection pressure on *A. crenata*; ***[2 max]***

D2. (a) a. a species is a group of organisms with similar characteristics, which can interbreed and produce fertile offspring;
b. sibling species may show similar characteristics but cannot interbreed (*e.g.* Pipistrelle bat in Britain);
c. some pairs of species are different but can interbreed (*e.g.* ruddy duck and white headed duck/many plant species);
d. some species always reproduce asexually so definition may not apply;
e. some breed in zoos/captivity, but will not interbreed in nature;
f. difficult to classify fossils as cannot decide if they could interbreed; ***[3 max]***
Unfamiliar examples should be checked for accuracy using the internet.

(b) a. speciation is the formation of new species (by splitting of an existing species);
b. *sympatric:* in the same geographical area/organisms occupy different niches/show different patterns of behaviour;
c. valid example *e.g.* common and short-toed tree creepers;
d. *allopatric:* in different geographical areas/geographic separation of species;
e. valid example *e.g.* cichlids in African lakes; ***[2 max]***
*Award **[1 max]** if only either sympatric or allopatric discussed.*
*Award **[1 max]** if only correct examples given with no description.*

D3. (a)
a. new species evolve from one ancestral species;
b. species evolve in different ways to become adapted to different ecological roles;
c. divergent evolution / homology;
d. different environments provide different selection pressures/new niches become available;
e. valid example *e.g. Galapagos finches*/vertebrate pentadactyl limb; ***[3 max]***

(b)
a. cultural evolution does not involve changes in the gene pool;
b. cultural evolution involves learning/largely acquired/not innate/not instinct;
c. example of cultural evolution (*e.g.* agriculture/language/customs/art /technology /other);
d. cultural evolution changes can happen in one lifetime (nurture);
e. cultural evolution can pass between non-related individuals;
f. cultural evolution responsible for many recent changes in the lives of humans/hastened by modern technology; ***[3 max]***

Option E — Neurobiology and behaviour

E1. (a) 31 cm *(units required) (Allow answers in the range 30.8 cm –31.2 cm)* ***[1]***

(b) direct/positive correlation / higher birth weight babies have larger head circumference ***[1]***
Do not accept directly proportional.

(c) a. head circumference decreases in babies exposed to high levels of cocaine;
b. low cocaine exposure has slightly/consistently lower head circumference than no cocaine at all birth weights;
c. effect of cocaine exposure on head circumference decreases as the birth weight increases (or converse);
d. smallest head circumference from high cocaine group / largest head circumference from no cocaine group; ***[2 max]***

(d) a. causes smaller head circumference;
b. at both low and high level of use / high cocaine has a greater effect/converse;
c. there is no proof that there is a cause and effect, just a correlation/there might be other variables influencing this relationship; ***[2 max]***

E2. (a) innate behaviour is independent of experience/environmental conditions/inherited while learned behaviour is influenced by experience/environment / *OWTTE* ***[1]***

(b) I eardrum / tympanic membrane
II cochlea
III auditory/vestibulocochlear nerve
IV semicircular canals ***[2 max]***
*Award **[1]** for every two correct.*

(c) (i) a. rods and cones are both light-sensitive cells;
b. rods are far more numerous than cones;
c. rods are distributed evenly throughout the retina while cones are particularly concentrated at and around the fovea;
d. rod cells are all the same/black and white vision but there are three types of cone cells (absorb red, blue and green colour)/colour vision;
e. rod cells absorb all the visible wavelengths but each type of cone cell absorbs a different range;
f. rods are longer and thinner, cones have cone shape;
g. rod cells are principally used for dim light and night vision while cone cells require bright light / rods give poor visual acuity while cones give good visual acuity;
h. the pigment in rod cells is rhodopsin while in cone cells is iodopsin;
i. each individual cone cell is fed to a single (bipolar) neuron, whereas many rod cells synapse with a single (bipolar) neuron; ***[3 max]***

(ii) *This question has had to be discounted.*
Please award marks in the following ratios:

Candidate mark total /16 for option E excluding E2. (c) (ii)	**Candidate mark for E2. (c) (ii)**
0–3	0
4–11	1
12–16	2

Please enter the appropriate mark, 0, 1 or 2 in the mark box rather than applying ticks.

E3. (a) a rapid <u>and</u> unconscious/automatic response (to a stimulus) ***[1]***

(b)

		Main role
a.	***Motor neuron***	carry impulses from central nervous system/CNS to muscles/glands/effectors;
b.	***Sensory neuron***	receive/carry impulses from receptors/sense organs to central nervous system/CNS;
c.	***Relay neuron***	connects sensory neuron and motor neuron;

[3]

Option F — Microbes and biotechnology

F1. (a) coliphages/viruses ***[1]***

(b)
a. number of both types (bacteria and viruses) is reduced;
b. the reduction of bacteria was greater than for viruses;
c. in the first 10 minutes reduction of bacteria is large whereas reduction of viruses is gradual;
d. after 30 minutes less than 0.0001% of bacteria remain while about 10% of viruses remain; *Accept any other reasonable comparison.* ***[2 max]***

(c)
a. not necessary for bacteria as nearly all have been killed;
b. necessary for coliphages as they take longer to denature/destroy/are still present;
c. depends whether pathogens in sewage are heat tolerant;
d. depends on the cost of the treatment;
e. depends whether presence of a few microbes in treated sewage is harmful; ***[2 max]***

(d)
a. anaerobic conditions / increases BOD (biological oxygen demand) / eutrophication;
b. low dissolved oxygen may kill (aerobic) organisms;
c. pathogens/cause health hazards (bathing or drinking water);
d. algal blooms;
e. diversity falls/favours organisms able to survive low oxygen levels; ***[2 max]***

F2. (a) I (is Gram-positive) because it has thick/outer layer of peptidoglycan/does not have outer layer (of lipids) external to peptidoglycan layer ***[1]***

(b)
a. anaerobic conditions / absence of air/oxygen;
b. (facultatively) anaerobic bacteria / *Bacillus*/*Thiobacillus*/*Pseudomonas* genera;
c. soil is waterlogged/bogs/marshes/other valid example; ***[2 max]***

(c)
a. organic matter such as agricultural crops/farming waste/aquatic plants/sewage waste can be used;
b. biomass is anaerobically digested;
c. by a combination of microorganisms (three different communities) to produce methane/biogas;
d. bacteria/Eubacteria convert the raw organic waste into a mixture (organic acids, alcohol, hydrogen and carbon dioxide);
e. (other) bacteria/Eubacteria use organic acid and alcohol to produce acetate (ethanoate);
f. methanogens/Archea produce methane (and CO_2) / $CH_3COOH \rightarrow CH_4 + CO_2$;
g. methane gas is collected and used as a fuel; ***[3 max]***

F3. (a) a. undesired effects *e.g.* cancer/death;
b. virus may infect cells other than the target cells;
c. inserted gene may disrupt vital genes already in the genome;
d. virus entry may trigger an immune response;
e. treatment must be repeated at regular intervals and all medical treatments carry risk; ***[2 max]***

(b) a. gene therapy is the insertion of genes into an individual's cells and tissues to treat genetic diseases / recombinant DNA technology to overcome genetic disease;
b. in somatic therapy the missing gene is inserted into body cells while in germ line gene therapy germ cells/sperm or eggs are modified by the introduction of functional genes;
c. somatic therapy is considered safe and ethically sound while it is not considered safe or ethical to attempt to tamper with germ cells / so far gene therapy has only been used on somatic cells *e.g.* CF/SCID;
d. the change due to germ line therapy would be heritable and would be passed on to later generations while in somatic therapy modifications and effects will be restricted to the individual patient only;
e. named example *e.g.* cystic fibrosis / SCID/severe combined immune deficiency syndrome; ***[3 max]***

Option G — Ecology and conservation

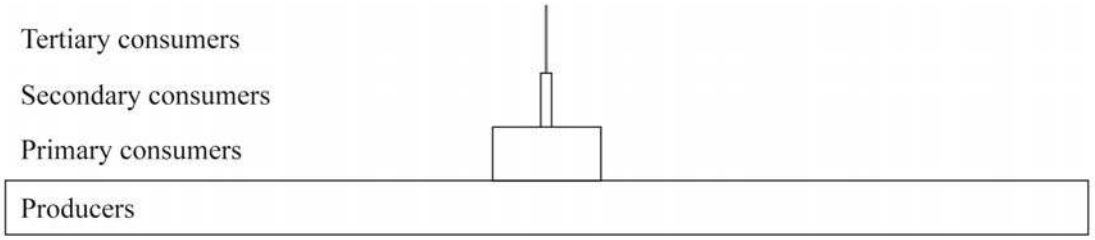
G1. (a) (i) (tank) 6 ***[1]***

(ii) (tank) 4 ***[1]***

(b) a. increasing phosphorus decreases mercury accumulation by *Daphnia*;
b. increasing concentration of phosphorus above tank 4 has little effect;
c. highest levels of mercury accumulation recorded at low phosphorus concentrations; ***[2 max]***

(c) a. increased phosphorus concentrations produce algal blooms/increased algae;
b. larger populations of algae result in smaller concentrations of mercury in the (individual) algae;
c. less mercury taken in/accumulated by *Daphnia* from their food; ***[2 max]***

G2. (a)



Values: primary consumers: 10 000 kJ m^{-2} yr^{-1}, secondary consumers: 1000 kJ m^{-2} yr^{-1} and tertiary consumers: 100 kJ m^{-2} yr^{-1}

a. correct values; *(allow 20 % error)*
b. correct trophic level labels; (*do not accept trophic level 1, trophic level 2 etc.)*
c. drawing showing proper proportions; *(height of each step the same, each bar no more than one quarter of the one below)* ***[3]***

(b) the dry mass / organic material (of a group) of organisms in a given area/habitat ***[1]***

G3. (a)
a. CFCs broken down (by UV light) to release chlorine;
b. CFCs/chlorine break down ozone in the stratosphere;
c. into oxygen;
d. ozone broken down faster than it can reform / one CFC can break down many ozone molecules;
e. holes in the ozone layer appear (at certain times of year);
f. allowing more UV radiation to reach the Earth's surface;
g. greater problem in southern hemisphere/Australia/New Zealand/Chile/South Africa; ***[4 max]***

(b) *temperature:* ***[2 max]***
a. body size/surface area to volume ratio affects the rate of animal metabolism/ability to conserve heat;
b. animals that regulate body temperature (homeotherms) can colonize a wider range of environments/habitats;
c. when animals have less control over their rate of metabolism (poikilotherms) choice of environment/habitat more determined by external temperatures;
d. fewer species can survive in extreme temperature and special adaptations are needed;

territory: ***[2 max]***
e. some establish and defend an area within a suitable habitat to attract mates/maintain food supply/rear young/avoid predation/competition;
f. can lead to intra and inter specific competition for space;
g. a territory may be established by an individual/breeding pairs/groups / may be limited places suitable as territories which affects distribution;
h. territory may be permanent or temporary / for breeding period / nomadic/migratory animals; ***[4 max]***