

CONDITIONALS

If current rates of emissions of greenhouse gases (GHG)(1)..... for another century, they(2)..... at least a quadrupling of total carbon dioxide concentrations in the atmosphere compared to pre-industrial levels.

- (1) (a) would continue (b) will continue (c) continues (d) continue (e) did continue
 (2) (a) would bring about (b) will bring about (c) brings about (d) bring about (e) did bring about

If just one sixth of the West Antarctic ice sheet(3)..... to melt, sea levels(4)..... by one metre, affecting many of the world's major cities, such as New York and London, and as much as 30 per cent of the total cropland in the world.

- (3) (a) is (b) would (c) will (d) are (e) were
 (4) (a) is rising (b) will rise (c) would rise (d) would have risen (e) would to rise

The United States has only four per cent of the world's population, yet it is responsible for nearly a quarter of total global greenhouse gas emissions. So if the US(5)..... the Kyoto agreement back in 1997, it(6)..... a much more hopeful sign that effective action to cut total emissions worldwide is possible.

- (5) (a) had signed (b) was signing (c) signs (d) signed (e) would have signed
 (6) (a) was (b) has been (c) would be (d) will be (e) would have been

On a weight per weight basis, the "greenhouse gas potential" of chlorofluorocarbons CFC11 and CFC12 is many thousands of times that of carbon dioxide. If CFC's(7)..... into the atmosphere they(8)..... there for several thousand years.

- (7) (a) release (b) will release (c) will be released (d) are released (e) would release
 (8) (a) remain (b) will to remain (c) are remaining (d) remains (e) would remained

If Italy(9)..... an extensive nuclear programme(10)..... to reduce its greenhouse emissions by significant amounts?

- (9) (a) will adopt (b) adopts (c) is adopting (d) is going to adopt (e) adopted
 (10) (a) would it could (b) could it can (c) would it be able (d) will it can (e) will it

.....(11)..... a cleaner, safer place to live today, if the Italian people.....(12)..... to abandon nuclear power?

- (11) (a) was Italy be (b) was Italy (c) is Italy (d) would Italy (e) would Italy be
 (12) (a) do not vote (b) are not voting (c) have not voted (d) had not voted (e) has not voted

Contraction and Convergence, C&C, has been proposed as an equitable global scheme to provide a framework for a smooth transition to a low level of CO₂ emissions from human activity (www.gci.org.uk/model/ideas_behind_cc.html). If, in coming years, C&C(13)..... adopted as the tool for managing CO₂ and other greenhouse gases, there(14)..... a transition to a point (convergence) where future entitlements to emit will have become proportional to population.

- (13) (a) will be (b) would be (c) was (d) is (e) were
 (14) (a) will be (b) would be (c) was (d) is (e) were

Developing countries argue that if they(15)..... unfairly penalised for climate change (which they are neither historically nor currently responsible for creating), then it(16)..... the industrialised countries that take the lead in reducing GHG emissions.

- (15) (a) would not be (b) would not to be (c) are not be (d) are not to be (e) were not be
 (16) (a) would must be (b) would must to be (c) would to be (d) should to be (e) should be

Grammar exercises devised by Jim McManus

Sources: "The Ecologist" magazine (www.theecologist.co.uk)
 and Global Commons Institute Website (www.gci.org.uk)

THE PRESENT PERFECT

(1) Complete the sentences with appropriate information about you.

- I (be born) in
- I (be interested) in my degree subject (insert length of time)
- I (be) at this university..... (insert start date)
- Before entering university I (study) at
- I (not learn) to yet
- I never (choose something you have never done)
- I (start) ago
- I just (choose something you have just done)
- I (do) exams so far.
- Today my first class (begin) at
- As regards course books, I already (buy)

(2) Complete the sentence with *been* or *gone*.

- 1 A Where's the laboratory manager?
B She's to a conference in Brussels
- 2 A Where have you ? You're so late
B Sorry, I had to wait till the experiment was completed.
- 3 A Are you going to the library to get the books we need today?
B No, I've already I went yesterday
- 4 A If anyone phones, tell them I've to lunch. I'll be back at two.
B OK, but remember I haven't to lunch either yet.
- 5 We've never to the annual conference, but we hope go to this year's in Japan.
- 6 A When are you going on holiday?
B I've already I went to Florida.
- 7 A What's happened to your colleague, Adrian?
B Didn't you know? He's to work in a laboratory near Cambridge.

(3) Fill in the blanks with the appropriate verb form

According to the synthetic biologist, Freeman Dyson, the Darwinian interlude, after three billion years,(1)..... now over. It(2)..... an interlude between two periods of horizontal gene transfer. The epoch of Darwinian evolution based on competition between species(3)..... about ten thousand years ago when a single species, Homo Sapiens,(4)..... to dominate and reorganize the biosphere. Currently, cultural evolution(5)..... a thousand times faster than Darwinian evolution, taking us into a new era of cultural interdependence which we call globalization. And now, in the last thirty years, Homo Sapiens(6)..... the ancient pre-Darwinian practice of horizontal gene transfer, moving genes easily from microbes to plants and animals, blurring the boundaries between species. We are moving rapidly into the post-Darwinian era, when species will no longer exist, and the evolution of life will again be communal. If you like, you can call that the evolution of a noosphere."

- | | | | | |
|-------------------|-----------------------|------------|------------|---------------------|
| (1) a) has | b) had | c) was | d) is | e) has been |
| 2) a) has | b) had | c) was | d) is | e) has been |
| 3) a) has ended | b) has been ending | c) ended | d) ends | e) has been ended |
| 4) a) has begun | b) has been beginning | c) began | d) begins | e) has been begun |
| 5) a) has run | b) is running | c) ran | d) runs | e) has been run |
| 6) a) has revived | b) is revived | c) revived | d) revives | e) has been revived |

Grammar exercises devised by Jim McManus

Source of Freeman Dyson article: www.metanexus.net/metanexus_online/show_article2.asp?id=9361

What is the physical process by which a mirror reflects light rays?

The oscillating electrical field in the incoming light wave produces a force on the charges inside the mirror. Most of the charges are --(1)-- too heavy (as is true for the nuclei of the atoms), or too tightly bound (as is true for most of the electrons), to vibrate significantly in response to this field. The comparatively loosely held bonding electrons, along with the free electrons present in metals, can move in response to these electrical forces, however. These electrons oscillate at the same frequency --(2)-- the incident light, which gives rise to the reflected wave.

As there are a great many electrons in the mirror, all vibrating at the frequency of the incident light, reflection from the mirror is really a group effort. All the electrons dance to the same music, --(3)-- rhythm is provided by the incident light wave. This coordination causes the reflected wave to make the same angle with respect to the mirror's surface --(4)-- does the incident beam.

A typical mirror consists of a piece of glass that has been coated with a layer of metal. Glass by itself reflects a little of the light, but the metal layer greatly boosts the reflectivity. If the metal --(5)-- perfectly conducting, it would reflect all of the light, but the conductivity of real metals is less --(6)-- perfect. This imperfection leads to some absorption of light in the metal. A polished silver surface, for example, reflects about 93 percent of the incident visible light, which is very good as metals go. Interestingly, if the metal layer --(7)-- very thin--only a few hundred atoms thick--then much of the light leaks through the metal and comes out the back. If you get the thickness of a metal layer right, you can make a beam splitter that divides an incident beam of light into two equal parts, with just a little bit of the light lost to the metal film itself.

As good --(8)-- the reflectivity of a silver mirror is, you can do --(9)-- better with dielectric mirrors. These reflectors consist of alternating layers of two transparent materials that have different indices of refraction. Dielectric mirrors can have reflectivities of 99.999 percent or better at the wavelength for --(10)-- they are designed. In these mirrors, essentially all of the incident light reflects, and virtually none is absorbed in the mirror or transmitted through it.

Source: "Ask the Experts" on the Scientific American Website – www.sciam.com

- | | | | | |
|---------------|------------|-------------|---------|-------------|
| (1) a: as | b: as well | c: either | d: or | e: neither |
| (2) a: as | b: to | c: by | d: that | e: than |
| (3) a: which | b: that | c: whose | d: why | e: what |
| (4) a: as | b: as well | c: either | d: that | e: than |
| (5) a: would | b: is | c: will be | d: were | e: would be |
| (6) a: as | b: that | c: than | d: does | e: more |
| (7) a: was | b: were | c: would be | d: are | e: is |
| (8) a: as | b: than | c: that | d: less | e: more |
| (9) a: as | b: more | c: much | d: less | e: same |
| (10) a: which | b: that | c: whosed | : why | e: what |

True or False ?

- TF1)** The majority of electrons in a mirror do not oscillate at the same frequency as the incident light.
- TF2)** A light wave is reflected from a mirror as a result of the coordinated vibration of many electrons.
- TF3)** As reflective metal coatings for mirrors, metals such as silver are among the most effective.
- TF4)** Some mirrors only begin to function as music is played at a particular rhythm.
- TF5)** Two transparent material differing as regards refraction index are used in dielectric mirrors.
- TF6)** As far as reflectivity is concerned, dielectric mirrors are equally effective at all light wavelengths.
- TF7)** As well as bonding electrons, free electrons, too, can vibrate in response to the oscillating electrical field in a light wave.

What is the physical process by which a mirror reflects light waves? - Comprehension questions

DOM.1 When, can we infer, do the loosely held bonding electrons and free electrons in a mirror begin to vibrate in response to the oscillating electrical field in an incoming light wave?

- RIS.A as soon as the light wave leaves its source.
- RIS.B as soon as the light wave is reflected back to its source.
- RIS.C as the light wave strikes the mirror.
- RIS.D as the light wave is perceived as a reflection in the eye of an observer.
- RIS.E as soon as the light wave has left the mirror through its back.

DOM.2 How does the reflectivity of a mirror formed by coating a sheet of glass with a layer of silver compare with that of a sheet of glass on its own and that of a dielectric mirror?

- RIS.A it is greater than that of the dielectric mirror, but not as great as that of the sheet of glass on its own.
- RIS.B it is greater than both that of the dielectric mirror and that of the sheet of glass on its own.
- RIS.C it is not as great as either that of the dielectric mirror, or that of the sheet of glass on its own.
- RIS.D it is less than that of the dielectric mirror, but greater than that of the sheet of glass on its own.
- RIS.E it is the same as that of the dielectric mirror, but not as great as that of the sheet of glass on its own.

DOM.3 Although coating a piece of glass with a layer of a metal such as silver considerably increases its efficacy as a mirror, why does this still not make it as effective as a dielectric mirror?

- RIS.A Since the metal layer greatly boosts the reflectivity of the glass, it is, actually, just as effective as a dielectric mirror.
- RIS.B As the metal is not perfectly conducting it absorbs some of the incident light, unlike the alternating transparent layers in a dielectric mirror, which reflect virtually all of the light.
- RIS.C As the metal is not perfectly conducting it allows all of the transmitted light to be transmitted through its back, unlike the alternating transparent layers in a dielectric mirror, which reflect virtually all of the light.
- RIS.D As metals such as silver have no free electrons, the incident light cannot produce a force on the charges in the mirror; a dielectric mirror, instead, has a great many free electrons which can vibrate in response to the incident light.
- RIS.E As a matter of fact, coating a piece of glass with a layer of metal makes it more effective than a dielectric mirror, owing to the fact that this latter just consists of layers of transparent materials.

DOM.4 Which ONE of the following statements can be inferred as TRUE, on the basis of the information provided in the text?

- RIS.A as the angle of incident light gets larger, the angle the reflected wave makes with respect to a mirror's surface gets smaller.
- RIS.B as the frequency of incident light gets smaller, the frequency at which the electrons in a mirror vibrate gets larger.
- RIS.C as the frequency of incident light gets smaller, the frequency at which the electrons in a mirror vibrate remains the same.
- RIS.D as the frequency of incident light approaches the wavelength for which it was designed, the reflectivity of a dielectric mirror decreases.
- RIS.E as the layer of metal coating a silver mirror gets thinner, the amount of incident light leaking through it and coming out the back increases.

DOM.5 Why might the metal layer coating the back of a mirror be carefully manufactured to a thickness of just a few hundred atoms?

- RIS.A in order to maximise the reflectivity.
- RIS.B so as to make as much of the light as possible leak through the back..
- RIS.C for the purpose of saving precious metals such as silver.
- RIS.D so as to obtain a beam splitter.
- RIS.E with the aim of dividing the light coming out of the back of the mirror into two equal parts.

GALILEO'S IDEAS Grammar – Question forms and Linkers

Q1 really true that inside a container in which a high vacuum has been produced, a steel ball and a cotton flock will fall with exactly the same speed?

- a) Is b) Does c) Is it d) Does it e) Has

A1 FALL OF BODIES IN A VACUUM. Yes, it is indeed true, because in the absence of friction forces all bodies fall with the same acceleration, that due to gravity, their mass and shape.

- a) independently b) irrespective c) instead of d) regardless of e) because of

Q2 Let us throw upwards, at an equal speed, two balls of equal size, one made of cork and the other of lead: if we assume that friction against air can be ignored, which of the two balls the greater height?

- a) will attain b) would attain c) attain d) attained e) would to attain

A2 FALL OF BODIES IN A VACUUM. The greatest height attained by each of the two balls will be identical, for the same reason as that given in the previous answer: the gradual reduction in the upward speed is always and only the downward acceleration of gravity, which is equal for all bodies.

- a) because b) owing c) consequence d) hence e) due to

Q3 Let us now suspend these two balls on threads of equal length, and with a push cause them to make small-amplitude oscillations: again friction, which of the two balls will swing back and forth more rapidly?

- a) ignored b) will ignore c) to ignore d) being ignored e) ignoring

A3 LAWS OF THE PENDULUM. In the absence of friction, the small-oscillation period of the pendulum is independent of the mass of the attached weight (as well as of the oscillation amplitude). The swing speed of the two balls will be identical.

- a) thus b) since c) as d) yet e) still

Q4 What is the direction of the force acting on a body thrown vertically upwards, at the instant when it to a halt and is about to begin its descent?

- a) is coming b) will come c) come d) comes e) came

A4 RELATIONSHIP BETWEEN FORCE AND VELOCITY At all points in its trajectory the body is always subjected to its weight, including when it becomes stationary at the point where its direction of motion reverses. The acting force is directed downwards.

- a) whether b) therefore c) nevertheless d) although e) though

Q5 Let us shoot a ball horizontally from a cannon at a given height and at the highest possible speed; then let us drop an identical ball freely from the same height: assuming the effect of air friction to be negligible, in which of the two cases the shorter time to hit the ground?

- a) the ball will take b) will take the ball c) will the ball take d) takes the ball e) the ball takes

A5 INDEPENDENCE OF MOTIONS The time taken will be the same in each of the two cases, the fall to the ground depends only on the acceleration of gravity, and is not influenced by any horizontal displacement caused by the shot.

- a) such as b) as c) whereas d) as long as e) as well as

Q6 What physical phenomenon a flying arrow gradually to lose speed as it moves away from the bow from which it was shot?

- a) is causing b) does cause c) does causes d) causes e) does causing

A6 PRINCIPLE OF INERTIA. The arrow advances due to inertia, because once the throw is completed there is no propelling force acting on it., the motion of the arrow would continue indefinitely at the initial velocity if no braking forces were present (in this specific case friction due to air).

- a) Currently b) Actually c) Eventually d) Unlikely e) Contrary

Q7 Why to extract the piston from a syringe if the hole for the needle is stopped up?

- a) a force requires b) a force is required c) is a force required d) requires a force e) force require

A7 *ATMOSPHERIC PRESSURE*. The outside surface of the piston is exposed to the air and is subject to atmospheric pressure, this is not the case for its surface on the inside of the syringe. The force that needs to be applied is thus 1 weight-kilogram for every square centimeter of the section of the piston.

- a) anyway b) hence c) whether d) however e) moreover

Q8 What is the physical mechanism that enables a drink through a straw?

- a) being sucked up b) sucked up c) to suck up d) to be sucked up e) be sucked up

A8 *ATMOSPHERIC PRESSURE*. During sucking, the liquid outside the straw is subject to the action of atmospheric pressure, the liquid inside the straw, where a partial vacuum is created by the sucking.

- a) unless b) unlike c) uneven d) unable e) except

Q9 As the earth rotates around its axis, why, together with birds, clouds and whatever else is suspended within it, not lose ground with respect to objects that are fixed firmly to the solid earth?

- a) the atmosphere b) the atmosphere does c) is the atmosphere d) the atmosphere is e) does the atmosphere

A9 *CONSERVATION OF ANGULAR MOMENTUM*. As a consequence of the process by which the planet was originally formed, the rotational motion of the earth is shared by all its parts, including those which are liquid and gaseous. slow down the atmosphere and prevent it from rotating along with the solid earth, a force capable of reducing the speed of this individual element of the system would be required (only possible if, in place of the vacuum beyond the atmosphere, there were some kind of immobile material against which friction were produced). *Quando gli uccelli avessero a tener dietro al corso de gli alberi con l'aiuto delle loro ali, starebbero freschi*

- a) For to b) In order to c) With a view to d) Owing to e) Due to

Q10 Suppose that the surface of the moon, instead of being rugged and opaque, were highly polished, so that it reflected like a mirror: to us to shine more or less brightly than it does at present?

- a) would it appear b) does it appear c) has it appeared d) did it appear e) will it appear

A10 *DIFFUSE REFLECTION*. If the moon a perfect mirror it would reflect light only in one specific direction, thus appearing extremely bright from one well-defined observation angle, but dark from all other angles. Its rough surface, instead, produces diffuse reflection, i.e. spreading in all directions.

- a) is b) would be c) will be d) would have been e) were

Grammar exercises devised by Jim McManus

Source for "Galileo's ideas":

"Thus Spoke Galileo" by Andrea Frova and Mariapiera Marenzana, published by Oxford University Press in 2006. This is the English translation of the original Italian version "Parola di Galileo", published by RCS-BUR.

THE MACHINERY OF CELL CRAWLING

People are often surprised, even alarmed, to learn that many of their cells crawl around inside them. Yet cell crawling is essential to our survival. Without it our wounds would not heal; blood would not clot to seal off cuts; the immune system could not fight infections. Unfortunately, crawling contributes to some disease processes, too, such as destructive inflammation and the formation of atherosclerotic plaques in blood vessels. Cancer cells crawl to spread themselves throughout the body: were cancer just a matter of uncontrolled cell growth, all tumors would be amenable to surgical removal.

The observation of cells crawling has suggested compelling ideas about the crawling mechanism. In 1786 the Danish biologist Otto F. Müller described a crawling cell as a "clear gelatinous body from which extends a glassy spike." The term "gelatinous" was inspired by the Latin verb *gelare*, meaning "to freeze." This notion of a mechanical state change in the cell - a "sol-gel transformation," as we now call it - has been very useful for picturing the mechanism of cell crawling and for isolating the molecular components of the machinery.

Cells in healing wounds and cancer cells crawl relatively slowly, at rates of 0.1 to 1 micron per hour. In contrast, cells involved in body defences against infection and hemorrhage move much faster. To fight infection, a human being produces daily more than 100 billion of the white blood cells called neutrophils. Neutrophils originate in the bone marrow, creep out of it to cruise through the bloodstream for a few hours, then crawl out of capillaries and into other tissues. At rates of up to 30 microns per minute, these migrating cells search for and ingest microorganisms infesting the skin, airways and gastrointestinal tracts. A neutrophil will move several millimeters in this way. In fact, the aggregate distance actively traveled every day by all the neutrophils in the human body would circle the earth twice.

As seen through an optical microscope, cell crawling involves extensions and contractions of the cell's outer rim, or cortex. In contrast with deeper areas of the cell, which are dotted with various subcellular organelles, the cortex appears clear and homogenous.

Cells crawl in response to external instructions. White blood cells follow trails of chemoattractants, diverse molecules derived from microorganisms or damaged tissues. Growth factors that trigger cell division can also induce directed cell movements. (*Scientific American* - September 1994)

DOM. 1 At what speed might a white blood cell travel to fight infection in a wound on the leg ?

- RIS. A Between one tenth of a micron and one micron per hour.
- RIS. B Up to 30 microns per hour.
- RIS. C Several millimeters per hour.
- RIS. D As much as 1,800 microns per hour.
- RIS. E Fast enough to circle the earth twice in a day.

DOM. 2 According to the information given in the text, which ONE of the following statements is FALSE ?

- RIS. A Between midday and midnight the combined distances travelled by all white blood cells in the human body is about the same as the circumference of the earth.
- RIS. B All tumors are amenable to surgical removal because cancer is just a matter of uncontrolled cell growth.
- RIS. C Scientists have known about the ability of cells to crawl in the human body for over 200 years.
- RIS. D The cortex of a crawling cell is similar to glass in colour.
- RIS. E When a cell crawls part of its cortex protrudes from its main body.

DOM. 3 Which ONE of the following describes factors involved in the mechanism by which cells crawl ?

- RIS. A Temperatures which are low enough to cause freezing.
- RIS. B Molecular machinery which transforms the cell's isolated components.
- RIS. C Mechanical state changes in which the cell's cortex behaves both as a solid and as a liquid.
- RIS. D Extensions and contractions caused by the contrast between the cell's outer rim and its deeper areas.
- RIS. E Organelles in the cell's deeper body undergo mechanical state changes and come to the surface.

DOM. 4 What might cause a neutrophil to start crawling ?

- RIS. A Various molecules produced by invading organisms.
- RIS. B Chemoattractants external to the human body.
- RIS. C Instructions from chemoattractants which follow a trail to the cell's exterior.
- RIS. D An external trail left behind by the directed movements of other neutrophils.
- RIS. E Growth factors derived from the division of a cell.

DOM. 5 Although we could not survive if our cells were not able to crawl, how might cell crawling damage our health?

- RIS. A Cells crawling out of wounds may cause death by bleeding.
- RIS. B Healthy cells crawl away from cancer cells instead of attacking them.
- RIS. C Cell crawling could prevent blood from clotting.
- RIS. D In cancer, cell crawling causes uncontrolled cell growth.
- RIS. E Crawling cells may mistakenly attack healthy tissue, and cause inflammation which destroys it.

Comprehension exercises devised by Jim McManus

1. Schrödinger tested the validity of his equation it to the ripple of waves around the hydrogen atom.

- a) for applied
- b) by applying
- c) to applying
- d) by application
- e) apply

2. The enzyme maltase in such a way that it can break the bond between the two glucose molecules forming maltose.

- a) has shaped
- b) is shaping
- c) is shaped
- d) does shape
- e) do shape

3. Along with visible light and infrared radiation, radio frequency radiation (RFR) is considered as "non-ionising radiation", and main biological effects are thought to arise from its ability to heat tissue.

- a) its's
- b) it's
- c) his
- d) its
- e) these

4. Generally speaking, the greater the number of pixels employed, an on-screen image will appear.

- a) the sharper
- b) sharper
- c) sharp
- d) sharpest
- e) the more sharp.

5. did it take Darwin to develop his theory of Natural Selection?

- a) How long
- b) How much times
- c) How many time
- d) How time
- e) How much long

6. Today genetic engineering of bacteria for mass production of substances like human interferon, human insulin and human growth hormone increasingly widespread.

- a) becomes
- b) is became
- c) is becoming
- d) is become
- e) has became

7. A programmer can insert a VBA program (macro) into a document that runs instantly the document is opened.

- a) whoever
- b) whatever
- c) how
- d) whenever
- e) anyhow

8. The lactose in milk is digestible only after down by lactase.

- a) break
- b) been broken
- c) is broken
- d) is breaking
- e) being broken

9. How many types of enzyme on average in the cytoplasm of a bacterial cell?

- a) there are
- b) are there
- c) there is
- d) is there
- e) is

10. Who, according to most authoritative computer scientists, the world wide web?

- a) did invent
- b) has invented
- c) had been invented
- d) invented
- e) was invented

11. Data were obtained from temperature/rain-gauge stations evenly distributed Italy

- a) all
- b) though
- c) thought
- d) throughout
- e) every

12. Although DVDs offer dramatically increased storage capacity over CDs, DVDs and CDs have the same basic optical storage technology.

- a) Nor
- b) Either
- c) Neither
- d) Both
- e) Never

13. So far this year, the Arctic 2 to 3°C warmer than the 50-year average, and spring melting this year began 17 days earlier than usual.

- a) has been
- b) was been
- c) was
- d) is been
- e) is has been

14. The source code of Linux is, that of Microsoft Windows, freely available.

- a) unlike
- b) as
- c) compared
- d) also
- e) whereas

15. a whale has three thousand million DNA bases, a certain salamander less than an inch long has over twenty times as many.

- a) Thus
- b) Despite
- c) Even
- d) Why
- e) While

16. What is protection against harmful longer wavelength UVA rays by in a sunscreen product?

- a) providing
- b) provides
- c) does provide
- d) provided
- e) do provide

17. The modern computer was conceived Alan Mathison Turing in 1935; in fact, today all digital computers are, in essence, "Turing machines".

- a) from
- b) by
- c) of
- d) in
- e) as

18. Many science graduates in Italy believe their chances of obtaining a research post in their own country is less than in Europe.

- a) else
- b) otherwise
- c) elsewhere
- d) somewhere
- e) everywhere

19. Solar cells function the unique electrical properties of N-type and P-type silicon in the presence of sunlight.

- a) owing
- b) since
- c) according to
- d) thanks
- e) because of

20. it is established whether mobile phone radiation has harmful biological effects, many people may already be experiencing health problems.

- a) So
- b) By the time
- c) Whereas
- d) All
- e) By

RELATIVE HUNGER

A recent experiment with a cannibalistic creature has provided experimental support for the extension of Darwin's theory of natural selection known as kin selection. Tadpoles of the spadefoot toad, when fed on whole-animal prey, develop into a specialized form that eats members of its own species. Yet they tend to avoid feeding on their close relatives.

Kin selection was proposed in the early 1960's by the British evolutionist William D. Hamilton. He argued that natural selection should favor genes that make animals act more altruistically toward their close relatives than toward unrelated animals. Aiding relatives could help genes spread through the population because close relatives are likely to carry copies of the same genes.

Hamilton's theory, which he expressed mathematically, is one of the principal planks of sociobiology. It spurred many biologists to examine how animals behave toward their kin, and researchers soon found that animals indeed often behave differently with close relatives than with other individuals. Many creatures, for example, will choose to be near their kin, as opposed to unrelated individuals.

Although these demonstrations have often been taken as evidence for kin selection, Alan Grafen, a theoretical biologist at the University of Oxford who is a scourge of uncritical experimenters, has chastised investigators for not ruling out other explanations. Grafen argued recently that some purported proofs of kin selection were nothing more than demonstrations that animals tend to associate with others that smell like themselves - a phenomenon that could have evolved for any number of reasons. Simply associating with relatives does not prove kin selection, Grafen noted.

David W. Pfennig of Cornell University thinks his experiment with the cannibalistic stands up to Grafen's critique and proves kin selection has tempered their appetites. Spadefoot tadpoles not fed on a whole-animal diet, he points out, become omnivores and do not eat members of their species. The omnivorous form, like many other creatures, shows a preference for associating with relatives. The carnivores, in contrast, prefer to associate with nonrelatives. When hungry, they swim around, "nipping" at any other tadpole they come across. A nonrelative unfortunate enough to be nipped is likely to be eaten, but a sibling is usually let go.

Pfennig believes the carnivores use chemical cues to recognize relatives. Because their preference for eating and associating with nonrelatives runs counter to the preference of the omnivorous form, even though they are genetically similar, Pfennig asserts kin selection is the most likely explanation.

Then why isn't cannibalism more common? Although kin selection might prevent the evolution of animals that eat close relatives, it would seem to favour the consumption of weak nonrelatives that would easily be subdued. Pfennig says he has one possible answer. In studies on larvae of tiger salamanders, he found that individuals that indulged in cannibalism were more likely to die from the effects of pathogenic bacteria and parasitic worms. That risk, he suggests, is one good reason not to take up the practice. "I wouldn't eat another human," he says.

Tim Beardsley - Scientific American, March 1992

Relative Hunger – comprehension questions

DOM.1 What, according to Grafen, could be the reason for many creatures choosing to stay near their close relatives, rather than near unrelated individuals?

- RIS. A They would simply be looking for copies of the same genes to spread through the population.
- RIS. B They would simply be expecting altruistic acts which will produce smells that they like.
- RIS. C Grafen does not believe there is any proof that animals tend to stay near their close relatives.
- RIS. D They would simply be tending to associate the smell of their relatives with unrelated individuals.
- RIS. E They would simply be tending to ikeep company with individuals which smelled similarly to them.

DOM.2 What does the theory of kin selection state?

- RIS. A Animals tend to select their kin as mates in order to increase the chances that their genes will be spread through the population
- RIS. B Genes which predispose animals to behave more altruistically towards members of their own family than towards members of completely different families, are likely to be favoured by natural selection.
- RIS. C Natural selection is likely to give an advantage to those genes which make members of a species act altruistically towards unrelated individuals, thus enabling their genes to spread through the population.
- RIS. D Only the fittest genes in any kinship group are likely to be favoured by natural selection.
- RIS. E There is a mathematical model which shows how altruistic deeds are relatively successful in keeping an even distribution of genes through a population.

DOM.3 How does Pfennig think that meat-eating Spadefoot tadpoles are able to differentiate between relatives and non-relatives?

- RIS. A They are able to distinguish between omnivores and carnivores.
- RIS. B They recognise siblings because they grew up together.
- RIS. C A relative emits a chemical substance which allows it to be identified as kin.
- RIS. D A chemical cue emitted by the meat-eating tadpole establishes which other tadpoles are also meat-eating and therefore which are its relatives.
- RIS. E A meat-eating spadefoot tadpole only associates with non-relatives so it doesn't need to differentiate between its kin.

DOM.4 What could be the genetic effect of an animal (A) helping its kin (K)?

- RIS. A The kin (K) which was helped would be influenced on the genetic level to return the favour.
- RIS. B Copies of the animal (A)'s genes would be transferred to the kin (K).
- RIS. C The animal (A)'s actual genes would probably spread through the population.
- RIS. D Genes in the kin (K) which were identical or highly similar to those of animal (A), may have increased chances of long-term survival.
- RIS. E Copies of the animal (A)'s genes would become more diffused through the population and therefore stand a greater risk of being destroyed by competing genes.

DOM.5 Why are cannibalistic animals less likely to survive?

- RIS. A There is a greater chance that they will be fed upon by carnivores.
- RIS. B They stand a greater risk of being killed by individuals which are not kin.
- RIS. C Only weak non-relatives die, strong cannibalistic individuals do survive.
- RIS. D There is a greater likelihood of a cannibal being infected by the larvae of tiger salamanders.
- RIS. E A cannibal is more prone to fatal effects from pathogenic bacteria and parasitic worms.

DOM.6 If Spadefoot tadpoles are fed vegetables as well as meat, what effect does this have on their behaviour?

- RIS. A They become omnivores, refrain from cannibalism and prefer to associate with relatives.
- RIS. B They remain cannibals, refrain from eating close relatives and prefer to associate with non-relatives.
- RIS. C They remain omnivores, refrain from eating kin and prefer to associate with non-relatives.
- RIS. D They become cannibals, refrain from eating members of the same species and prefer to associate with relatives.
- RIS. E They become hungry, refrain from staying still and swim around with both relatives and non-relatives.

DOM.7 How does the experiment with Spadefoot tadpoles support the theory of kin selection?

- RIS. A The experiment does not support the theory of kin selection.
- RIS. B Despite being a cannibal, a tadpole still prefers to associate with its close relatives.
- RIS. C Even if it is cannibalistic, and hungry, a tadpole will still not eat its close relatives.
- RIS. D Whether a tadpole is carnivorous or omnivorous, it still tends to eat with its close relatives.
- RIS. E In certain conditions a tadpole prefers to associate with non-relatives, but it still eats relatives it comes across.

DOM.8 Which ONE of the following statements is TRUE, according to the information presented in the article?

- RIS. A The theory of kin selection is one of the major disproofs of sociobiology.
- RIS. B Darwin's version of kin selection was expressed mathematically by Hamilton.
- RIS. C A carnivorous spadefoot tadpole may "nip" a close relative, as well as an unrelated individual.
- RIS. D Pfennig's reluctance to eat another human is based on primarily ethical grounds.
- RIS. E The reason why animals don't eat their weak kin is because of the power of the family bond.

DOM.9 Why was Grafen against many of the researchers who were trying to find evidence to support kin selection?

- RIS. A He was against uncritical experimenters for not demonstrating that alternative explanations for their results were unacceptable
- RIS. B He thought the uncritical experimenters were a scourge.
- RIS. C He reckoned they had come up with too great a number of reasons for interactions between like-smelling animals.
- RIS. D He was against investigators who didn't seek to establish general rules for animal behaviour.
- RIS. E He chastised researchers who didn't use Hamilton's mathematical models sufficiently carefully.