Understanding Basic Science

総合教材：科学の基礎を英語で読む

Edited with Notes & Study by
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EIHŌSHA

SCIENCE Vol. 1

by

Graham Hill and John Holman

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はしがき

本書はGraham Hill & John Holman両氏による*SCIENCE 1*の中から，大学生向きの興味深い題材を抜粋・編集したもので，理系・文系を問わず，あらゆる分野の学生にも楽しめる基礎科学の読解用教材となっています．マスメディアが取り上げるセンセーショナルなトピックを追うのではなく，しっかりした科学の基礎原理を，平明な英語を介して説明するのが本書の目的ですから，理工系の学生にとっては専門分野に進む準備段階での基礎知識として，また文系の学生にとっては一般常識として活用できます．

FOR STUDYでは，各課の重要構文・表現を文法に即して説明し，NOTESでは専門用語を中心に詳細な説明を加えることによって，より深い理解への指針となるよう配慮しました．また，EXERCISESは昨今，特に重要視されているTOEICを視野に入れた問題形式とし，読解ばかりでなくリスニング問題も組み入れました．

本書が，真摯に科学を学ぶ学生諸君の手引きとなることを期待して止みません．

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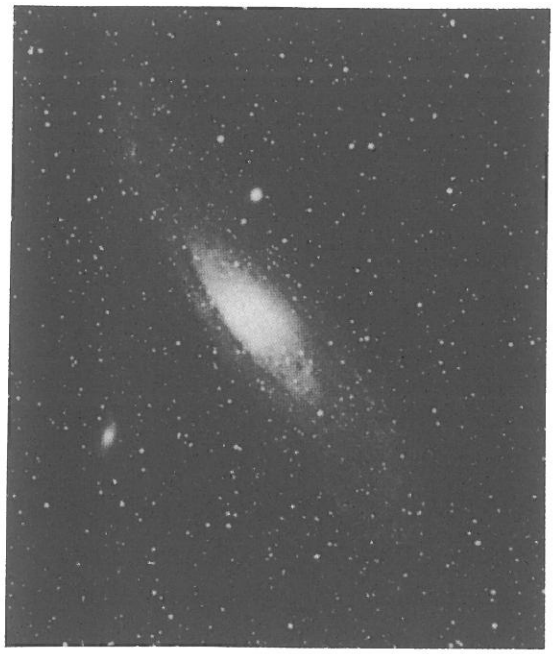
Understanding Basic Science

総合教材：科学の基礎を英語で読む

LESSON 1

UNIVERSE



(*Above*) The galaxy Andromeda is similar to our own. It is 10^{18} km across, and there are billions of other galaxies in the universe.

Stars are the units or building blocks of even larger star systems known as galaxies. Our own Sun is only one star in a huge galaxy containing over one hundred billion stars. And this is not all. Beyond our own galaxy there are billions of other galaxies which make up the building blocks of the universe.

Look at the photograph of the galaxy. It contains millions and millions of stars. The distance across the galaxy is about one million million million (10^{18}) kilometres. The Earth may seem large to us, but its diameter of 13,000 kilometres is tiny compared to the distances in space. In fact, astronomical distances are so large that they are not usually expressed in kilometres but in light-years. This is the distance that a beam of light can travel through space in one year. Light travels 300,000 kilometres every second or about ten million million kilometres per year.

The building blocks for solar systems are planets. Our own solar system contains nine planets, which move around the Sun in roughly circular paths called orbits.

Figure 1 shows the relative sizes of the planets in our solar system and

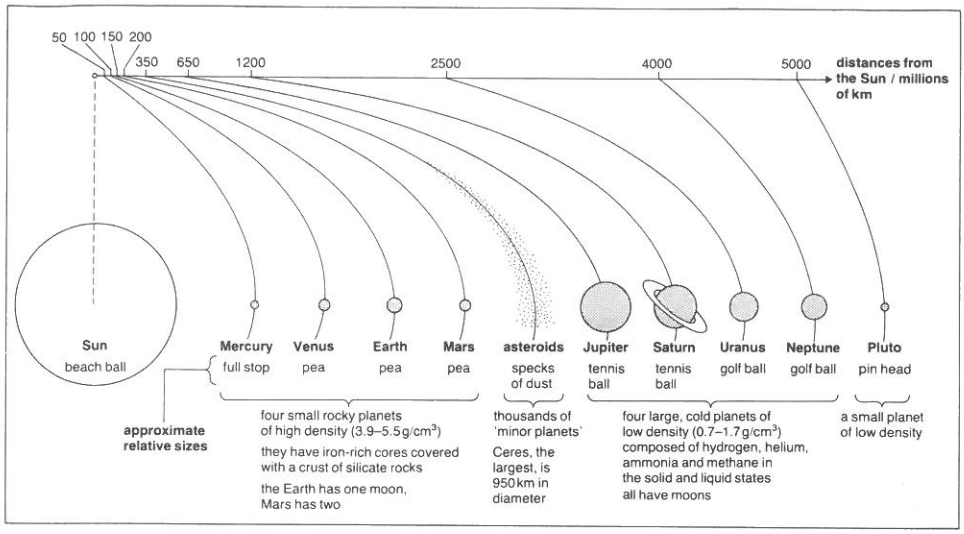


Figure 1　The solar system

their distances from the Sun. The Earth, which is 150 million kilometres from the Sun, takes one year to complete its orbit. This is small compared to Pluto which is about thirty times further from the Sun and takes 250 years to complete one orbit. Smaller bits of rock and dust also orbit the Sun. These include comets, meteors and meteorites.

All the planets in our solar system circle the Sun in the same direction and in roughly the same plane. This has led to the suggestion that the solar system formed from a vast revolving cloud of gas which slowly contracted under its own gravity. As the material condensed, a large central mass formed a new star (the Sun), while the surrounding material condensed to form the planets.

NOTES

1– **building block**「基本要素(成分)，構成要素」 / 3– **galaxy**【天文】「銀河，(銀河系外の)星雲」 / 25 **planet**【天文】「惑星，遊星」 / 27 **orbit** (*n*)「(天体・人工衛星・宇宙船の)軌道」(*vt*)「(天体の)周囲を軌道を描いて回る」 / 31 **Pluto**【天文】「冥王星」1930年に米国の Lowell 天文台の Tombaugh により発見された太陽系の最外側にある 9 番目の惑星．1979 年 1 月から 99 年 3 月までは海王星 Neptune が最外側になった． / 33 **comet**【天文】「彗星(すいせい)，ほうき星」 / 33 **meteor**【天文】「流星」a falling star, a shooting star ともいう． / 33 **meteorite**【天文】「隕石」 / 37 **contract**「収縮する，収縮させる」 / 37 **gravity**【物理】「重力，(地球の)引力」 / 37 **material**「物質，(物の)成分，素材」 / 38 **mass**「質量，(粒子・部分・事物の)集まり，塊，集合体」

FOR STUDY

1. 文の基本（主語＋述語動詞）を理解する．

(7–) Beyond our own galaxy there are billions of other galaxies which make up the building blocks of the universe.

① Beyond our own galaxy は副詞句で，there are . . . の構文．

② 主語は billions of other galaxies.

③ which make up the building blocks of the universe は主語を修飾する形容詞節．

（例文） There is no single process or step that all scientists use.（すべての科学者が用いる一様な方法や手段はない．）

2. 関係代名詞の用法について；① 関係代名詞の種類は先行詞によって決まる．② 関係代名詞の格は，従属節中での働きによって決まる．

(8–) (1) . . . there are billions of other galaxies which make up the building blocks of the universe.

(21–) (2) This is the distance that a beam of light can travel through space in one year.

（例文） (1) Many animals have a brain which controls their actions.（多くの動物はその行動を支配する脳を持っている．）

（例文） (2) Is this the picture that was painted by the artist?（これはその画家によって描かれた絵ですか．）

3. 関係代名詞の継続（非制限的）用法（一般に関係代名詞の前にコンマを用いて，先行詞の性質・状態を付加的に，挿入的に叙述する用法．）

(25–) (1) Our own solar system contains nine planets, which move around the Sun . . .

(29–) (2) The Earth, which is 150 million kilometres from the Sun, takes one year to complete its orbit.

（例文） The continent, which geologists call Pangaea, split and the separate parts drifted to their present positions.（その大陸を地質学者はパンゲアと呼んでいるが，それは分裂してそれぞれの部分が現在の位置に移動した．）

EXERCISES

I. Listen to each question and choose the correct answer.

1. Are there many stars in our galaxy?

(A) _____

(B) _____

(C) _____

2. What are the building blocks for solar systems?

   (A) _____

   (B) _____

   (C) _____

3. How many planets are there in our own solar system?

   (A) _____

   (B) _____

   (C) _____

4. How many years does it take the Earth to go around the Sun?

   (A) _____

   (B) _____

   (C) _____

5. Look at Figure 1. What does this figure show?

   (A) _____

   (B) _____

   (C) _____

II. Choose the correct answer to fill each blank.

1. ( ) our own galaxy there are billions of other galaxies.
   (A) At (B) Besides (C) For (D) Despite

2. How many planets does the solar system ( ) of?
   (A) consist (B) contain (C) include (D) involve

3. All the planets in our solar system ( ) the Sun in the same direction.
   (A) bring around (B) take around
   (C) move around (D) stop around

III. Choose the wrong usage in each sentence.

1. Our own Sun is only (A) one (B) star in a huge galaxy what (C) contains more than (D) one hundred billion stars.

2. Comparing (A) to the distances in (B) space, the Earth's diameter is (C) very small. (D)

3. Astronomical distances (A) are not (B) usually express (C) in kilometres but (D) in light-years.

IV. Rearrange the following English words in the correct order to express the Japanese sentences above them.

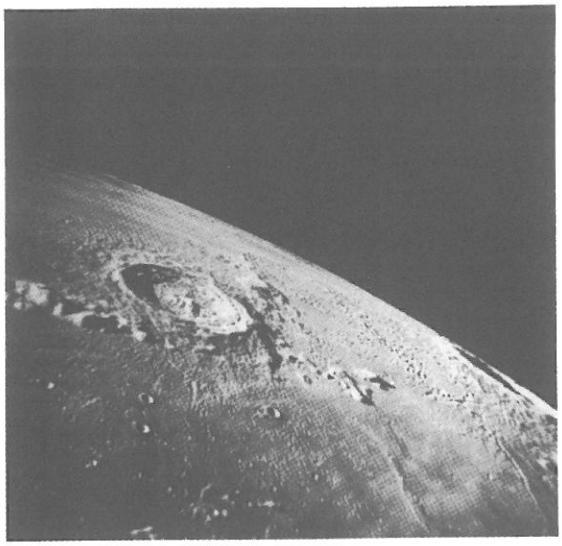
1. 太陽は太陽系の中心である.
   The, the, the, Sun, centre, system, solar, of, is.

2. 隕石は惑星に衝突する大きな岩石である。
   Meteorites, planets, the, strike, large, which, rocks, are.

3. 太陽の直径は地球のほぼ 100 倍である.
   The Sun's diameter, a, times, the, about, that, of, hundred, Earth, is.

LESSON 2

THE SUN, THE EARTH AND THE MOON



The surface of the Moon.

Our Sun is an average-sized star made mainly of hydrogen and helium. Its diameter is about a hundred times that of the Earth and it accounts for more than 99% of the mass of the solar system. The temperature on the surface of the Sun is about 6,000°C, but at its centre the temperature rises to about fourteen million degrees Celsius. These high temperatures result from continuous nuclear reactions. Within the Sun, hydrogen atoms are forced together (fused) at high temperatures and pressures forming helium. This gives out vast quantities of heat, which keeps the temperature high.

We now know that the Earth was once a molten mass of rock which has cooled down over millions of years. During this period, heavier materials sunk to the centre of the Earth forming a core of dense molten rock surrounded by less dense, cooler material in the mantle (Figure 2). Lighter materials remained on the surface forming a thin crust about fifty kilometres thick. Outside this crust, gaseous materials which have not condensed form the atmosphere. The Earth's atmosphere is composed mainly of nitrogen and oxygen, together with several other rarer gases.

For hundreds of years, people have observed the Moon and wondered what its surface would be like and whether it had any plants or animals. All the mystery and speculation ended in July 1969 when American as-

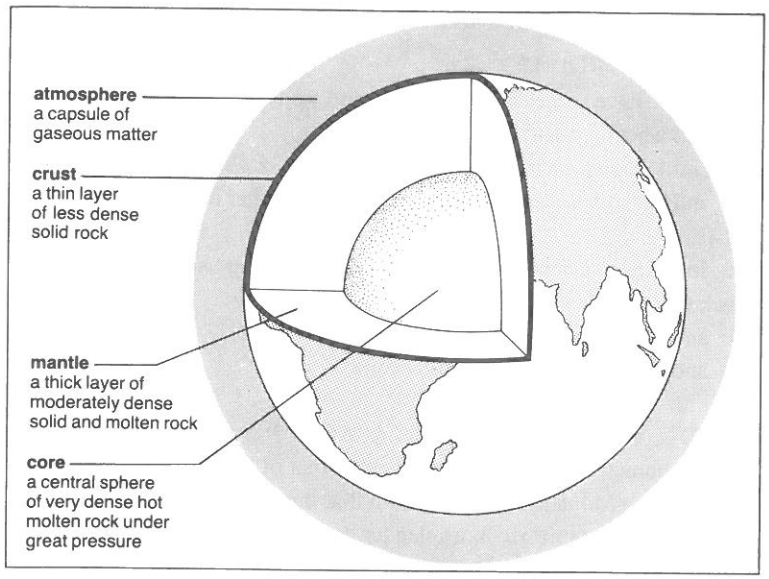


Figure 2 Layers of the Earth.

tronauts landed on the Moon in order to carry out experiments and bring samples of dust and rocks back to Earth. Tests on Moon rocks have shown that they are similar to those on Earth, but with different proportions of the elements. The high proportion of titanium has led some scientists to conclude that the Moon was never part of our own planet, as was once thought. They have suggested that the Moon formed separately and then became trapped in the Earth's gravitational field. The Moon takes 27.3 days to orbit the Earth. We can see the Moon at night because the Sun's rays are reflected from its surface. During the day, the sky is too bright for the Moon to be more than faintly visible. Probably the most important influence that the Moon has on the Earth is in controlling the tides, although the Sun's gravitational pull also affects the tides.

NOTES

6 **account for . . .**「…を占める，…を説明する，…の責任をとる」 / 13 **Celsius**「セ氏の，摂氏の，セルシウス（温度）目盛り (Celsius scale) の」この温度目盛りを考案したスウェーデンの天文学者 Anders *Celsius* (1701–44) の名にちなむ．摂氏という表記は *Celsius* の漢字音訳「摂爾思」から．cf. Fahrenheit＝華氏． / 14 **result from . . .**「…から生ずる，…に起因する」cf. result in . . .＝…に終わる，…に帰着する． / 18 **molten**「(金属・岩石などが) 溶融した」 / 22 **crust**【地質】「地殻」 / 28– **American astronauts** Apollo 11 で月面に着陸した Neil A. Armstrong ほかの乗組員． / 29 **carry out . . .**「…を実行する」cf. carry on . . .＝…を続ける． / 35 **gravitational field**【物理】「重力場」

FOR STUDY

1. 等位接続詞 and は何と何を結ぶか.

(26–) . . . people have observed the Moon ① and wondered what its surface would be like ② and whether it had any plants or animals.

① and は observed the Moon と wondered . . . を結ぶ.

② and は what its surface would be like と whether it had any plants or animals を結ぶ.

(29–) . . . in order to carry out experiments ③ and bring samples of dust ④ and rocks back to Earth.

③ and は carry out . . . と bring . . . を結ぶ.

④ and は dust と rocks を結ぶ.

2. 前出名詞の反復を表わす that (単数); 複数のときは those を用いる.

(3–) (1) Its diameter is about a hundred times that of the Earth.

(30–) (2) Tests on Moon rocks have shown that they are similar to those on Earth, . . .

(例文) The legs of a horse are more slender than those of an elephant. (馬の脚は象の脚よりほっそりしている.)

EXERCISES

I. Listen to each question and choose the correct answer.

1. What is our Sun mainly composed of?

(A) _____

(B) _____

(C) _____

2. How hot is the surface of the Sun?

(A) _____

(B) _____

(C) _____

3. Why is the Moon seen at night?

   (A) _____

   (B) _____

   (C) _____

4. How many days does the Moon take to go around the Earth?

   (A) _____

   (B) _____

   (C) _____

5. Look at Figure 2. What is the thick layer inside the Earth called?

   (A) _____

   (B) _____

   (C) _____

II. Choose the correct answer to fill each blank.

1. The Sun ( ) for more than 99% of the mass of the solar system.
   (A) brings (B) takes (C) sets (D) accounts

2. Rocks provide us ( ) many of the raw materials for industry.
   (A) to (B) with (C) in (D) as

3. American astronauts landed on the Moon in order to ( ) experiments into practice.
   (A) get (B) keep (C) put (D) take

III. Choose the wrong usage in each sentence.

1. The temperature (A) raised (B) to thirty degrees (C) Celsius in Tokyo and (D) Yokohama yesterday.

2. This (A) high temperatures are caused (B) by (C) continuous nuclear reactions (D).

3. It (A) has been shown that (B) Moon rocks are (C) similar to that (D) on Earth.

IV. Rearrange the following English words in the correct order to express the Japanese sentences above them.

1. 太陽はわれわれに光と熱のエネルギーを与える.
   The, light, us, heat, the, of, Sun, and, energy, gives.

2. 地球は大洋や湖のある唯一の惑星である.
   The Earth, is, and, has, the, only, that, lakes, planet, oceans.

3. ガリレオは月の表面を観察するために望遠鏡で月を見た.
   Galileo, the, a , its, observe, in, through, surface, to, moon, order, telescope, looked at.

LESSON 3

LIVING THINGS

Felis tigiris

There is a vast variety of living things, and studying them would be impossible without sorting them into groups. Scientists sort living things into groups with similar characteristics. The smallest group is called a species. Members of a species are very like one another and can breed together. For example, all dogs are members of the same species and can breed together. Dogs cannot breed with cats, which are a different species.

Similar species are grouped into a genus. For example, all the cats, including lions and tigers as well as domestic cats, are in the same genus, called *Felis*. But there are still many, many different genuses, and further grouping together is needed.

Some broad classifications are fairly obvious, for example, plants and animals. Within the animals, it is easy to classify according to whether the animal has a backbone (vertebrates) or no backbone (invertebrates). Vertebrates themselves may be "warm-blooded" like a human or a bird, or "cold-blooded" like a frog or a lizard. Plants may be seed-producing or non-seed producing. A simple way of classifying plants and animals is shown in Figure 3.

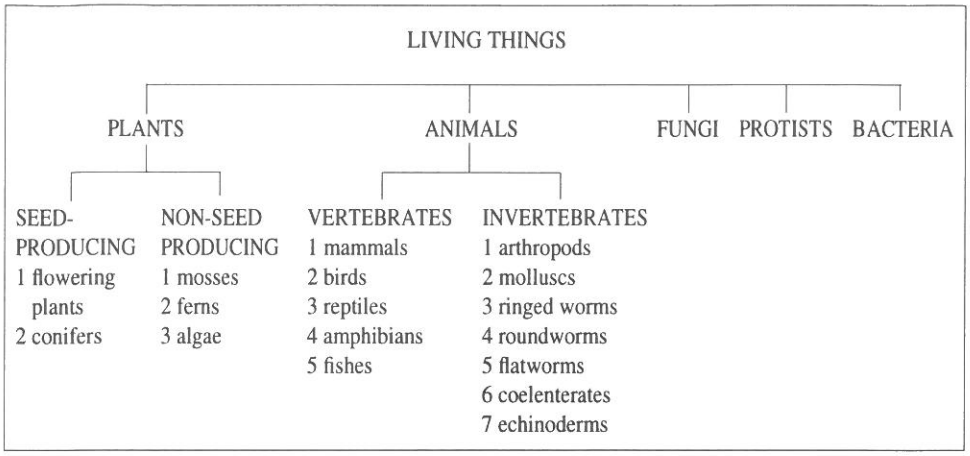


Figure 3 A simple way of classifying living things.

All living things feed, but the variety of their diet is enormous. Many animals (lions and hawks for example) are carnivores, and eat nothing but meat. Many more (horses, grasshoppers, snails for example) are herbivores, and eat nothing but plants. Badgers and humans are examples of the many omnivores which eat both meat and plants. Another group are parasites, which live off other organisms. For example tapeworms feed on the contents of the human gut, and fleas feed on blood.

Most plants make their own food. Fungi lack the chlorophyll needed to do this. They are saprophytes, feeding off dead or decaying organisms.

Many of the characteristics of an organism are decided by its diet. Its food determines both where it lives, and the organs it needs to break down and use this food.

NOTES

9 **species**（単数・複数とも同形）【生物】「種」生物分類の基本単位． / 15 **genus**（複 genera, genuses）【生物】「属」生物分類で科 (family) の下位，種 (species) の上位． / 17 ***Felis*** 【生物】「ネコ属」 / 21 **vertebrate** 【生物】「脊椎動物」 / 21 **invertebrate** 【生物】「無脊椎動物」 / 27 **carnivore** 【生物】「肉食動物」 / 28– **herbivore** 【生物】「草食動物」/ 30 **omnivore** 【生物】「雑食動物」 / 31 **parasite** 【生物】「寄生生物，寄生虫」 / 33 **chlorophyll** 【生化学】「クロロフィル」葉緑素，炭水化物の光合成を行う． / 34 **saprophyte** 【生物】「腐生植物」

FOR STUDY

1. 形容詞句と副詞句（前置詞＋名詞／代名詞）の文中での働き
   (5–) Scientists sort living things into groups with similar characteristics.
   ① into groups は sort を修飾する副詞句
   ② with similar characteristics は groups を修飾する形容詞句
   （例文） Take the bud from the end of a twig.（小枝の端から蕾を採ってみなさい.）
   ① from the end は take を修飾する副詞句
   ② of a twig は the end を修飾する形容詞句

2. ～ing（動名詞）は文中で主語，他動詞の目的語，前置詞の目的語として用いられる.
   (2–) . . . studying them would be impossible without sorting them into groups.
   （例文） Measuring your pulse rate tells how fast your heart is beating.（脈拍を測ると，心臓がいかに速く打っているかがわかる.）

3. one another = 互いに；通例，三者以上の間に one another を，二者では each other を用いる．しかし，現在ではこの区別なしに用いることがある.
   (9–) Members of a species are very like one another . . .
   （例文） These universities cooperated with one another for the development of research.（これらの大学は研究の発展のために相互に協力した.）

EXERCISES

I. Listen to each question and choose the correct answer.

1. What do you call the smallest group of living things?

   (A) _____

   (B) _____

   (C) _____

2. What are the animals that eat only plants?

   (A) _____

   (B) _____

   (C) _____

3. What genus do tigers belong to?

   (A) _____

   (B) _____

   (C) _____

4. Are we vertebrates or invertebrates?

   (A) _____

   (B) _____

   (C) _____

5. Look at Figure 3. How many groups are living things basically classified into?

   (A) _____

   (B) _____

   (C) _____

II. Choose the correct answer to fill each blank.

1. Members of a species are ( ) to one another and can breed together.
   (A) likely (B) resemble (C) nearly (D) similar

2. It would be impossible to study living things ( ) we didn't sort them into groups.
   (A) if (B) why (C) unless (D) what

3. All the cats, including not only domestic cats ( ) lions and tigers, are in the same genus, called *Felis*.
   (A) and (B) but (C) for (D) or

III. Choose the wrong usage in each sentence.

1. We cannot (A) answer the question without (B) knowing (C) far (D) characteristics.

2. There is (A) relatively few (B) species in the desert, which is (C) an unfavorable habitat (D).

3. Both (A) the boys and (B) the girls played (C) tennis with one other (D).

IV. Rearrange the following English words in the correct order to express the Japanese sentences above them.

1. 生物のそれぞれの種は名前を持っている.
   Each, things, of, name, has, living, a, species.

2. 生物は成長に必要な物質を得なければならない.
   Organisms, the substances, obtain, growth, need, to, that, have, they, for.

3. 動物は植物や他の動物を食べることによってその必要な物質を得る.
   Animals, or, plants, get, animals, other, their, eating, necessary, by, substances.

LESSON 4

CELLS

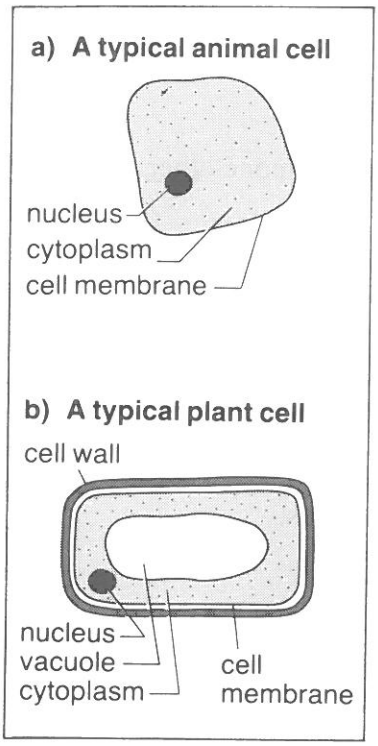


Figure 4.1

All organisms are made up of large numbers of cells. Cells are too small to see by eye, but can be quite easily observed under a microscope. You can scrape cells off the inside of your cheek and look at them under the microscope. A thin sheet of cells can be peeled off one of the inner layers of an onion and viewed microscopically.

It turns out that cells from animals (like the cheek cells) and cells from plants (like the onion cells) look rather different. Figure 4.1 shows a typical animal cell and a typical plant cell. Both types of cell have some parts in common.

■ A nucleus

The nucleus controls everything going on in the cell. It contains chemicals needed to make the cell divide and form a new copy of itself.

■ Cytoplasm

The cell contains a substance called cytoplasm. All the living processes of the cell go on in the cytoplasm. It is the cell's workshop, producing energy and other chemicals needed by the cell.

■ The cell membrane

This thin layer forms the boundary of the cell, but it lets some substances (such as water) move in and out.

Plant cells have three other features which animal cells do not possess.

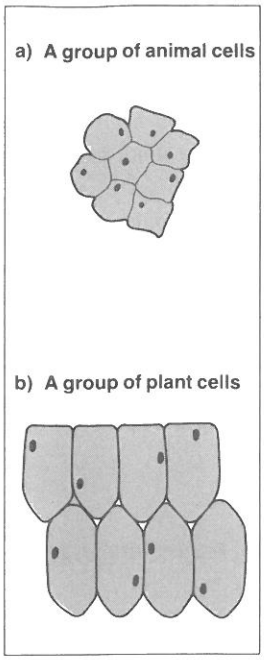


Figure 4.2

■ A cell wall

This wall is made of a tough material called cellulose. Just under the cell wall is the cell membrane. Because of the tough cell walls, groups of plant cells appear more regularly arranged than groups of animal cells. The tough regular cells help the plant to keep its shape.

■ A vacuole

A large part of the volume of a plant cell is occupied by a watery liquid. This part is the vacuole. The liquid in the vacuole creates a pressure on the cell wall which keeps the cell wall rigid. The vacuole is separated from the cytoplasm by a membrane.

■ Chloroplasts

The cytoplasm of cells from the leaves and stems of plants contains little green bodies called chloroplasts. These contain chlorophyll, and it is in these chloroplasts that photosynthesis goes on.

NOTES

見出し **cell**【生物】「細胞」 / 15 **in common**「共通な，共同で」 / 16 **nucleus** (複 nuclei, nucleuses)【生物】「核，細胞核」 / 20 **cytoplasm**【生物】「細胞質」 / 24 **membrane**【生物】「細胞膜」 / 30– **cellulose**【生化学】「セルロース，繊維素」 / 36 **vacuole**【生物】「(植物細胞の)液胞」 / 43 **chloroplast**【植物】「葉緑体」 / 47 **photosynthesis**「光合成」特に植物で二酸化炭素と水と無機塩から太陽光線をエネルギー源として，葉緑素などの働きで炭水化物を合成する反応.

FOR STUDY

1. 受動態の表現 (cf. Lesson 13–2)

① 受動態は主語が動作をされる文で，述語動詞が [be＋過去分詞] で表現される.

(40–) The vacuole is separated from the cytoplasm by a membrane.
＝A membrane separates the vacuole from the cytoplasm.

(例文) A lot of rocks were carried down by the flood.＝The flood carried down a lot of rocks. (多くの岩石が氾濫によって押し流された.)

② 動作主が不特定の人の場合には，by us, by them, by people などの表現をしない.

(1–) All organisms are made up of large numbers of cells.

（例文） English is spoken at the international conference.（その国際会議では英語が話される.）

2. too . . . to ～（とても…なので～できない）= so . . . that (s) cannot ～

(2–) Cells are too small to see by eye, . . . =Cells are so small that we cannot see them by eye, . . .

（例文） He ran too fast for us to catch up with.=He ran so fast that we could not catch up with him.

3. 使役動詞の用法；S + V + O + C（原形不定詞）の構文に用いる使役動詞は make, let, have, help, bid. ただし help は to 不定詞を用いることもある. get（…させる）は to 不定詞を用いる.

(18–) (1) It contains chemicals needed to make the cell divide and form a new copy of itself.

(25–) (2) . . . it lets some substances (such as water) move in and out.

(34–) (3) The tough regular cells help the plant to keep its shape.

（例文） (1) The teacher made his students observe a plant.（先生は学生に植物の観察をさせた.）

(2) The teacher let his students take a break.（先生は学生に休憩させた.）

(3) Tom helped his friend (*to*) write his research paper.（トムは友人が研究レポートを書くのを手伝った.）

EXERCISES

I. Listen to each question and choose the correct answer.

1. Are animal cells different from plant cells?

(A) _____

(B) _____

(C) _____

2. What is a cell wall made of?

(A) _____

(B) _____

(C) _____

3. What is the part that controls everything going on in the cell?

   (A) _____

   (B) _____

   (C) _____

4. What makes the plant cells look more regularly arranged than the animal cells ?

   (A) _____

   (B) _____

   (C) _____

5. Look at Figure 4.1. Is there a vacuole in a typical plant cell?

   (A) _____

   (B) _____

   (C) _____

II. Choose the correct answer to fill each blank.

1. Cells are so small that we ( ) see them by eye.
   (A) cannot (B) must not (C) should not (D) need not

2. The cell contains a substance ( ) is called cytoplasm.
   (A) who (B) whom (C) which (D) what

3. Plants differ ( ) animals in many ways, but particularly in being able to make their own food by photosynthesis.
   (A) of (B) for (C) from (D) to

III. Choose the wrong usage in each sentence.

1. Some chemicals make (A) the cell to divide (B) and form (C) a new copy of itself (D).

2. A cell wall is one (A) of the three features that (B) animal cells do (C) not possesses (D).

3. Because (A) the liquid in the vacuole, the cell wall is kept (B) rigid (C) by a pressure on it (D).

IV. Rearrange the following English words in the correct order to express the Japanese sentences above them.

1. 細胞は生物の基本成分である.
   Cells, for, organisms, are, building, the, blocks.

2. 植物の細胞は顕微鏡ではっきり見える.
   Plant, a, seen, clearly, microscope, are, under, cells.

3. 人体内には細胞がするさまざまな仕事がある.
   There, cells, do, different, to, jobs, many, for, are, human body, the, in.