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# 科普读物

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# REGENERATION OF LIMBS

Most people would agree thatit would be wonderful if humans could regenerate limbs. Those who have lost their arms or legs would be complete again. The last 10 years ,doctors have reported regeneration in smaller parts of the body, most often fingers.

Regeneration is not a newly—discovered process. For centuries, scientists have seen it work in some kinds of animals. Break off a lizard's tail, for example, and it will grow a new tail. Scinetists now are looking for a way to turn on this exciting ability in more highly developed animals, including humans. Their experiments show that nerves, cell chemistry and the natural electric currents in the body all seem to have a part in this process.

The body of every animal contains general purpose cells that change into whatever kind of cells the body needs . Animals such as the lizard or salamander use these cells to regenerate a new tail or leg when the old one is broken off. These cells collect around the wound. They form a mass called a blastema . The cells of the blastema begin to change. Some become bone cells, some muscle cells, some skin cells. Slowly, a new part regrows from the body outward. When completed, the new part is just like the old one .

More than 200 years ago, Italian scientist Luigi Spallan-

zani showed that younger animals have a greater ability to regenerate lost parts than older animals. So do animals lower on the ladder of evolutionary development. The major difference seems to be that less—developed animals have more nerves in their tails and legs than humans do in their arms and legs. Salamanders whose nerve supply is cut off, for example, lose their baility to regenerate. And baby opossums will regrow a leg only if extra nerve tissue is implanted at the wound.

Another helpful piece of information was discovered in the late 1800s Scientists found that when a creature is injured, an electrical current flows around the wound.

The strength of the current depends on how severe the wound is and on how much nerve tissue is present.

In 1945, American scientist Meryl Rose tested another idea about regeneration. He thought a new limb might grow only from an open wound. Doctor Rose cut off the front legs of some frogs, below the knee. He kept the wounds wet with a strong salty liquid. This prevented skin from growing over the wounds. The results were surprising. Frogs do not regenerate newlegs naturally. But these frogs began to grow new limbs. About half of each cut-off leg grew back again. New bones and muscle developed.

This research has led doctors to new ways of treating cut-off fingers. Doctors have observed, for example, that many children and some adults will regrow the top of a finger if the wound is left open. And experiments by several researchers

have confirmed that mice and monkeys can regrow the ends of their toes. The researchers say the results depend on where the cut is located and how it is treated.

Why is it necessary to keep the wound open? A number of scientists suspect that the electrical current produced at the injury causes and directs the regrowth. If the wound heals over, the electrical current stops.

Doctor Robert Becker, in New York state, studied the connection between regeneration and electricity. He measured the electrical current produced when he cut off the leg of a salamander, an animal that regenerate. Then he measured the current produced when he cut off the leg of a frog, which usually does not regenerate. The current was the same in both wounds. But it did not remain the same. The current disappeared from the frog's wound as new skin grew over the wound. It disappeared only after the salamander had grown a newleg.

Doctor Becker developed an idea to explain this . He said the nervous system creates an electrical force in the body. He said an injury interferes with this force and the interference could act as a signal to cells to repair the damage. Doctor Becker looked for evidence. He measured the flow of electricity found at many poinst on the skin of humans and animals. The measurements showed the existence of an electrical force around the nervous system of the body. Next, he attempted to prove that cells are affected by differences in the levels of elec-

tricity.

Doctor Becker studied how electricity affects bone cells. He found that when a bone bends under pressure, a positive electrical charge is produced on the stretched side. A negative charge is produced on the other side, where the cells are pushed together. The negative charge caused new bone cells to form on that side. A negative electrical charge from outside the body produced the same results.

Another scientist, Steven Smith, studied Doctor Becker's work. He decided to use electricity to regenerate the leg of a frog. The scientist cut off the frog's leg. He put a wire in the remaining part of the leg . The wire acted as a tiny battery, sending electricity into the wound.

Regeneration took place and about half the leg grew back. The growth stopped only when the leg had grown beyond the reach of the electrical current.

Steven Smith carried the experiment further with rats. He developed a way to move the wire producing the electrical current so it could follow the growth of the new leg. For the first time, a rat—a mammal like humans—was able to regenerate a new leg ,complete in every detail.

Scientists are now working to understand why regeneration happens sometimes, but not always. Many believe the answer will be found in the way genetic materialis turned on and off

When an egg and sperm—unite, they quickly reproduce

into a mass of general—purpose cells. These first cells seem to have the ability to develop into any kind of tissue. Each contains all the genetic information that makes us who we are. But as we develop, the cells take on special tasks. Some become blood cells. Some nerve cells. Some skin of bone cells. They on longer need to use all the genetic information they contain. These cells never lose this genetic information. They simply turn it off.

Scientists would like to know what causes this, and how the genetic information is turned on again when it is needed to grow new cells. They also want to learn how the cells seem to know how to build a new part exactly like the old one. How do they know where to begin building and when to stop?

David Stocum, an American scientist, says cells at a wound have a memory for their position. He says that is how they know to regrow only the missing part of an arm or leg.

Experiments with vitamin A have confirmed this "position memory." An indian doctor, Iqbal Naizi, cut off the legs of tadpoles. The tadpoles began to regenerate new legs. Then Doctor Naizi put vitamin A into the water in which they lived. He was surprised to see that some tadpoles grew yet another leg out of the regenerating one. Other tadpoles grew two legs out of the same wound. The vitamin A had somehow interfered with the cells'position memory.

Doctor Stocum says the next step is to study the chemical reactions that are taking place between the cells and the vita-

min. Somehow, he says, the vitamin A is causing the cells to make mistakes in turning on their genetic information.

## 肢体再生

大多数人都认为，如果人的肢体能够再生，那真是太妙了。这样，那些丧失胳膊或腿的人就可以重新成为完整的人了。这样的日子还很遥远。但是，在过去 10 年中，医生报道了他们使身体上的较小部分（最常见的是手指）再生的事例。

再生并不是一种新发现的方法。几个世纪以来，科学家就看到它在某些动物身上出现。例如，蜥蜴的尾巴断了可以长出新的。科学家现在正设法使包括人在内的更高级动物具有这种令人激动的能力。他们的实验表明：身体中的神经、细胞化学成分和天然电流似乎都有这种功能。

每个动物的体内都有通用细胞，它们可以变成身体所需要的任何细胞。蜥蜴或蝾螈等动物在尾巴或腿断了时会用这些细胞再生新的。这些细胞集中在受伤部位的周围，形成芽基。芽基的细胞发生变化，有的变成骨细胞，有的变成肌肉细胞，有的变成皮肤细胞。慢慢地，从体内向外重新长出新的部分。新的部分长成后同老的完全一样。

200 多年以前，意大利科学家卢吉·斯帕兰扎尼证明，年轻的动物比年老的动物具有更大的再生能力，进化程度较低的动物也具有较大的再生能力。主要的差别似乎是：低级动物的尾巴和腿中的神经比人类臂腿中的神经要多。例如，如果蝾螈的神经切断后就丧失了再生的能力。只有把新的神经组织置于幼鼠的受伤部位，新的腿才能再生出来。

19 世纪末，发现了另一有帮助的信息。科学家发现，当动物受伤时，受伤部位周围有电流流动。电流的大小取决伤势的严重程度和神经组织的多寡。

1945 年，美国科学家梅里尔·罗斯试验了关于再生的另一个想法。他认为，只有未愈合的伤口才能长出新肢体。罗斯医生把一些青蛙的前腿在膝下切断。他用浓盐水使伤口保持湿润。这使伤口不致长皮愈合。结果是令人吃惊的。青蛙没有长出和原来一样的新腿。但是，这些青蛙却开始长出新腿，每一条被砍断的腿大约重新长出了一半，有了新的骨骼和肌肉。

这项研究使医生们采用新的方法来治疗断了的指头。例如，医生们注意到，许多儿童和一些成年人的指头尖断了，只要伤口不愈合，是会重新长出来的。一些研究人员进行的实验证实，老鼠和猴子的脚趾尖是可以再生的。这些研究人员说，结果如何，取决于伤口的位置和治疗的方法。

为什么必须不让伤口封闭愈合呢？一部分科学家认为，伤口部位产生的电流引起并指导着再生。如果伤口愈合，电流就停止了。

纽约州的罗伯特·贝克尔医生研究了再生和电流之间的关系。他一切断了有再生能力的蝾螈的腿，测量所产生的电流，他又切断了通常没有再生能力的青蛙的腿，也测量所产生的电流。两者的伤口所产生的电流是一样的。但电流没有保持一样，青蛙的伤口的电流随着新皮的长成消失了，而蝾螈的电流持续的时间则要长得多，它在蝾螈长出新腿后才消失。

贝克尔医生提出了解释这种现象的理论。他说，神经系统在体内产生了电力。他说，创伤干扰了这种电力，创伤的干扰

给细胞发出再生的信号。贝克尔医生寻找了证据。他测量了人和动物皮肤上许多地方的电流情况。这种测量表明，体内神经系统周围存在着电力。接着，他试图证明，细胞受到不同电力强度的影响。

贝克尔医生研究了电力是如何影响骨骼细胞的。他发现，当骨骼受到压力而弯曲时，扩张的一端产生正电，另一端则产生负电，在那里细胞聚在一起，负电使这里形成新的骨骼细胞。体外的负电也产生同样的结果。

另一位科学家史蒂文·史密斯研究了贝克尔医生的工作。他决定用电力使青蛙的腿再生。这位科学家切断了青蛙的腿。他把一根电线插入腿的剩余部分，这根电线起着一节小电池的作用，把电送入伤口。

再生过程发生了，青蛙长出大约一半被切掉的腿。在腿长到超出电流能涉及到的地方时，就停止了生长。

史蒂文·史密斯进一步用老鼠进行了实验。他想出一种办法，即移动产生电流的电线，使之可以跟上新腿的生长。像人类一样同属哺乳动物的老鼠第一次可以再生出一条完整的新腿。

接着，科学家又努力了解，为什么再生过程有时发生，但并不始终如此。许多人认为，答案将在遗传物质的启用与关闭的方式中找到。

当卵子与精子结合时，它们迅速繁殖大量通用细胞。这些首批细胞似乎有能力发展成任何组织。每一个都含有那种使我们成为独一无二的遗传信息。但是，随着我们的发育，这些细胞担负了专门的任务，有些变成了血液细胞，有些变成了神经细胞，有些变成了皮肤细胞或骨骼细胞。它们不再需要使用

它们所拥有的所有遗传信息了。这些细胞永远不会丧失这种遗传信息，它们只是关闭起来而已。

科学家希望了解产生这种现象的原因，以及在需要产生新的细胞时，遗传信息又是如何重新被启用的。他们还需要了解，细胞是如何知道怎样把新的部分创造得同老的完全一样的。它们又是如何知道在哪里开始创造和什么时候停止的呢？

美国科学家戴维·斯托卡姆说，伤口的细胞记得它们的位置。他说，正是由于这个原因，它们知道只需再生臂或腿失去的部分。

用维生素 A 进行的实验证实了这种"位置记忆"。印度医生伊克巴尔·奈齐切断了蝌蚪的腿，这些蝌蚪再生新腿，接着，奈齐把维 生素 A 放进蝌蚪生活的水中。他惊讶地发现，一些蝌蚪从再生的腿中又长出一条腿。另一些蝌蚪则从同一个伤口长出两条腿。维生素 A 干扰了细胞的位置记忆。

斯科卡姆说，下一步是研究细胞和维生素之间的化学反应。他说，维生素 A 使细胞在启用它们的遗传信息方面犯错误。

## MOON LANDING
## 20TH ANNIVERSARY

The 20th anniversary of the moon landing is being celebrated this week (July 1989) throughout the United States. All kinds of events are planned: Contests for Fullerton, California. A re—creation of the moon landing at the flight control center in Houston, Texas.

Some of the major events will take place in Washington at the Smithsonian's Air and Space Museum. The three Apollo—11 astronauts — Neil Armstrong, Buzz Aldrin and Michael Collins—will speak at a public ceremony at the museum. President Bush and other officials will join them.

The Air and Space Museum will remain open long past its normal closing time for a huge public celebration. Telescopes will be placed outside the museum so people can look at the moon. Visitors will be able to touch tools and clothing similar to those used by the Apollo crew. They can listen to the Nuclear Diodes, a group of robots that play rock music. And they will watch a film of the moon landing shown on televisions thuoughout the museum. They will share ahain in one of the most exciting events in human history.

Let us now go back in time 20 years. The Apollo—11 astronauts were speeding toward the moon.

Neil Armstrong was the flight's commander. He was a test pilot. And he had flown in space before on one of the two —person Geminiflights. Armstrong was a calm person, a man who talked very little. Edwin"Buzz" Aldrin was the pilot of the moon lander spacecraft, named Eagle. He also had flown on a Gemini flight. And he also was a quiet man ,except when he talked about space. Michael Collins was the pilot of the command spacecraft, Columbia. He would wait in orbit around the moon while Armstrong and Aldrin landed and explored the surface. Collins, too ,had flown in space before. He was popu-

lar and always ready with a smile.

Halfway to the moon, the astronauts broadcast a television program to Earth. The broadcast showed how astronauts move and work in the weightlessness of space. The broadcast also showed the Earth behind Apollo－11. And it showed the moon growing larger in the blackness ahead.

The days passed. The pull of the moon's gravity grew stronger. As Apollo－11 neared the moon, it was moving at 6,500 kilometers an hour. The astronauts fired rockets to slow the spacecraft enough to put it into moon orbit. Apollo－11 circled the moon while the crew prepared for the landing. Finally, it was time to separate the lander, Eagle, from the command spacecraft, Columbia.

Armstrong and Aldrin moved through the small opening between the two spacecraft. Then they moved Eagle away from Columbia. As Armstrong reported, "The Eagle has wings." Humans were about to land on the moon.

On Earth, all activity seemed to stop. President Richard Nixon gave federal government workers the day off to watch the moon landing on television. Most state and local governments and businesses also declared the day a holiday. Around the world, 500－million persons watched the television report. Millions more listened to their radios.

Armstrong and Aldrin fired the lander's rocket engine. This slowed the spacecraft and sent it down toward the landing place, an area known as the moon's Sea of Tranquility. A