MS. PENNY TEACHES … SCIENCE IS FUN!

Penny 老師教你創意玩科學：黑膠唱片機、針孔相機、擴音喇叭……全部自己做，25 個必學原理 ╳ 75 個超酷實驗，在家上最有趣的理化課！

Does science give you a headache? Do you find it impossible to get to grips with scientific principles and how to apply them? This book presents 25 essential scientific principles from everyday life, and 75 simple but super-cool scientific experiments and offers children a stress-free way of learning about science.

STEAM education is very popular at the moment, but do you tense up at the thought of physics and chemistry? Do you stress when you think about science? Then let Ms. Penny show you how to do amazing experiments and learn basic scientific principles. She'll show you the most fun ways to enter the world of science.

Designed as a 12-month course, this book presents 25 essential scientific principles from everyday life through 75 simple and fun experiments. There are clear diagrams explaining the scientific principles, lists of the materials needed and step-by-step instructions, making it super-easy for readers to carry out the experiments. As all the materials needed can be found at home, there's no need to spend more money on preparing specially. Interesting scientific facts and phenomena from the world around us are brought in too, making science easy to follow and relevant.

Ms. Penny has many years of experience in science education. She has specially designed this collection of experiments to suit the interests of students aged 11 to 15, so they will stop being afraid of science, and want to do experiments every day!

Category: Non-Fiction

Publisher: Rye Field

Date: 6/2017

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Pages: 272

Age: 10+

BOOKS FROM TAIWAN

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Ms. Penny received her MSc from the Institute of Mineral Resources Engineering, National Taipei University of Technology. She has designed science courses for children and teacher training programs for multiple organizations and universities in Taiwan. She is currently the CEO of Sun Culture Enterprise Co., Ltd., and is dedicated to promoting popular science education activities. Sun Culture's brands combine scientific and cultural creativity, hand-made games, and TV media, and are welcomed by nearly a thousand primary and secondary schools in Taiwan.

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Translated by Helen Wang

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Lesson 1

Science is Fun 1: Extracting DNA

Cells are so small that you need a microscope to see them, and DNA is found in the nucleus of a cell, so you'd definitely need a microscope to see it! This experiment shows you how to extract and examine DNA yourself!

Science is Fun 2: Collecting fingerprints

You leave a trace wherever you go, and you leave fingerprints on everything you touch. Everyone's fingerprints are unique. Let me show you a simple way, using things you have at home, to make invisible fingerprints visible!

Science is Fun 3: Cottage cheese

Protein is a very important component of the human body. It's also a source of calories. Through the cheese-making process we can understand how protein is broken down and how the human body then absorbs and reconstitutes the protein it needs.

Lesson 2

Science is Fun 4 & 5: How strong are leaf veins? Leaf skeleton bookmark

These two units about leaf-veins are essential for understanding Planet Earth. They explain the characteristics and functions of leaves, and leaf skeletons allow us to examine leaf-veins in detail. If you fold a paper according to the leaf-veins, even soft newspaper can stand up on its own.

Science is Fun 6: Banana tattoos

No ink is required for banana tattoos. Just break into the cells in the banana skin and expose the enzymes to the air! In this unit you'll learn about oxidization of fruit, and how to preserve different kinds of fruit.

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Lesson 1

Where Life Begins!

See your own DNA!

All creatures on earth, including animals, plants and bacteria, are formed of cells. The cell is the basic unit for all creatures, but different organs and different cell structures can create variations.

Cell structure

Cells are made up of three basic components: the cell membrane, the cytoplasm and the nucleus:

● **The nucleus** contains [genetic] material, including the DNA.

● **The cytoplasm** has different areas that function in different ways: for example, substances secreted in the cell are packaged and classified in the "golgi complex", and proteins are synthesized in the “ribosomes”.

● **The membrane** is a thin wall around the cell that prevents substances entering or leaving the cell.

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Genetic material: chromosomes, DNA, genes

Inside the cell nucleus are chromosomes, and inside the chromosomes is the DNA. Inside the DNA are the genes. Genes come in pairs and have special functions. In terms of size: chromosome > DNA > gene.

- **Chromosomes** are found inside the cell nucleus. They are made of DNA and protein twisted together. Different creatures have a specific number of chromosomes in their cells: for example, humans have 23 pairs of chromosomes (a total of 46 chromosomes). 22 of these pairs are inherited, and another pair determines gender.

Do more intelligent creatures have more chromosomes? Not necessarily. In 2013 scientists discovered a kind of ciliate (a hairy single-celled organism) that had 15,600 chromosomes! It’s just one of many simple organisms that have thousands of chromosomes!

- **DNA** is short for deoxyribonucleic acid (*deoxyribo* means that the oxygen [*oxy*] and sugar [*ribo*] has been removed [*de*] from the nucleic acid; the nucleic acid is the molecules that carry information in the cells). DNA is regarded as the genetic code. Everyone is different. DNA looks like a double-stranded helix, and is made up of four parts: A = adenine, G = guanine, C = thymine, and T = cytosine.

Genes are the basic genetic units, and each gene is a piece of DNA with a special function. Genes are passed on from parents to the next generation. Humans have about 20,000 to 30,000 genes, which determine our appearance, intelligence, and also our health.

According to Mendel’s laws, genes come in pairs - one from the father, one from the mother - and a single gene may be either dominant or recessive. For example, curly hair is a dominant gene, straight hair is a recessive gene, and when a dominant and a recessive gene come together, the dominant gene will usually dominate (as the name suggests!).

We can use the chessboard pattern to predict the appearance of the next generation. For example, if the gene for curly hair is H (dominant), and straight hair is h (recessive), and Dad has curly hair,

and Mum has straight hair, can you work out what the children's hair gene will be?

Q1 – If Dad has curly hair (HH) and Mum has straight hair (hh): …

It's clear that all their children will have the same hair gene (Hh) and curly hair

Q2 – If Dad has curly hair (Hh) and Mum has straight hair (hh):

As the chessboard pattern shows, there is a chance that some of their children may inherit two recessive genes (hh) and have straight hair!

Blood type: the same method can be used to predict blood type. There are three genetic factors in blood types: IA, IB, and i. which give the following results:

- Type A can be IA IA or IA i
- Type B can by IB IB or IB i
- Type O is i i
- Type AB is IA IB

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Science is Fun 01: Extracting DNA

The key things you need to extract DNA

(1) Shampoo (must contain sodium lauryl suflate) – this will dissolve the cell membrane
(2) Salt – this will absorb the DNA, which is slightly negatively charged
(3) Tinned pineapple – the pineapple enzyme will dissolve the protein in the cell
(4) Ethanol (alcohol, 95%) – this will dehydrate the DNA solution, leaving only the DNA

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Level of difficulty ★★★☆☆ Needs adult supervision? □ Yes ■ No

School Curriculum: Grade 7, Term 2. Chapter 2 – Genetics

Materials needed:

1. Kiwi
2. Tinned pineapple
3. Chopsticks
4. Ethanol
5. Methylene blue liquid [aquarium disinfectant]
6. Cups
7. Dropper
8. Test tube
9. Cooking salt

10. Shampoo
11. Water

Step-by-step instructions

1. Put the kiwi in one cup, and mash it with the chopsticks
2. In another cup, prepare Solution A – 5 ml shampoo, 15 g salt, 50 ml water
3. Pour the mashed kiwi into Solution A, and stir with the chopsticks
   Solution A + mashed kiwi
4. In another cup, prepare Solution B – 5 ml tinned pineapple juice, 95 ml water
   5 ml 95 ml

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   A + mashed kiwi + B
5. Pour Solution B into Solution A and mix well
6. Strain the mixture through a filter
   Solution A + mashed kiwi + Solution B → clear liquid
7. Pour the clear liquid into the test tube, up to about a third
   Clear liquid 1/3
8. Using the dropper, let a few drops of ethanol run down the inside of the test tube
9. When the ethanol meets the liquid a cotton wool-like substance (polymerized DNA) will appear
   Cotton wool-like substance
10. Using the dropper, drop some methylene blue solution on to the cotton wool-like substance, to make it easier to see

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In ancient China, were fingerprints used like signatures?

In ancient China, instead of marking a cross on a document, people would use fingerprints. In the past, sales contracts were signed by both buyer and seller with fingerprints, which shows that even then fingerprints could be used to prove or represent a person's identity. Why were fingerprints used as a sign of identity? Because they have the following characteristics:

When you touch, you leave a mark

There are many substances in sweat, and those components have low volatility and are sticky. When you touch something, the sweat on your finger leaves a fingerprint, which can be crucial in forensic identification.

My sweat is sticky, and clings to the surface of things!

Fingerprints don't change

Fingerprints are formed when babies are still in the womb! And they remain the same throughout your life – your fingerprints will grow with you, but the size is the only thing that changes. So, they can be used as reference evidence on documents.
My fingerprints will never grow old!

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Fingerprints are unique
We use the features of a fingerprint to determine whether two fingerprints are the same (an average fingerprint has about 100 features). If two fingerprints share 13 features in common, they're considered to be the same. Statistical analysis has shown that in 10^{49} people, there might be two identical fingerprints, so the probability is very low.

Fingerprints can repair themselves
The hands of people who do heavy physical work over a long period of time will be very worn, and their fingerprints will not be so clear. But, with rest, fingerprints will regenerate. And if an injury prevents regeneration, the injury will leave a scar, which can replace the fingerprint as distinguishing evidence. So there's no need to worry about fingerprints disappearing.

My fingerprints have disappeared!!
My fingerprints have come back!!
With rest, fingerprints will regenerate.

How long do fingerprints last?
How long a fingerprint lasts depends on the temperature and humidity of the environment, and the amount of sweat secreted. According to records, 30-year-old fingerprints can still be identified.
We've found fingerprints!
Caught after thirty years!