

MURCHE'S
SCIENCE READERS

BOOK II.

THE MACMILLAN COMPANY

SCIENCE READERS

BOOK II

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SCIENCE READERS



BY

VINCENT T. MURCHÉ

REVISED AND ADAPTED FOR USE IN SCHOOLS, WITH A PREFACE BY
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BOOK II

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PREFACE

OF this series of Science Readers, Books I, II, and III are adapted to Secondary Grades comprising pupils who are in their third and fourth years of school work. Both the reading and the subject matter of Books IV, V, and VI are suitable for Grammar Grades.

At the end of each of the first three volumes will be found a short summary of the lesson. This is a helpful feature. The teacher who reads this carefully, then the reading lesson itself, will secure both the needful knowledge and valuable suggestions for a successful method of imparting it.

Take, for example, Lesson XXX. Read the summary at the end of the volume, and then the lesson itself. Do not allow

the children to read it until the points have been brought out in the manner indicated in the text, which might be as follows :

In default of a live rabbit, put on the blackboard as realistic a drawing of a rabbit as it is possible for you to make.

What kind of an animal is this? Why do you think so? Does it hear quickly? Why do you think so? Why do its ears go up? What else can it do quickly? Why? Where are its eyes? Where are yours? Why is it better for the rabbit to have its eyes at the side of the head?

How does it eat? Why is its upper lip split?

What are the feet like? Why?

This should be immediately followed by the substance of Lesson XXXII, taught in the same way.

After each series of lessons so taught, the part of the book relating to the subject may be used for supplementary reading.

Each reading lesson is illustrated in a

way that will serve vividly to recall the teaching, thus emphasizing the important points.

The lessons are progressive, each one of a series being built on the facts taught in the previous lesson. Moreover, the subject matter—the properties of bodies; the nature, growth, and structure of plants; the common types of animals; minerals and metals; the phenomena relating to weather; in short, all the conditions which surround us—is exactly the science which should be taught in the elementary schools.

L. L. W. WILSON,
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CONTENTS

LESSON	PAGE
1. POROUS BODIES	3
2. SPONGE—AND ITS USES	6
3. THE SPONGE	9
4. FILTERS	12
5. THE POOR MAN'S FILTER	15
6. SOLUBLE	18
7. SOLUBLE SUBSTANCES	21
8. STARCH	23
9. WHAT STARCH IS	25
10. STARCH FOR FOOD	28
11. SOLUBLE AND INSOLUBLE	31
12. SOAP	33
13. CORN	35
14. KINDS OF CORN	38
15. ADHESIVE	41
16. CEMENTS	43
17. WHEAT AND RICE	46
18. FUSIBLE	48
19. MAIZE	51
20. ABOUT METALS	53
21. SOME MORE ABOUT METALS	56
22. IRON ORE	58
23. IRON	61
24. THE COW	64
25. CAST-IRON	68
26. MILK, BUTTER, CHEESE	71
27. WROUGHT IRON	73
28. THE HORSE	76

LESSON	PAGE
29. STEEL	82
30. THE RABBIT	84
31. COPPER	88
32. THE RABBIT AT HOME	91
33. LEAD	94
34. THE MONKEY	97
35. TIN	100
36. THREE CLASSES OF MONKEYS	103
37. ZINC	108
38. THE MOLE	110
39. SILVER	114
40. GOLD	117
 SUMMARY OF LESSONS	 121

BOOK II

Lesson I

POROUS BODIES

FRED and Willie came home very proud from school one afternoon. 'What do you think, Norah?' said Fred. 'We have both been put up into the next class. Teacher picked out a few of the best boys to go up. I am so glad Will was put up with me.'

'And only think, Norah,' said Willie. 'We shall still have our jolly object lessons. We had a lesson this afternoon about porous bodies. Shall we tell you all about it, Norah?'

'Oh, do, please,' said Norah.

'Well then,' said Fred, 'you must

first tell us all the porous bodies you can remember.'

'Oh yes,' said Norah. 'Sponge, bread, sugar, chalk, dry clay, charcoal, and coke are all porous. They all suck up liquids into their pores.'

'Quite right,' said Fred. 'Now watch me. This is a tumbler about half-full of turpentine. This piece of cane has been standing in the tumbler a few minutes. See what happens when I put a match to the top of the cane.'



'Why, it bursts into a flame at once,' said his sister. 'How is that?'

'I'll show you,' said Fred, 'just as teacher showed us. Look at the holes in the bottom of the cane.'

'Then I suppose,' said Norah, 'the pores of the cane absorb the turpentine, and take it up to the top.'

'That's just it,' said both the boys. 'The cane is porous.'

‘Now look here. Do you know what this is?’ said Fred.

‘It is a piece of the wick of the lamp,’ said Norah.

‘See,’ said Fred, ‘I will dip it into this water. Now when I take it out and squeeze it, some water runs out of it. What does that prove, Norah?’

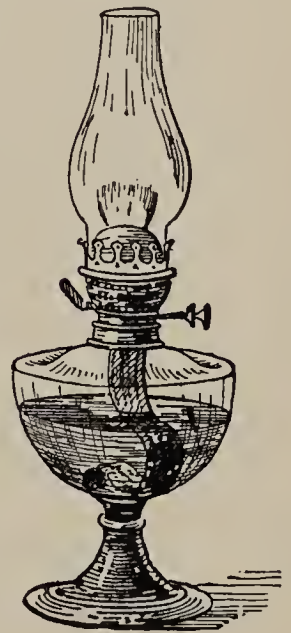
‘It proves,’ said she, ‘that the wick is porous, and that it absorbs liquids.’

‘Quite right,’ said Fred.

‘Now think of the wick in the lamp itself. The lower part of the wick is in the oil, but it is the upper part that gives the light.’

‘Oh, I think I see,’ said Norah; ‘the wick must be something like the cane. I suppose it absorbs the oil, and carries it up to the top, where it burns.’

‘That is right, Norah,’ said Willie; ‘and a candle burns in the same way. The heat melts the tallow into a liquid.



The wick absorbs the liquid tallow, and carries it up to the top, where it burns.'

Lesson II

SPONGE—AND ITS USES

'Oh, boys,' cried Norah, as she rushed into the room, 'do come with me at once. Our dear old Ponto has cut his foot in the garden. The poor old fellow is in such pain, and it is bleeding very badly.'

'All right, Norah,' said Fred. 'You run and get a sponge and some warm water, Will.'

In a very short time they were all round their dear old playfellow. Fred bathed the foot with the warm water, while the others stroked him, and tried to make him forget the pain. The foot was, as Norah had said, very badly cut.

The children bound it up with some clean linen rag, and then took him into the kitchen. There they made him lie

down in a warm corner of the room, while they sat and watched him.

‘What a good quiet old fellow he was



all the time we were washing his foot,’ said Norah.

‘Yes,’ said Fred, ‘but I took care not to hurt him. Nothing would have done it so well as a sponge.’

‘Suppose we have a talk about the

sponge,' said Willie, 'while we sit with Ponto.'

'Right,' said Fred. 'What is the first thing any one would notice about the sponge?'

'It is porous or full of holes,' said Norah. 'When it is put into water it absorbs or sucks up the water.'

'How can we get the water out again?' said Fred.

'By squeezing it,' said Will. 'It is a soft body, and we can squeeze it.'

'What happens when we squeeze it, and then let go?'

'It springs back to its former size and shape,' said Will, 'because it is elastic.'

'Yes,' said Fred, 'and then it is ready to absorb water again.'

'Because the sponge is porous and elastic, soft and smooth, it is the very best thing we can use to wash a sore place of any kind.'

'Mother always uses a sponge,' said Norah, 'to wash baby. Baby's skin is

ery tender, and the soft smooth sponge does not scratch it.'

Lesson III

THE SPONGE

'Isn't it strange?' said Fred; 'we were talking about the sponge last night, and to-day we have had a lesson on it at school.'

'I know now what a sponge is. I have often tried to think, but I could never make it out, till teacher told us to-day.'

'I never thought it could be an animal,' said Willie.

'It is not quite right to call it an animal,' said Fred. 'Teacher says it is the skeleton of an animal, that's all.'

'An animal,' said Norah. 'Where do such an animal live?'

'It lives,' said Fred, 'at the bottom of the sea; and a strange life it must be. It cannot move about, for it is fixed to the rocks by a sort of root.'

'I suppose,' said Norah, 'as this is

only the skeleton that we see, it must have some flesh on it when it is alive?’

‘Oh yes,’ said Fred, ‘but the flesh is only a sort of soft jelly. That all runs away, when it is taken out of the water. Nothing is left but the tough, elastic, porous framework of its body.’

‘But,’ said Norah, ‘if it is an animal, I suppose it has a mouth ; it must eat.’



‘Well,’ said her brother, ‘it has a great many mouths. All these little pores in the sponge are so many mouths. Teacher says it feeds by drawing itself up, and then swelling out again. You know that the sponge is very elastic.’

‘Every time it swells itself out, some water rushes in through these little pores, and with the water the food on which

the sponge lives. When it draws itself up, the water is sent out again through the larger holes. The sponge keeps back all that it wants for food. That is not sent out with the water.'

'What a strange animal!' said Norah. 'How do they get the sponges, Fred?'

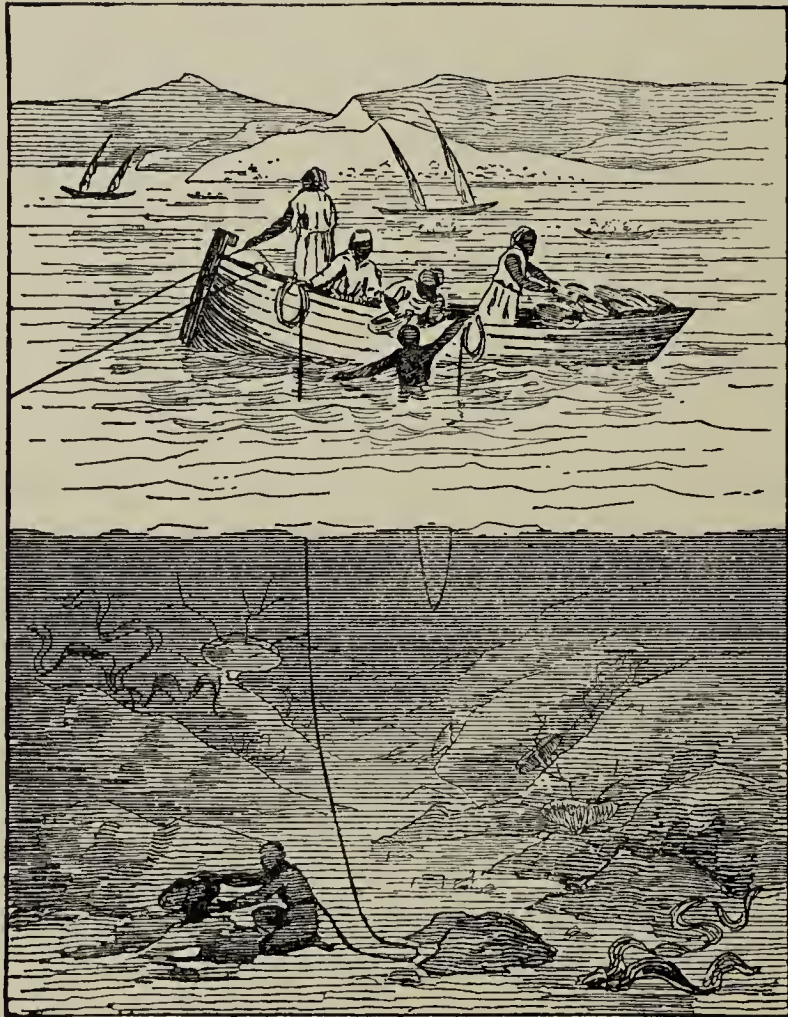
'Teacher told us all about it, didn't he, Fred?' said Will. 'Men have to go down to the bottom of the sea to get them. They are called sponge-divers. I'm glad I am not a sponge-diver, though.'

'Oh, do tell me all about it,' said Norah.

'Well, these divers are trained to dive while they are boys. They are taken out to the place in a boat. When they are ready, they fix a large stone to their foot and slide down to the bottom, holding a rope in their hands.

'As soon as they get to the bottom, they cut away with a long knife as many sponges as they can. These they put into a bag slung round their neck. They can't stay under water more than

three minutes, and then they are drawn up by the men in the boat.'



‘What a dreadful life it must be!’ said Norah.

Lesson IV

FILTERS

‘You know, Norah, when mother makes the coffee for breakfast, she pours it through a strainer,’ said Fred.

‘What is the strainer made of?’

‘It is a sort of muslin bag,’ said Norah.

‘Quite right. But why does she use this bag?’

‘The muslin is porous. The holes, or pores, in it are only large enough to let the clear liquid run through. The thick coffee-grounds cannot pass through them, and are left in the bag.’

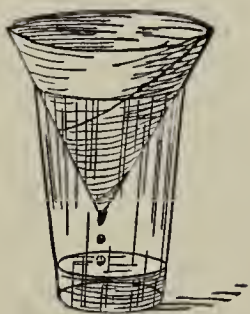
‘Teacher had a bag made of flannel. You know flannel is porous. We can see the pores in it. Well, he poured some muddy water in this bag, and held the bag over a basin. The pores were not large enough to let all the solid mud pass through. That was kept back, and the water, that dripped through into the basin, was nearly clear. Well then, he poured this into another bag made of some kind of cloth with still smaller pores. When the water came through this it was quite clear. All the little grains of mud, that had passed through

the pores in the first bag, were kept back now. The pores in this second bag were too small to let them pass.

‘I thought at once of mother’s coffee-strainer. But teacher gave us another name for these porous bags. He calls them filters. He says when we pass a liquid through them, we filter it.

‘I am going to show you a very pretty little filter now, made of blotting-paper. Teacher made some for the lesson. He gave me these to try with at home.

‘See, there are three pieces of blotting-paper, cut round, and folded across the centre at right angles. When I open them out, I can make a little funnel with them.



‘Now I will stand the funnel in a tumbler, and pour into it some of this chalk and water. See, the liquid looks thick and white like milk. Watch what happens when I pour it into the filter. Drop by drop, the water trickles through the pores of the

blotting-paper. But it is clear water now. All the little pieces of solid chalk, that were floating in the water, are left behind in the blotting-paper. The blotting-paper is a filter. It filters the liquid I put into it.'

Lesson V

THE POOR MAN'S FILTER

'I say, Fred,' said Willie, 'shall we tell Norah about the biggest filter in the world?'

'Oh yes, do, Fred,' said Norah.

'Perhaps we can make Norah tell herself all about it, Will,' said Fred. 'You remember what a heavy rain we had last night, Norah?'

'Oh yes,' said Norah, 'the water stood in great puddles in the road.'

'Where are the puddles now?'

'They are all gone ; the water has sunk down into the earth,' said Norah.

'Why does the water sink into the earth?'

‘Because the earth is porous and absorbs it,’ said Norah.

‘Quite right,’ said Fred. ‘But is all earth porous?’

‘No. Clay is not porous,’ said his sister.

‘You know we found a spring the other day when father took us for a walk?’

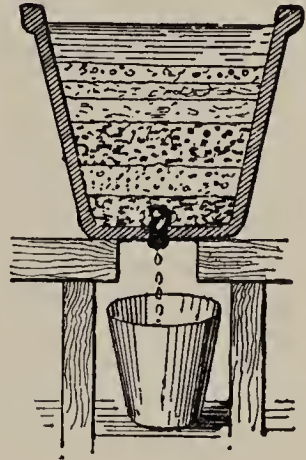
‘Oh yes,’ she said, ‘and we had a good drink. What clear, bright, sparkling water it was, Fred.’

‘Ah,’ said he, ‘that clear water came from some dirty puddle of rain-water, which sank into the ground drop by drop. It kept sinking through gravel, sand, and rock, till it came to something like clay. It could not sink through the clay, for clay is not porous. Then it had to burst its way somewhere, and it came bubbling out of the ground as a spring.’

‘Now I know what you mean,’ said Norah. ‘The earth itself is a filter. It lets the clear water pass through its pores, but holds back all the mud.’

‘That’s quite right, Norah,’ said Fred.

‘Now I’m going to make a filter for ourselves. It is so easy to make, and costs so little that teacher calls it the Poor Man’s Filter. Father has given me this nice clean flower-pot and all



the things I want. I will first plug up the hole in the bottom with a piece of sponge. Then I will cover this with a layer of small charcoal an inch or two deep. Above the charcoal I will put a layer of fine sand, about the same thickness.

‘All these things—sponge, charcoal, and sand—are porous. We have a filter now, ready for use. But as I have some charcoal and sand left, I will put two more layers in.

‘Now if we pour any dirty muddy water into the top of the flower-pot, we shall see it trickle through the bottom clear and bright.’

Lesson VI

SOLUBLE

‘We had another lesson to-day,’ said Fred, ‘about things which dissolve and things which melt.’

‘Let me join you for a few minutes,’ said his father; ‘I have here some loaf-sugar broken up fine. I will put some of it into this tumbler of water; the rest into this iron spoon. Fred shall stir the water in the tumbler. I will hold the spoon over the fire. Now watch. I think we can make it all clear.’

‘Look,’ he went on, ‘the pieces of solid sugar in the spoon are changing into liquid sugar. We can see it flow about in the spoon. This sugar is melted.’

‘Your sugar, Fred, cannot be seen in the water, although we know it is there. It is dissolved.’

‘Thank you, father,’ said the children. ‘That makes it very plain.’

‘Teacher gave us a new name for

things that dissolve,' said Fred. 'All things that dissolve are said to be soluble.'

'Yes,' said Willie, 'and when we dissolve any of them, we make a solution.'

'Teacher showed us the meaning of



these three hard words in another way,' said Fred. 'I think I know clearly now what a solution is. I will try and do it as he did it.'

'Here is some chalk, crushed up into

powder. I will put a spoonful of it into this glass of cold water. Now we will stir it up well. Can you see the chalk?’

‘Yes,’ said Norah, ‘the water looks thick and white like milk.’

‘The tiny little bits of solid chalk are floating about in the water,’ said Fred. ‘They will not dissolve. If we stir it all night, the chalk will not dissolve.’

‘We cannot see the salt, sugar, and other things when they dissolve. The water looks quite clear. It is a solution. This chalky water is as thick and white as ever. If we leave the glass to stand for a time, all the wet solid chalk will sink to the bottom, and the water will become clear, and may be poured off. But there will not be any chalk in it. All the chalk will be left at the bottom.’

‘If we dissolve a substance in water, we cannot pour away the water, and leave that substance at the bottom.’

Lesson VII

SOLUBLE SUBSTANCES

‘Come and help me, Will,’ said Fred. ‘I’ve got all ready, and I want to show Norah why some things dissolve in water.

‘I have a tumbler here, filled with water to the brim. I want you to stir it gently, while I put some salt into it—a spoonful at a time. Are you ready? One, two, three, four, five, six. Now we must be careful—seven. I have put seven spoonfuls of salt into the tumbler of water. But if you look you will see some of the salt is now settling at the bottom.’

‘I suppose,’ said Norah, ‘the salt that sinks to the bottom is not dissolved.’

‘That’s right,’ said Fred. ‘The rest of the salt is all dissolved; we cannot see it.’

‘But, Fred,’ said his sister, ‘the tumbler was full to the brim at first. If you had put seven spoonfuls of water in, it would have run over the

top. How have you been able to put seven spoonfuls of salt in?’

‘Ah,’ said Willie, ‘that’s the funny part of it.

‘The water is porous. As the salt dissolves it breaks up into such tiny morsels, that they can find their way into the pores of the water. When these pores are all filled, the water can dissolve no more salt. The rest sinks to the bottom in a heap.’

‘Now we’ll empty this away, and do the same with some lime,’ said Fred.

He put in seven spoonfuls of the lime, but by the time he had done there was a great heap of wet lime at the bottom. The water too was flowing over the top of the glass.

They waited till the water was clear. Then they poured it out into another tumbler. To make sure there were no solid bits of lime in the water, they made it filter through blotting-paper.

‘Now look,’ said Fred, ‘I am going

to breathe into the water through this straw. If there is any lime dissolved in it, the water will turn white like milk as I breathe into it.

‘See, it looks quite milky already,’ he added. ‘The water has got some lime in it. All the lime did not sink to the bottom of the tumbler. Some of it was dissolved. Water dissolves a large quantity of salt, but only a little lime.’

Lesson VIII

STARCH

‘What is this, Norah?’ asked Fred.

‘It is some of the starch that mother uses to make your collars stiff,’ said Norah.

‘Well, I want to have a chat about starch this evening,’ said Fred.

‘Watch what happens when I put some of it into this tumbler of water.’

‘It sinks to the bottom, and lies there just as we put it in,’ said Norah.

‘Wait while I stir it up well,’ said Fred. ‘Now tell us what you see.’

‘The water is thick and milky-looking now, as it was when we put the chalk into water,’ said Norah.

‘Stir it a little more,’ said Fred. ‘Perhaps we can make it clear then.’

‘No,’ he went on, ‘we cannot make it clear with all our stirring. What does that mean, Norah?’

‘The starch will not dissolve in the water,’ said Norah. ‘It is not soluble. The little pieces of solid starch are floating about in the water. It is this which makes the water thick like milk.’

‘Now, we will put some of this thick liquid into a basin, and pour boiling water on it,’ said Fred. ‘The rest we will stand aside in the tumbler.’

‘Why, the boiling water seems to swell it up,’ said Norah, ‘into a jelly.’

‘Yes,’ said Will, ‘that’s just it. The hot water breaks up the little solid bits of starch that are floating about. Pour

some more boiling water on it, Fred, while I stir it with the spoon.

‘See now, Norah,’ he added, ‘the jelly has become a thin clear liquid. The starch is dissolved at last.’

‘Oh, I see,’ said Norah; ‘the starch will not dissolve in cold water, but it dissolves in boiling water.’

‘Now, look at the other starch in the tumbler of cold water,’ said Fred.

‘Why, the water is quite clear now,’ said Norah. ‘Where is the starch?’

‘Look at the bottom of the tumbler,’ cried Willie. ‘It has all sunk down there. If we pour off the water, we shall leave all the starch at the bottom. None of it is in the water, because it will not dissolve in cold water.’

Lesson IX

WHAT STARCH IS

‘You remember our chat about starch, Norah,’ asked Fred. ‘Would you like to see me make some starch now?’

‘Ah,’ said Norah, ‘I know you are a very clever brother, but I don’t think you can make starch.’

‘Then watch me, and see,’ said Fred. ‘Look, this is some flour. I will tie it up in this piece of muslin. All I have to do is to work it up between my fingers and thumb in this basin of water. See, the water is getting white and milky-looking, because I am washing the starch out into it. This flour—the flour that makes our bread—contains starch.’

‘Teacher made some starch from a potato,’ said Willie. ‘He says the potato contains more starch than the flour.’

‘Let us have another look at the basin,’ said Fred.

‘Why,’ said Norah, ‘the water is not white like milk now; it is quite clear. Where is the starch?’

‘Look at the bottom and you will see it,’ said Fred. ‘See, I will pour off the clear water. The thick, wet, solid stuff at the bottom is the starch.’

‘Teacher, you see, showed us how to get starch from flour and potatoes,’ said Willie, joining in. ‘But he told us too that it is found in all plants. Some plants contain more starch than others.



The plants store up this starch as a supply of food for themselves.’

‘He told us too,’ said Fred, ‘that the starch is always in tiny grains, too small to be seen with the naked eye.

‘We saw a picture of these grains as they would look, if our eyes were sharp enough to see them. They are really little bags of starch.’

‘You remember, sister,’ he added, ‘that starch will not dissolve in cold water. It dissolves in boiling water. The boiling water makes the little bags swell and burst. This sets free the real starch inside the bags and it dissolves. Cold water only loosens the little bags one from another, so that they float about. It does not burst them.’

Lesson X

STARCH FOR FOOD

‘If some one had told me a week ago,’ said Willie, ‘that we eat starch every day, it would have sounded like a joke. But we know now that it is true, for our bread and puddings and cakes and potatoes all contain starch.’

‘Teacher was talking about sago, arrowroot, and tapioca,’ said Fred. ‘He says they are almost pure starch.’

‘I have seen mother make sago and tapioca puddings,’ said Norah. ‘Can you tell me anything about them, Fred?’

‘I’ll try,’ said Fred.

‘Let us think about the sago first. Mother gave me some in this saucer. Look at it. It is like little round balls.

‘Teacher says it comes from a tree called the Sago Palm, that grows in very hot lands. It is got from the soft matter in the stem, which we call the pith.

‘When the tree is fully grown, it is cut down, and the soft pith is taken out. This pith then looks something like the inside of a dried apple. It is rather sticky, too, like gum.



‘The pith is first crushed into powder, and then washed and kneaded in water. This presses all the starch out, just as we did out of the flour in the muslin bag.

‘When the water settles, the starch is left at the bottom. It is first partly

dried, and then it is pressed through a sieve with small round holes.'

'Oh, then,' said Norah, 'this is why we always see it in little round balls.'

'Quite right,' said Fred. 'Now let us look at the arrowroot. This too is almost pure starch. It comes from the underground stem of a plant that grows in hot lands. It is got by breaking this stem in pieces, and kneading it up in water, as they knead the sago pith. When dried, it forms this white powder.'

'Tapioca is just the same sort of thing. It is almost pure starch. It is got from the root of a plant. The root must be broken up, and treated just like the sago pith and the arrowroot. The starch, that is left at the bottom of the water, is dried on hot plates. As it dries, it is stirred about with an iron rod. This makes it form in lumps as we see it here.'

Lesson XI

SOLUBLE AND INSOLUBLE

‘I want to have another chat to-night,’ said Fred, ‘about things which we can dissolve. I suppose Norah can name some of them?’

‘Oh yes,’ said Norah; ‘we can dissolve salt, sugar, alum, lime, and soda.’

‘What do we say about them, because we can dissolve them?’

‘We say they are soluble,’ said his sister.

‘Suppose we dissolve salt. Can you tell me what we get?’

‘We get a solution of salt. If we dissolve sugar, we get a solution of sugar.’

‘Teacher told us in our lesson to-day,’ said Willie, ‘that the water which dissolves these things is called a solvent.’

‘Now you know,’ said Fred, ‘we once put some bits of flint, wood, iron, and glass into water. Did they dissolve?’

‘No,’ said Norah, ‘they did not dis-

solve. We cannot dissolve them. They are not soluble.'

'We have found out, too,' said Willie, 'that chalk and starch will not dissolve. They are not soluble. Teacher told us that the right word for this is insoluble. Insoluble means not soluble.'

'I'll try and show you something now that teacher showed us to-day,' said Fred. 'Look at this greasy oil-bottle. Suppose we wish to clean it out—to get rid of all the oil. What shall we do?'

'Wash it out with hot water,' said Norah.

'Very well,' said Fred, 'I'll fill the bottle with hot water and shake it up. I wonder whether the oil has gone,' said he, after shaking it well. 'No, it has not gone. It is still hanging to the sides of the bottle. The oil is insoluble.'

'Now I will put some pieces of soda into the water. Look what happens when I shake up the bottle.'

‘Why, the oil mixes up with the water now,’ said Norah.

‘Yes,’ said Fred, ‘the soda breaks up the oil into tiny drops, and dissolves it.’

‘Water will not dissolve oil ; but soda is a solvent for oil and fats of all kinds.’

Lesson XII

SOAP

‘I didn’t think,’ said Willie, ‘that greasy oil-bottle and the soda could have anything to do with soap. Did you, Fred?’

‘No,’ said Fred, ‘I didn’t. Suppose we have our lesson all over again now.’

As soon as tea was over Fred said, ‘Do you remember that greasy oil-bottle, Norah?’

‘Oh yes,’ said Norah ; ‘the soda dissolved the oil, although the water would not dissolve it.’

‘Now look,’ said Fred ; ‘this bottle is half-full of oil. Smell it and see that

it is oil. I have got here a strong solution of soda. What does that mean?’

‘A solution of soda is some soda dissolved in water,’ said Norah. ‘I suppose you call it a strong solution, because you have put a lot of soda in it.’

‘Now I will fill the bottle up with the solution,’ said Fred, ‘and we’ll give it a good shaking. Tell me what you see.’

‘The oil seems to be mixing with the soda,’ said Norah.

‘Quite right,’ said Fred; ‘if I shake it a little more, the soda will dissolve all the oil. It will form a new substance.’

‘We will stand it down for a minute or two and let it rest.’

‘Look at the bottle now. The watery part of the mixture is at the bottom, a new substance is floating on the top. This is not oil, but oil dissolved in soda.’

‘Let us take some of it out and rub it in our hands. It is not greasy or oily now. It is soft and smooth.’

‘It feels just like soap,’ said Norah, as she rubbed her hands.

‘So it does,’ said Fred; ‘and it is soap, although it is not hard soap fit for use. It contains a great deal of water.’

‘How could we get rid of the water in it, Norah?’

‘I suppose,’ said Norah, ‘we should have to boil it.’

‘Quite right,’ said both the boys. ‘When the water boils away, the soap becomes solid. And now, Norah, you know how soap is made.’

‘It is not always made of oil,’ added Fred. ‘Tallow, suet, fat, and grease of all kinds are used to make soap.’

Lesson XIII

GRAIN

‘You know, Norah, when we were talking about starch, I made some to show you,’ said Fred. ‘I made it from some flour, and flour is made from wheat.’

Here are some grains of wheat. Do you know where they come from?’

‘They grew on plants in a wheat-field,’ said Norah.

‘Well, now,’ said Fred, ‘we are going to have a talk about these grain-plants. Teacher told us we could understand the grain-plants by looking at the stems of some tall grass. So Will and I have been hunting about to find some grass that would do. We have found some. Suppose we have a look at it.’



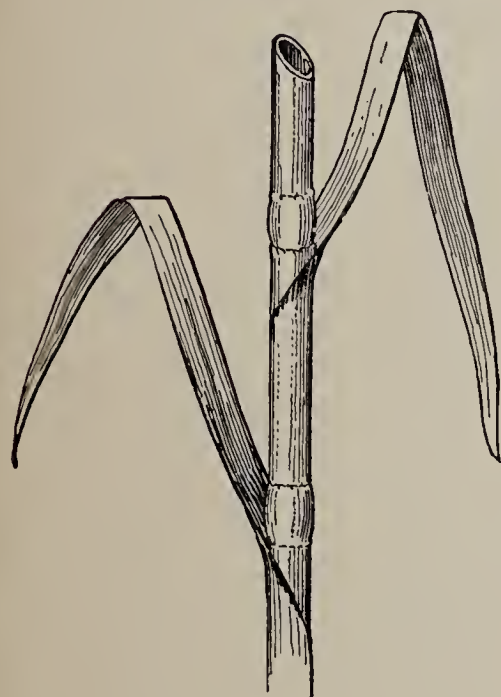
‘We will begin with the leaves. They are long, narrow, and pointed, and not like most of the leaves we see. We call them blades of grass. If we hold them up to the light, we see that the veins run side by side, from one end of the leaf to the other. The veins are parallel.’

‘Look! There is a swelling or knot in the stem, where each leaf joins it.’

The leaves all spring from these knots or joints.

‘Now let us split open the stem with this knife. You see it is hollow.’

‘But,’ said Norah, ‘I can’t see what



all this has to do with the grain-plants.’

‘Well,’ said Fred, ‘the grain-plants are just like this grass. They are grasses. We call them the grain-grasses.’

‘Now we know,’ Fred went on, ‘that the grass and the grain-plants both have

tall hollow stems with joints in them, and long, narrow, pointed leaves. Each grain-plant sends up five or six stems.

‘This grass, you see, has some small green flowers at the top of the stem. When the flowers die off, they leave the seeds behind in a long ear.



‘The grain-grasses have green flowers too, and after the flowers, long ears full of seeds or grains. Here is an ear of wheat. If we pull the ear to pieces, we shall find a great many grains of wheat. Each grain is held in a sort of shell of thin, light, but strong skin. This we call the husk. The husk protects the grain from the sun and rain, till it is fully grown and ripe.’

Lesson XIV

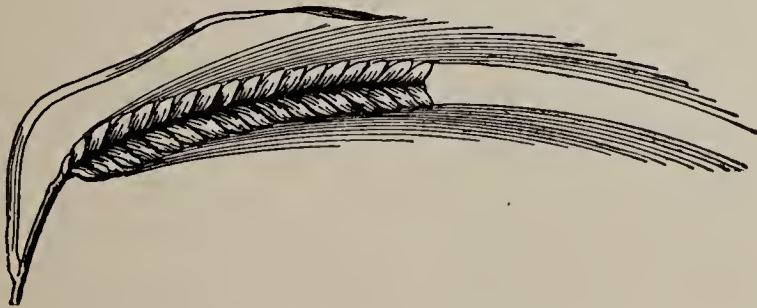
KINDS OF GRAIN

‘We are going to have another talk about grain this evening,’ said Fred.

‘We have picked out some kernels from the chicken’s food, and father has got these ears for us.’

‘Here is the wheat. Let us take that first, as teacher did,’ said Willie. ‘This is the best of all the grains for making flour for bread, biscuits, cakes, and puddings. It forms the chief part of our food. The ears are full, and the kernels themselves are round and plump.’

‘The ear of barley,’ said Fred, ‘is not at all like the ear of wheat. Each grain



ends in a long spike. This is called the beard of the ear. Barley is hardy and will grow where we could not grow wheat. It does not make nice, sweet, white bread, like our wheaten bread. People never use it for bread when they can get wheat. Nearly all the barley we

grow in this country is used in making malt. It is also used for feeding pigs and poultry.



‘This is an ear of oats. Each grain in this ear hangs loosely by itself, with its open end downwards towards the ground. As the grain grows the rain runs off, and does not lodge in it, or it would rot it.’

‘The flour made from oats is called oatmeal. In countries where wheat will not grow, the people live on oatmeal cakes and porridge, instead of wheaten bread.’



‘There is another kind of grain called rye,’ said Willie. ‘In this country we mix rye with other flours to make Boston brown bread. Rye-flour makes a very coarse, heavy bread. But the

people in some lands are glad to get even that.'

Lesson XV

ADHESIVE

'I wish you would mend our scrap-book, mother, please,' said Norah. 'Some of the leaves are very loose.'

So after tea mother got the mucilage and stuck the leaves in again, and made the book quite neat.

'Why did mother use mucilage, Norah?' asked Fred. 'Wouldn't water do?'

'Water is not sticky,' said Norah; 'it would not make the leaves stick.'

'Try and remember a hard word that means the same as sticky, Norah. It is adhesive. Mucilage is adhesive or sticky.'

'What else could we use besides mucilage to stick the leaves?'

'Some paste would do as well.'

'Have you ever seen any one use paste to stick paper?' Fred asked again.

'Oh yes,' said Norah. 'The man used

paste when he put the paper on the wall of the parlor the other day.'

'And the men who post up the bills in the streets,' said Willie, 'always do it with paste.'

'But,' said Norah, 'you can stick paper with sealing wax. I have seen father melt the wax in the flame of the candle, and drop it on the paper. When it gets hard it sticks fast to the paper.'

'Now look at this postage stamp, Norah,' said Fred. 'How do we stick it on the letter?'

'We wet the back of the stamp,' said Norah, 'and press it on the paper.'

'Quite right,' said Fred, 'and you know we stick our envelopes in the same way. The part that we wet is covered with an adhesive substance.'

'Teacher says,' he added, 'that this adhesive substance is known as starch gum. Let us see what it really is.'

‘You know what happens to starch if we put it into cold water?’

‘Starch is insoluble in cold water,’ said Norah.

‘Yes,’ said Fred, ‘but if dry starch is baked in an oven it becomes changed. It turns brown, and will easily dissolve in cold water. In this form it is called starch gum, the very substance on the back of the postage stamp and the edge of the envelope.

‘It is pasted on the stamps and other things with a brush, and dries very quickly. When we want to use it, we wet it, and it will stick fast.’

Lesson XVI

CEMENTS

‘Suppose we have another chat about those adhesive substances,’ said Fred. ‘What do we use to stick paper, Norah?’

‘We stick paper with mucilage, paste, sealing wax, and starch gum,’ said his sister.

‘Quite right,’ said Fred. ‘Teacher says we may call each of these things a cement. Cement is only another name for an adhesive substance—a substance to make things stick together.’

‘I saw father use some cement of another sort last week. He used it to mend a chair. He put the broken edges of the wood together, with some of this cement between. The chair is quite strong now. The cement has made the broken parts stick fast.’

‘Why, you mean glue,’ said Norah. ‘I saw father mending the chair. Of course glue must be an adhesive substance. It is a cement for wood.’

‘Those men who work with bricks and stone,’ said Fred, ‘use another sort of cement. Glue would not do.’

‘I suppose you must mean mortar,’ said his sister.

‘Quite right,’ said Fred. ‘Mortar is an adhesive substance. It is the very

sort of adhesive substance to make bricks and stone hold fast together.'

'What do the men use to make their mortar, Fred?' said Norah.

'Mortar is made of lime and sharp



sand mixed into a paste with water,' said Fred.

'When it dries it becomes very hard—as hard as the stone itself.'

'The stone-mason,' added Willie, 'always uses a special sort of mortar. It is

made from chalk and lime mixed with clay. He calls it cement. It is mixed up with sharp sand and then made into a paste with water, just as the bricklayer makes his mortar. It is used where great strength is wanted. It becomes as hard as the stone itself when it dries.'

Lesson XVII

WHEAT AND RICE

'You remember our flour in the muslin bag, Norah?' asked Fred.

'Yes, you squeezed the bag of flour in the basin of water,' said Norah, 'and washed out all the starch into the water.'

'I am going to do it again now,' said Fred. 'You watch me.'

After squeezing and kneading the bag for some time Fred said, 'I think I have got most of the starch out now. Let us open the bag and look inside.'

He did so, and showed his sister a thick, sticky substance left behind in the bag. 'This,' said he, 'is gluten. It is

the most important part of the flour. It is the gluten that makes our flesh and bones, and all the parts of our body. Wheat and oats are the best of all the grains for food, because they contain more gluten than the others.

‘Do you know what I have in this saucer?’

‘That is some rice,’ said Norah.

‘Yes,’ said Fred ; ‘rice is another kind of grain. Teacher washed the starch out of some rice-flour in class to-day, but when he opened the bag there was nothing left inside. The rice-flour is pure starch. It contains no gluten. Rice-flour would not be fit for bread.’

‘Where does rice grow, Fred?’ asked Norah.

‘It grows in the very hot parts of the world. It grows best in places where the soil is wet, and the air always hot and moist. It would not grow here.’

‘It is a grass, just like all the other grain - plants,’ said Willie, ‘with tall,

hollow, jointed stems, and long pointed leaves or blades.'



'Teacher says,' added Fred, 'that after the seeds are sown in the rice-field, the men flood the whole field with water for several days. When the water is drained off, the little plants can be seen pushing their way up through the soft wet mud.'

'The hot sun soon begins to dry the fields, and then the men let in the water again and again, to cover them while the plants grow.'

'What a strange sight a rice-field must be!' said Norah.

Lesson XVIII

FUSIBLE

'Go and get the old iron spoon, Will,' said Fred. 'We'll have our lesson all over again when Norah comes in.'

Away ran Willie, while Fred went to find one or two things he wanted for the lesson, and they were soon ready to begin.

‘Now, little girl,’ said Fred, ‘you have seen me use this iron spoon before. What did I do with it?’

‘You put a piece of wax in it and held it over the fire,’ said Norah.

‘What then?’ asked Fred.

‘The wax melted.’

‘What does that mean?’ he asked again.

‘The solid wax became liquid wax, and flowed about,’ said Norah.

‘I think, too, we have melted something else besides wax,’ said Will.

‘Oh yes,’ said Norah, ‘we melted sugar in the spoon too.’

‘I want to use the spoon again now. Do you know what this is, Norah?’

‘It is a piece of lead, I think,’ she said.

‘You are right, sister. It is lead,’ said Fred. ‘Now look and see what happens when I put this lead in the spoon, and hold it over the fire.’

‘The lead has melted and the liquid flows about in the spoon just as the other things did,’ said Norah:

‘Yes, it has melted,’ said Fred. ‘Teacher gave us a new name to-day for this melting. We may say we melt the lead or fuse it. Fuse and melt mean the same.’

‘Yes, and the things that we can fuse,’ said Will, joining in, ‘are fusible. Some things, such as wood, brick, slate, and stone, do not melt with heat. They are said to be infusible—that is, not fusible. Teacher pointed out to us that some of our minerals are useful to us entirely because they are fusible. Like lead, they can all be melted or fused with heat. We call them metals.’

‘Can you tell any of the metals, Norah?’ said Fred.

‘Iron and copper are metals as well as lead,’ said Norah.

‘Yes,’ said Will, ‘and so are gold, and silver, and tin, and zinc.’

Lesson XIX

CORN

‘Can you tell me, Fred, what these big seeds are?’ said Norah. ‘I picked them out from the chicken’s food. They are not like any of the grains.’

‘Ah,’ said Fred, ‘but they are grains of corn. This corn is sometimes called maize, sometimes Indian corn. We had a lesson on corn the other day; so, if you like, we will chat about it now.’

‘Let us begin with the plant itself. It grows from six to ten feet high. Its stem is very strong and about as thick as your wrist. It is hollow and jointed, like the stems of the other grain-grasses. The leaves spring from the joints in the stem. They are long, broad, and pointed, and the veins in them run side by side. The ear is called a cob. There is one in the corn-dealer’s window. Let us go and look at it.’

Away they ran, and were soon round

the shop window. Fred made them compare the cob with the ears of wheat, barley, and oats.

‘How very large it is by the side of the other ears of grain, and how closely



the grains are set,’ said Norah. ‘No wonder it has such a very strong stem.’

‘Let us now go back to the plant again,’ said Fred. ‘Teacher made us think of those long, broad leaves. All the time the ear is growing the leaves fold themselves round it. They cover it up in a sort of sheath, to protect it.’

‘When this sheath is no longer wanted

the leaves spread open, and the ear peeps out, able to take care of itself.'

'Corn grows in the warmer countries of the world,' said Will. 'It never ripens in cold lands.'

'As the grains are so large,' said Norah, 'I suppose this kind of grain is better than wheat or oats or any of the others.'

'No,' said Fred, 'you are wrong. The biggest things are not always the best. Corn contains very little gluten. It consists mostly of starch. Corn-flour is much used for making bread.'

'Corn is used very largely for making a flour for puddings and custards. This corn-flour is only the starch of the grain. I daresay Norah could tell us how to get the starch from the flour.'

Lesson XX

ABOUT METALS

'Look at this knife, Norah,' said Fred. 'Do you know what it is made of?'

‘It is made of steel,’ said Norah.

‘Quite right,’ said Fred. ‘See what a bright polished surface it has. When it gets dirty what must we do?’

‘We must rub it,’ said Norah; ‘that will polish it again. The more we rub the brighter it will shine.’

‘Right,’ said Fred. ‘Now, look at the copper kettle on the stove. That, too, is very bright. How is it kept bright?’

‘It must be rubbed like the knife; and so must the tins that hang in the kitchen. They always look bright.’

‘Teacher gave us a new name for this brightness of the metals,’ said Fred. ‘He calls it lustre. You must learn to say that these bright-shining metals are lustrous—full of lustre or brightness.’

‘I found my pocket knife just now. Here it is. I lost it a few days ago in the garden; but look at it. It is no longer bright and shining. It is covered with red rust. Iron and steel soon rust if they are left out in the weather.’

‘Do all the metals rust like this?’ asked Norah.

‘No,’ said her father, who had been listening to the children. ‘Look at these gold and silver coins. They never rust. They would not rust if I left them out in the garden for a week.’

‘We call gold and silver the precious metals,’ father added, ‘because they never rust. All the others are called common metals.’

‘Teacher showed us a sheet of gold leaf, thinner than the thinnest paper I ever saw,’ said Fred. ‘It was beaten out thin with hammers.’

‘I have here a piece of lead. Watch while I beat it flat with this hammer. You know,’ he added, ‘if I had beaten a piece of coal it would have broken in pieces, for it is brittle. The metals then cannot be brittle. Teacher gave us a new word for all the metals that can be hammered out thin. We say that they are malleable.’

Lesson XXI

SOME MORE ABOUT METALS

‘I say, Fred,’ said Willie, ‘we didn’t finish with the metals last night. Norah would like to hear all about wire, I daresay.’

‘Oh yes,’ said Norah, ‘I should ; and can you tell me how they make wire, Fred? Father was using some wire to-day no thicker than sewing thread. I should like to know how they make it.’

‘Well,’ said Fred, ‘teacher showed us some coils of wire of all sorts in our lesson, and told us how it is made.’

‘Let us take this piece of iron wire. This was made from a thick round bar of iron a few inches in length. It was first made red-hot in the fire. As it got red-hot it became soft. In this state it was taken out with tongs and forced through a hole in a strong steel plate. The hole was smaller than the iron bar itself, and

it is easy to see that it squeezed the iron as it went through.'

'Of course,' said Willie, joining in, 'this made the iron bar thinner, and at the same time longer.'

'Yes, I understand,' said Norah.

'Well,' said Fred, 'after it had been through this hole, it was forced into a smaller one, and drawn through it; then through a still smaller one, and so on, each hole being smaller than the last.'

'I think I can understand it all now,' said Norah. 'Every time the iron was drawn through a hole, it became thinner and longer, until at last it made a great length of this thin wire. But is all wire made like this, Fred?'

'Yes, dear,' said her brother, 'all wire is drawn out through holes in a steel plate in the same way.'

'Teacher gave us a name for metals which can be drawn out into wire. They are said to be ductile. Ductile means able to be drawn out. They are ductile

because they are tough or tenacious, and hold firmly together.'

'Whenever you see,' added Will, 'a piece of wire, Norah, you will be able to say at once, "This metal must be ductile and tenacious, or it could not have been drawn out into wire."''

Lesson XXII

IRON ORE

'Do you know, Norah,' said Willie, 'which is the best of all the metals?'

'I should think gold is the best,' said his sister; 'it is worth so much money, and is so bright and beautiful.'

'No,' said Will, 'gold is not the best metal. Iron is the best, because it is so useful. Teacher says it is the King of Metals. We see more things made of iron than of any other metal. Here comes Fred. Suppose we have a chat about iron now.'

'All right,' said Fred, 'I'm ready.'

Where did this iron poker come from at first, Norah?’

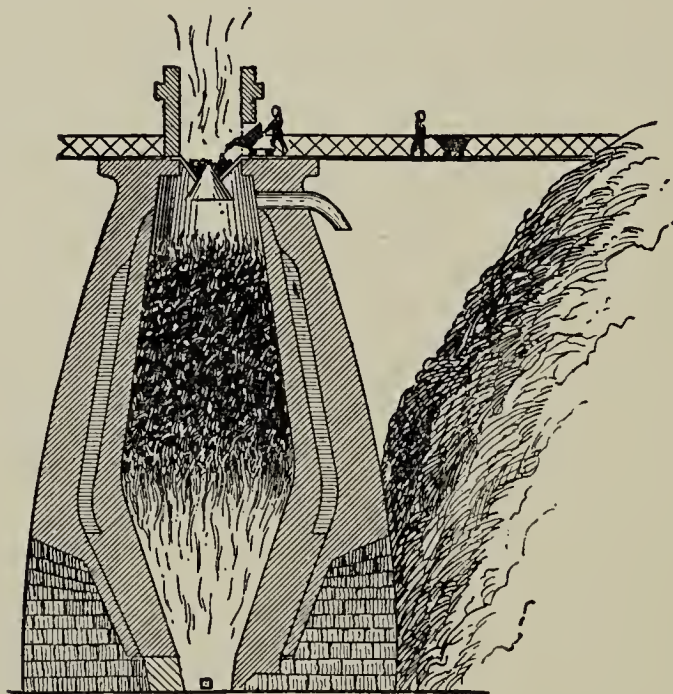
‘The iron was dug out of great pits in the earth, called mines,’ said Norah. ‘That is why we say iron is a mineral.’

‘That’s right,’ said Fred, ‘but the iron was then only like a rough stone. It was called iron-ore or iron-stone. Much has to be done to make it fit for use.

‘The iron-stone is first mixed with coal, and piled in great heaps in the open air. The heaps are set on fire and left to burn for days. This is called roasting the ore. It burns away the sulphur and some of the other useless parts of the ore. The roasted iron-stone is next put into the blast furnace. This great furnace is made of solid stone and brickwork, built in the form of a cone or sugar-loaf. Just think of a great sugar-loaf seventy feet high, Norah.’



‘Teacher showed us a picture of a blast furnace,’ said Will. ‘It was so easy to understand all about it from the picture. It looked as if the great furnace had been



cut down through the middle, from the top of the cone to the ground.

‘There was a gallery all round the top, and we could see the men on the gallery wheeling barrows filled with ironstone and fuel. The furnace is always fed from the top. Every half hour the men throw in their barrow-loads of iron-ore, coke, and lime. The furnace burns

day and night, and is never once allowed to go out for years.'

'I suppose the great heat melts the iron in the ore,' said Norah, 'for iron is fusible.'

'Quite right, little sister,' said Fred, 'and the melted iron sinks to the bottom of the furnace, because it is heavier than the other substances.'

Lesson XXIII

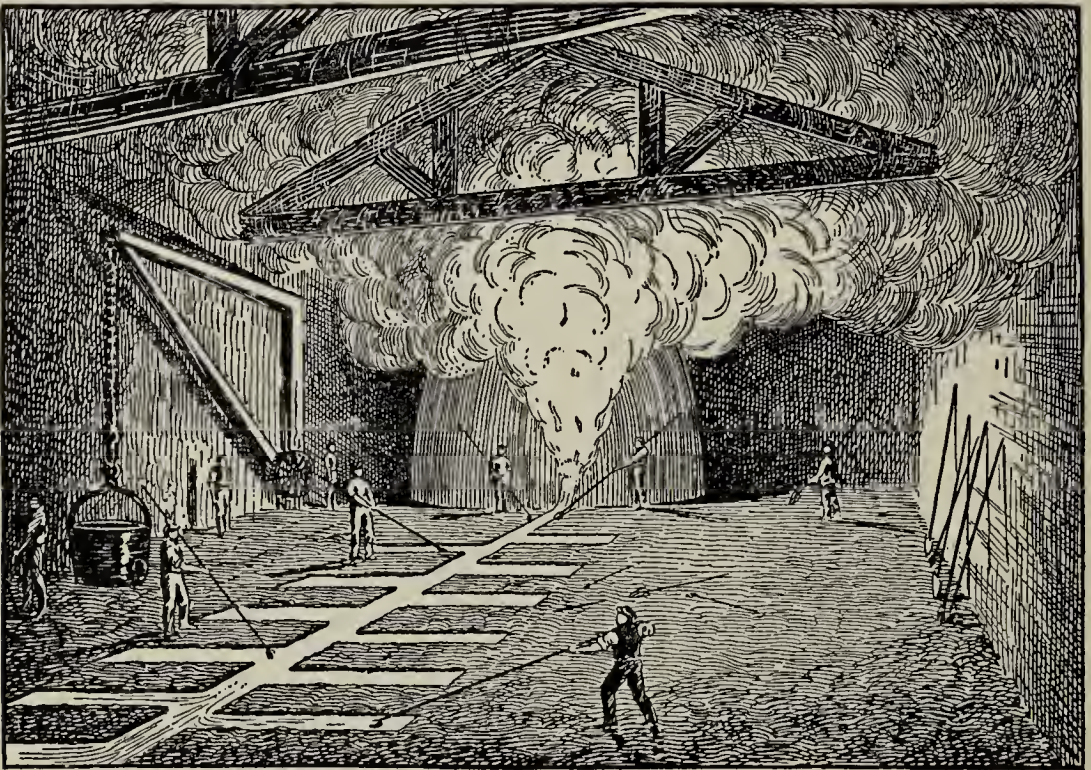
IRON

'Fred,' said Norah, 'do tell me what becomes of that melted iron at the bottom of the blast furnace.'

'There is a hole in the side of the furnace,' said Fred. 'The men keep it plugged up close and strong with fire-clay. Every twelve hours they come with long iron rods, and break away this clay plug. Then of course out comes the red-hot liquid iron.'

'The floor all round the furnace is laid thick with sand; and channels about

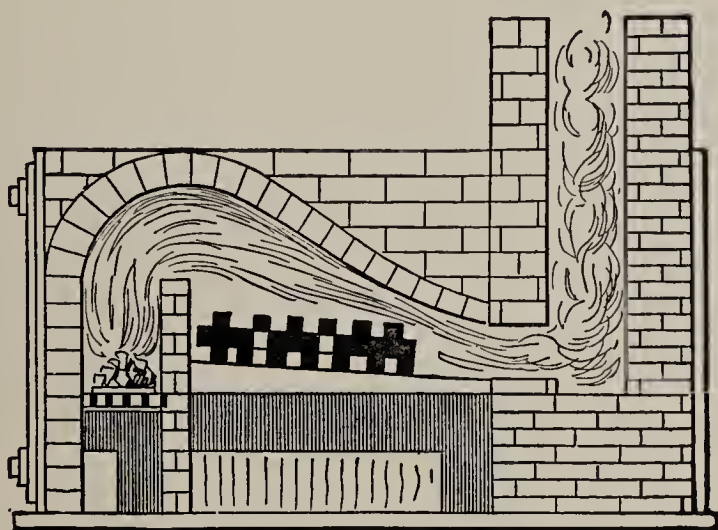
four inches wide are made in the sand. As the red-hot liquid metal flows out through the hole in the furnace-wall it runs into these moulds of sand. When it gets cold it forms solid blocks of iron.



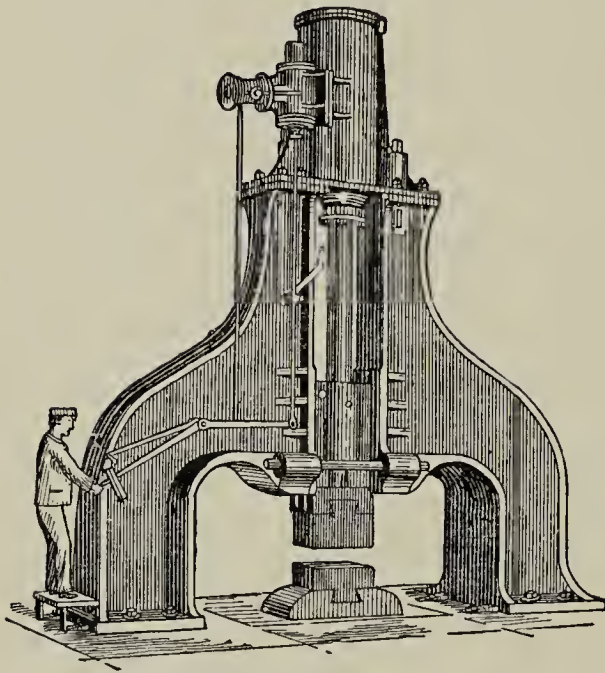
The blocks are called pigs of iron. The iron itself is known as pig-iron. It is also called cast-iron, because it is cast or poured in the liquid state into the sand moulds, and left to cool.'

'And is this pig-iron fit now to make all sorts of things?' asked Norah.

‘Well, no,’ said Fred. ‘Cast-iron is not fit for every purpose. These cast-iron pigs have to be melted again in great pots in the puddling furnace. This is an intensely hot furnace where a flame is made to play over the iron, although the iron itself is never allowed to touch



the fuel which is burning. In the blast furnace the iron got mixed up with some of the charcoal of the coal and coke. In the puddling furnace this is all burnt away, and then the melted iron is poured out into moulds. It cools in the moulds and forms solid blocks of iron. But you see it is still only cast-iron.



‘The blocks of iron are again put into the puddling furnace. This time the iron is not allowed to melt. It is simply heated till it is soft and plastic. Each block is then taken out of the furnace, and beaten while it is red-hot with immense hammers worked by steam engines.

‘The iron is heated and hammered in this way again and again. When it has been worked up enough, it is cut into bars while it is soft.

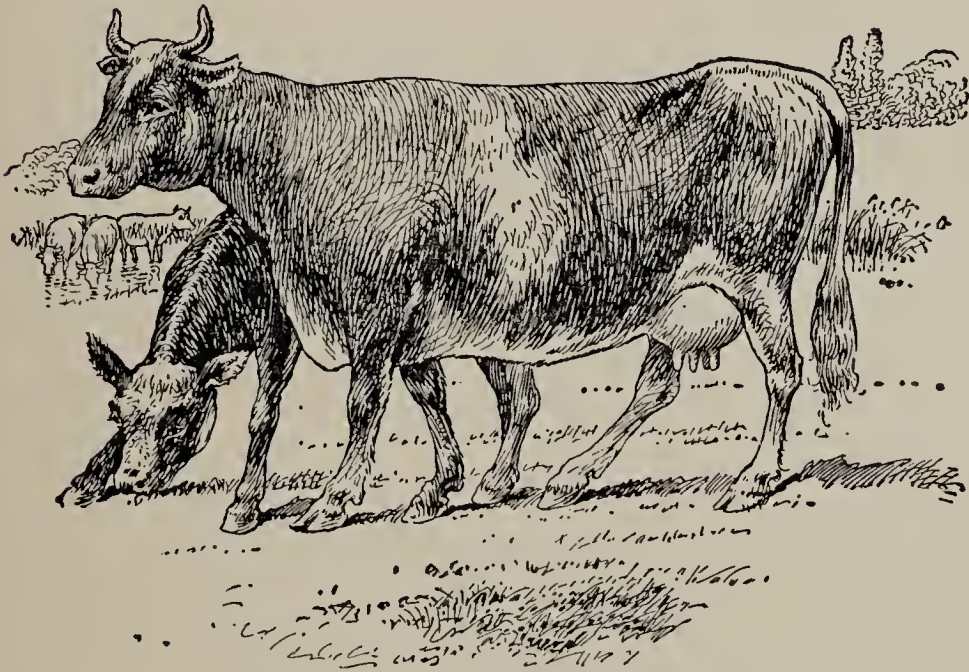
‘It is now ready for use, and is called wrought iron.’

Lesson XXIV

THE COW

‘Suppose, Norah, you tell us all you know about the cow.’

‘Very well,’ said Norah, ‘I’ll begin by saying that the cow is a large thick-set animal, with short, stout, strong legs, just fit to support so heavy a body. It has a thick skin, which we call a hide, and the hide is



covered with close smooth hair. It has a pair of smooth, pointed horns, and large broad ears; and its eyes are large and gentle looking.’

‘Now I think that’s very good for a little girl,’ said Willie. ‘Suppose we begin, Fred.’



‘All right,’ said Fred, ‘we’ll have a look at the feet. The cow’s foot is just like the sheep’s foot. It has four toes, but it walks only on the two front ones. The two short toes behind never touch the ground.

‘Each toe is covered with a hard, horny case, which we call a hoof. The foot looks as if it were split or cloven in two. We call it a cloven hoof.

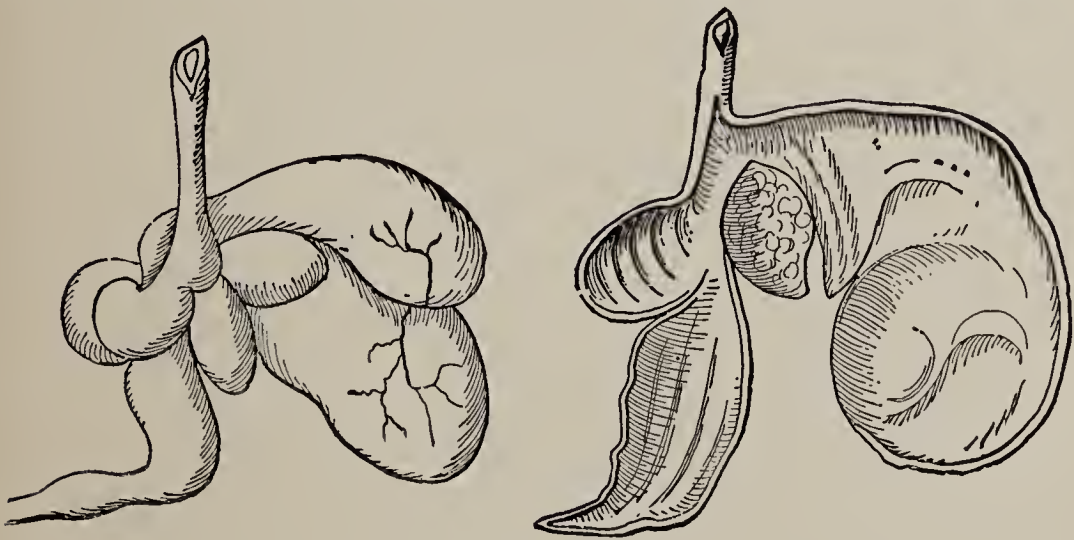
‘Now I want to ask a question. What do you remember about the animals that have cloven hoofs?’

‘They chew the cud,’ said Norah.

‘They do,’ said Will. ‘Suppose you tell us all about it, Fred.’

‘Well, you remember that these animals have four stomachs,’ said Fred. ‘When they are feeding, they bite off and swallow the grass, till they have filled the first stomach, or paunch. From the paunch the grass is sent into a second bag or pouch, which has little hollows

all round its sides. The grass collects in little cuds or pellets in these hollows, and the cuds are passed up into the mouth to be chewed. When it is chewed enough it is swallowed again. But it goes into a third stomach now, and



from this is passed on to the fourth stomach to be digested.

‘Now just a word about the teeth of these cud-chewers. What do you remember about the sheep’s teeth, Norah?’

‘It has no teeth at all in front of the upper jaw, only a thick, hard pad.’

‘Right,’ said Fred. ‘Then, too, the back teeth have broad, flat crowns, and the lower jaw moves from side to side, as well

as up and down. These teeth are called



grinders. They have to crush and grind up the food as in a mill.'

'Quite right,' said Fred. 'Now

don't forget, Norah, that the cow is exactly like the sheep in all these things.'

Lesson XXV

CAST-IRON

'I want you to help me to think about cast-iron again,' said Fred. 'First of all, why do we call it cast-iron, Norah?'

'The iron is melted into a liquid,' said Norah, 'and poured or cast into a mould.'

'Teacher showed us,' said Willie, 'that cast-iron is very useful in its own way, but this is only because it is not like other iron. It fuses or melts easily and with less heat than wrought iron.'

'Yes,' said Fred, 'and when it is cooling in the mould, it swells out and presses

into every corner. It must take the exact shape of the mould.

‘Cast-iron is just the metal to use for all sorts of articles, where beauty of shape is wanted. We can mould it into any shape we please.’

‘But,’ Willie joined in, ‘these cast-iron things won’t stand much hard wear and tear, for cast-iron is very brittle, and breaks very easily.’

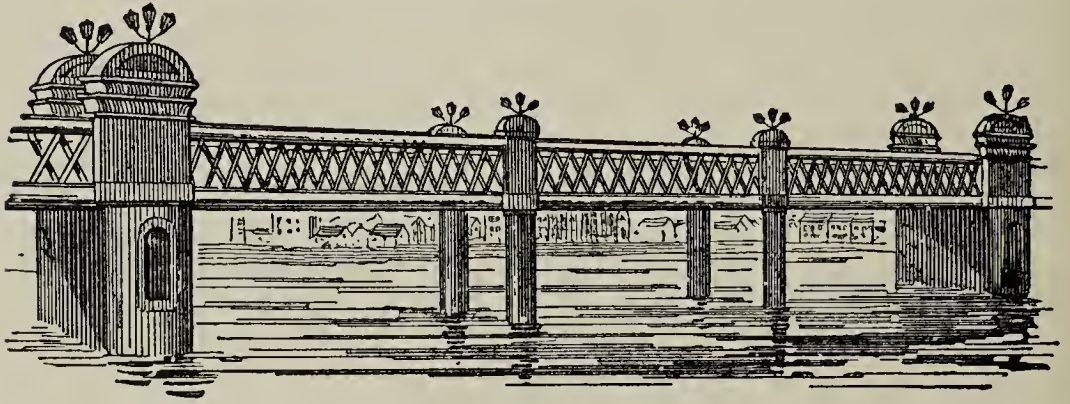
‘Cast-iron is used for making fenders, fire-grates, railings, iron bedsteads, brackets, saucepans, and kettles,’ said



Fred. ‘These things will last a long time if fairly used.’

‘Teacher showed us too,’ said Willie, ‘that cast-iron will bear almost any amount of downward pressure. It will neither twist out of shape nor break. This is why the great pillars to support bridges and arches are always made of

cast-iron. The stands for our desks at school are made of cast-iron. They will bear any amount of pressure ; but they



would snap in two with a blow, because they are so brittle.'

'Can you tell us, Norah,' asked Fred, 'something we can't do with cast-iron?'

'Well,' said Norah, 'as the cast-iron is so brittle, it could not be beaten out into thin sheets. It would break with the blows of the hammer.'

'Quite right,' said Fred, 'cast-iron is not malleable.'

'And as it will not hold together, it could not be drawn out into wire. It would break apart with the pulling.'

'Right again. Cast-iron is not ductile, and cannot be made into wire.'

Lesson XXVI**MILK, BUTTER, CHEESE**

‘While we were talking about the cow the other day,’ said Norah, ‘we forgot all about the milk she gives us. Milk forms part of our daily food. We drink it ; we put it in our tea, coffee, and cocoa ; we use it for making puddings with sago, corn-flour, rice, and tapioca.

‘I’ve been thinking that as these starch foods cannot make flesh, perhaps we put milk with them, because the milk can make flesh. Is that so, Fred?’

‘Wait,’ said Fred, ‘and I’ll show you that you are quite right, Norah.

‘Did you ever see some milk that had been left to stand for a time?’

‘Oh yes,’ said Norah ; ‘there is always a thick cream floating on the top.’

‘Well,’ said Fred, ‘this cream is a mass of very tiny cells or bags of fat. Each cell is like a little bladder, with an extremely thin skin. In the dairy they skim off this cream to make butter.’

‘Yes,’ said Norah, ‘but how do they make the butter, Fred?’

‘The cream is put into a churn,’ said Fred; ‘the dairy-maid keeps on turning the handle to shake the cream about. The object of shaking the cream is to



break the thin skin of those little fat cells. When the little bladders break, the fat in them is set free, and forms into a solid lump of butter.’

‘We saw something else in the milk,’ said Will. ‘I daresay Norah has often seen milk when it has turned sour.’

‘Oh yes,’ said Norah, ‘I saw some

sour milk to-day. There was something white and thick and solid floating in it.'

'Well,' said Willie, 'teacher got some of this stuff out of the milk, by pouring a sour liquid called rennet into it.'

'But what did the rennet do to the milk?' said Norah.

'It made some of the milk form into white solid lumps,' said Fred. 'These lumps are called curds. The rest of the milk is known as whey.'

'This curd,' Fred added, 'is the part of the milk which is able to make flesh. You know, of course, that the cow's milk is meant to feed her little calf, till it is able to look after itself. It is the curd of the milk that builds up the growing body of the little calf.'

'Did you know, Norah, that cheese is made from these curds of milk?'

Lesson XXVII

WROUGHT IRON

'Teacher showed us some things made

of wrought iron to-day,' said Willie. 'They are not at all like the cast-iron things we were talking about.

'He had a strip of wrought iron. He beat it with a hammer. He bent it and



twisted it about in all sorts of rough ways. But it did not break, because wrought iron is very tough and flexible.'

'Teacher showed us too,' said Fred, 'that wrought iron is malleable. It is

not malleable when it is cold, as lead is. Iron must be made red-hot before it can be hammered out. When it is red-hot it becomes plastic, and can be hammered into any shape we please.'

'I have watched the blacksmith at the forge,' said Norah. 'He puts the iron into the furnace and makes it red-hot. Then he lays it on the anvil, and beats it with his hammer. The iron which he works must be wrought iron, I suppose, for it is malleable.'

'Teacher next showed us some iron wire,' said Willie. 'It could not be cast-iron, for cast-iron is not ductile. This iron had been drawn out into very fine wire, and it must be ductile.'

'I say, Norah,' said Fred, 'you know we went to the blacksmith's shop to get my iron hoop mended?'

'Yes,' said Norah. 'I watched him put the broken ends of the hoop into the fire, and when they were red-hot he hammered them together.'

‘Quite right,’ said Fred. ‘It is almost as easy to weld wrought iron together, when it is red-hot and plastic, as it is to join two pieces of clay or putty.’

‘Wrought iron can be made into any kind of article with the help of the forge, hammer, and anvil. It is malleable, and can be beaten into any shape we please. It is ductile and tough, and can be drawn out into wire of any thickness.’



‘Its immense strength renders it just the thing for making girders, or beams for bridges, and arches, and great buildings. It is used for making steam engines, which have to do all sorts of work. Chains, too, of all kinds are made of wrought iron, because wrought iron will bear any amount of tugging and straining without giving way.’

Lesson XXVIII

THE HORSE

‘We are going to talk about the horse,’ said Fred. ‘We’ll all go into the

stable, and have a look at our dear old Tommy—the best horse in the world.



‘Now, Norah,’ he began, after they had petted and stroked Tommy, ‘what can you tell us about him?’

‘I should begin by saying that the horse is a big strong animal,’ said Norah. ‘He is bigger than the cow. We use him to draw heavy loads, because he is so strong.’

‘Very good,’ said Will, ‘and he is useful because he obeys his master, and is quiet, gentle, and patient at his work.’

‘Now let us look at Tommy. Look at his beautiful large, gentle eyes. Dear sensible old fellow, he looks almost as if he knew what we were saying.’

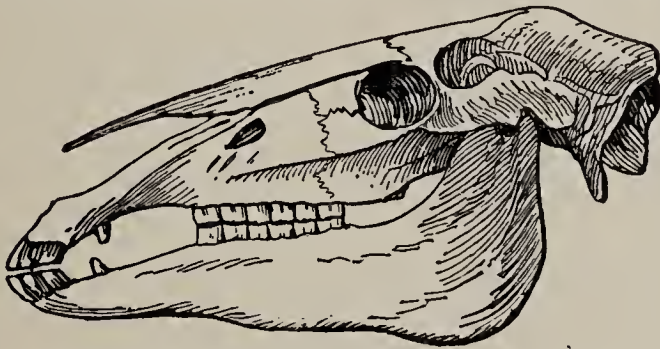
‘Do you notice,’ said Fred, ‘that the eyes are set not quite in the front of the face, but a little to the side? The horse can see well all round him. Notice his ears too. They are short, erect, and pointed, and very sharp. Did you see Tommy prick up his ears as we came in?’

‘In his wild state the horse is very timid. He wants sharp eyes and ears to warn him when his enemies are near.’

Father came in just then, and Fred asked him to show them Tommy’s teeth.

‘Come on, Tommy, old boy,’ said their father, ‘open your mouth, and let the children see your teeth.’

Fred pointed out the six, sharp, cutting teeth, top and bottom. ‘There is no pad in the top jaw,’ said he. ‘The cow and the horse do not feed in the same

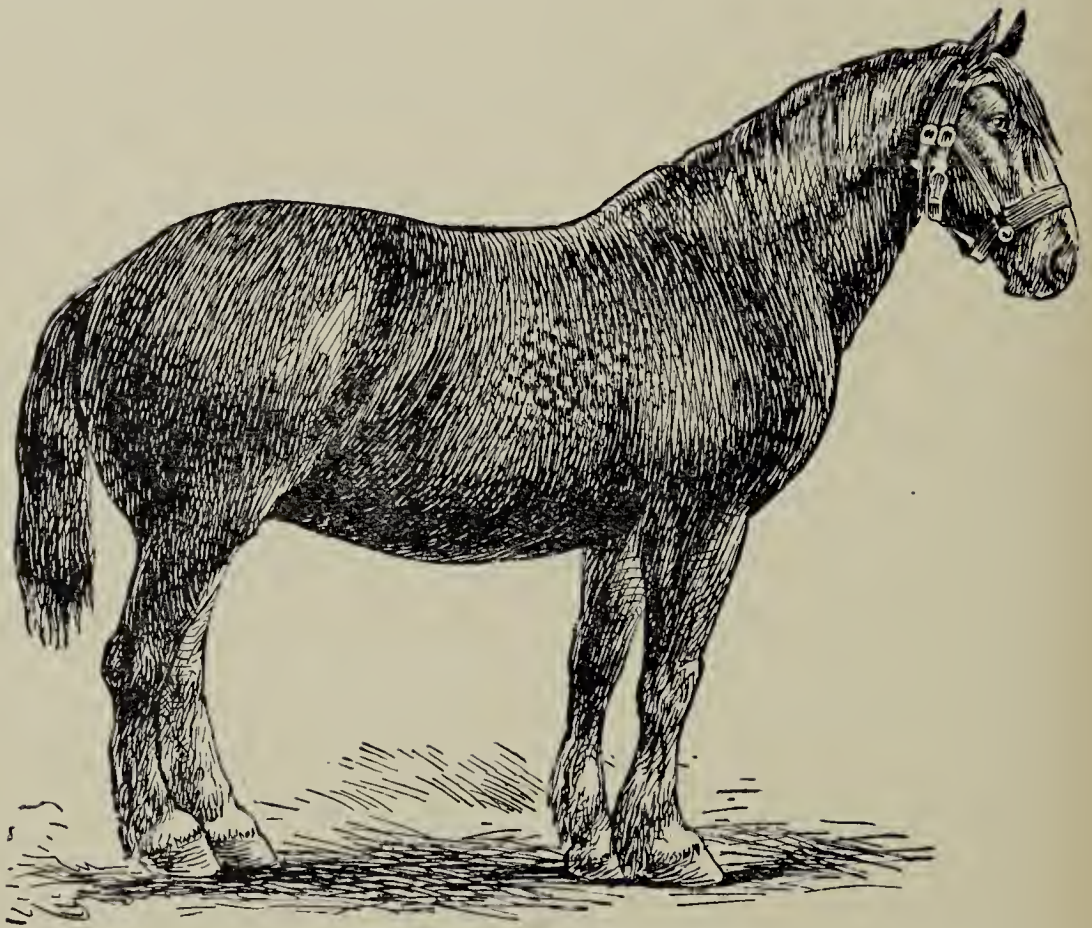


way. The horse nibbles the grass a mouthful at a time, and chews it up at once, before he swallows it. He does not chew the cud. Look at Tommy's great grinding teeth. They are meant to crush up his food.

‘The horse's foot is not cloven, like the cow's foot. It is one solid piece—a single toe; and this one toe is covered with a hard, horny case, or hoof.’



‘How do the wild horses manage, Fred? They have no one to make shoes for them. Oh, and I say, does it hurt Tommy when they nail those iron shoes on his feet?’



‘One question at a time, dear, please,’ said Fred.

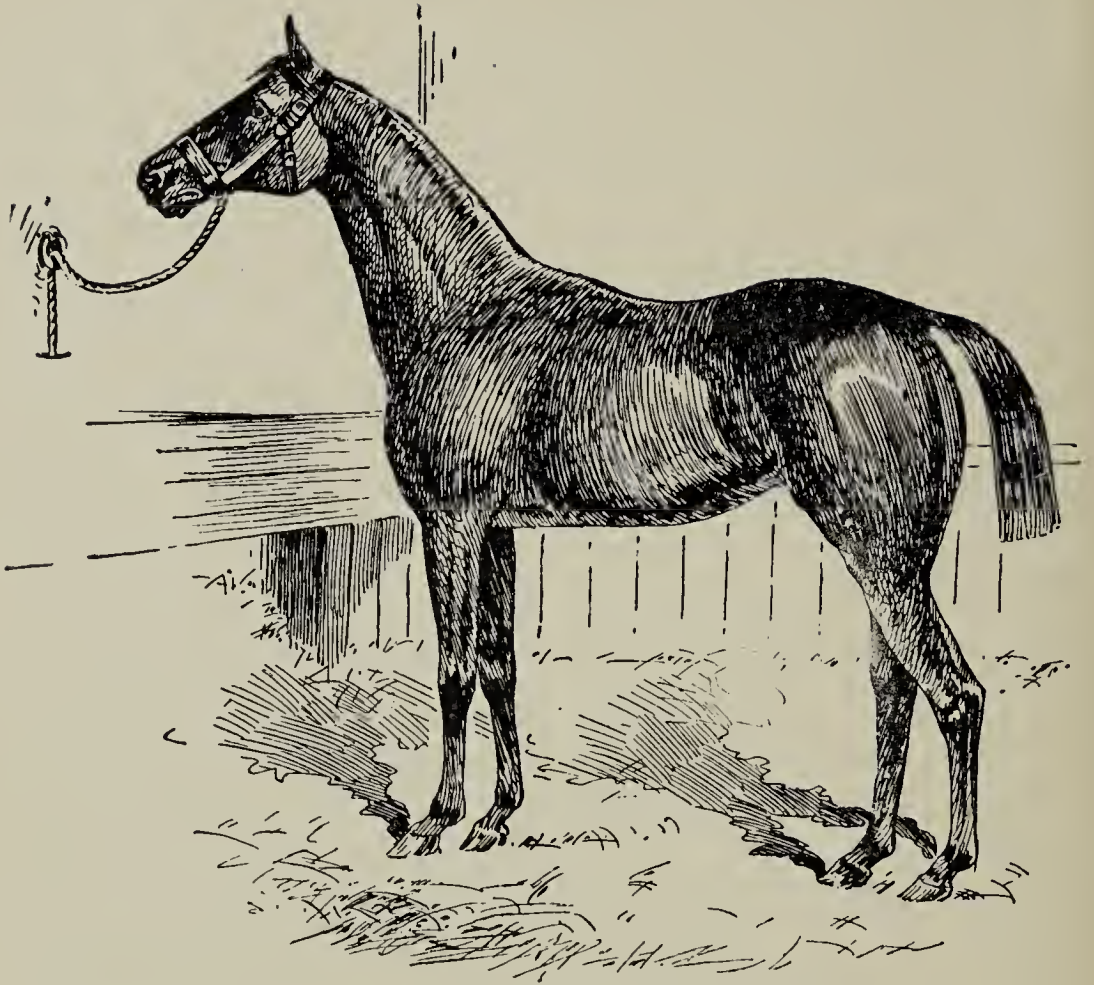
‘The wild horses live on smooth grassy plains. Their hoofs do not wear out as they do on our stony roads. We put shoes on their feet to save them from

wearing away on the stones. You will be glad to know that the blacksmith does not hurt the horse, when he drives the long nails into his hoof. The hoof is a hard substance like horn. It can be cut as easily as we cut our nails.

‘Here are some fine pictures of horses. The first one is the cart-horse, a powerful animal for drawing heavy loads.



‘This is the hunter. He carries his master on his back.



‘This one is the race-horse, a very fleet runner.’

Lesson XXIX

STEEL

‘Fred,’ said Willie, ‘I have been thinking about our lesson ever since we left school. Steel must be a very wonderful metal. Why, we might almost say it is two metals all in one.’

‘Well,’ replied Fred, ‘there are two kinds of steel, and each of them is very unlike the other in many ways.’

‘How very strange, Fred,’ said Norah, ‘and yet I think you told me that all steel is simply iron in another form.’

‘I can’t tell you exactly how the steel is made,’ said Fred. ‘It is kept for weeks in a furnace at one fixed heat, and then left to cool.’

‘Some of it is afterwards cut up into small pieces, and melted in strong wrought-iron crucibles, or pots, in a very hot furnace. The melted metal is poured out of the crucible into moulds, and left to cool. It makes a special kind of steel fit for special purposes. It is known as cast steel.’

‘Some of the steel is not melted in crucibles, but simply heated, and hammered, and welded, again and again, just as the wrought iron is served in the puddling furnace. Steel treated in this

way makes quite another kind of metal. It is known as shear steel.

‘Cast steel is as fusible as cast-iron, but it is as malleable as wrought iron.’

‘That must make it doubly useful,’ said Willie.

‘Yes,’ said Fred, ‘it does. Don’t you remember teacher said that the cast steel can be used for moulding or casting, or it can be heated in the forge, and then worked up, beaten, welded, rolled, or cut, just as they treat wrought iron?’

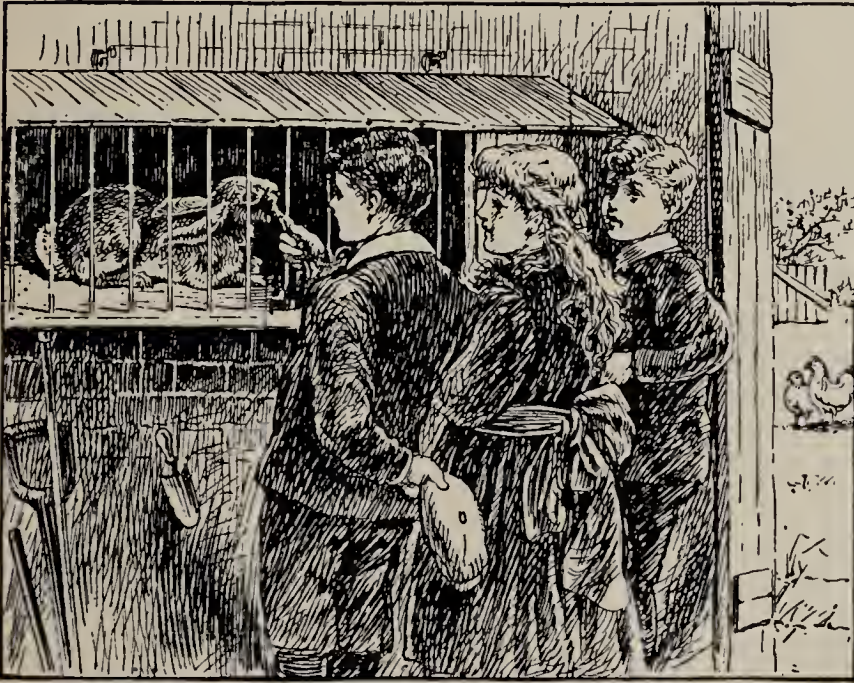
‘Our great guns are made of this cast steel,’ said Willie, ‘and so are most of the steel parts of engines and other machines. Shear steel is used for making knives and all cutting tools, as well as springs for watches, locks, doors, and carriages. It is very elastic.’

Lesson XXX

THE RABBIT

‘Come and see what father has given me for my birthday present,’ said Norah

—‘a pretty tame rabbit in a cage. Isn’t it a beauty, boys? It is nearly as



big as our dear old Tabby, and, like her, it has a thick coat of soft warm fur.’

‘It is really a beauty, dear,’ said Fred and Willie in one breath.

‘Look at its long ears,’ Norah went on, ‘and they are so sharp. At the least sound up they go. And then its large, soft, gentle eyes. Look at them. They are very bright and sharp, although they are soft and gentle.’

‘Do you see,’ said Fred, ‘that the

rabbit's eyes are placed at the sides of the face, not in front? In its wild state



it has many enemies among the flesh-eaters. It is a timid little thing, and cannot fight them. It must get away as fast as it can. The eyes are placed at the sides of the face to help it to see all

round as well as in front.

‘Now, I think, perhaps I can tell you something you do not know about your rabbit,’ Fred added. ‘To begin with, if you look at the top lip, you will see that there is a cleft up the middle, which divides it into two halves. As it moves the lips, you can see the four front teeth, two in the upper jaw and two in the lower. They are long, broad, and flat, and very sharp at their edges. Teacher calls them chisel teeth. You have seen father cut



off pieces of wood in slices with his chisel.

‘Let us give Bunny this carrot, and watch how it eats. See, it gnaws or nibbles off pieces with its front chisel teeth. The rabbit is called a gnawing animal because it eats like this. The top lip is split to help it in its gnawing.’

‘Look, Fred,’ said Willie, ‘the lower jaw moves from side to side, as well as up and down, while the rabbit is eating.’

‘Then I suppose,’ said Norah, ‘the other teeth in both jaws are grinders, for chewing or grinding up the food.’

‘Now I want you to look at the feet,’ said Fred. ‘The front legs are shorter than the hind ones. Rabbits move very quickly, but instead of running like most animals, they leap or jump about on their strong hind legs.’

‘If you look at the toes you will see that they are strong, and that each toe has a thick blunt claw. If we put Bunny

out in the garden it would soon begin to scratch up the ground with its claws.'

Lesson XXXI

COPPER

'Look, Norah,' said Fred, 'here is mother's copper coal scuttle. Suppose we have a talk about copper. What is the first thing you notice about it?'

'Its color is bright red, and it has a shining surface,' said Norah.

'Quite right,' said Fred. 'Remember that copper is the only red metal, and that it has a bright lustre.'

'Now look at the scuttle again,' he added. 'You will see that it is made of thin sheet copper. How was this made?'

'It was beaten out, or rolled out,' said Norah.

'What does that tell us?' asked Fred.

'It tells us that copper is malleable.'

'It is,' said Fred, 'one of the most malleable of all the metals.'

‘Now I will hold the scuttle up,’ he went on, ‘and you shall strike it with this stick. What do you notice?’

‘It gives out a loud ringing sound,’ said Norah.

‘Yes,’ said her brother, ‘it does, and we say that copper is sonorous, which means loud-sounding.

‘This is copper wire—some thick, some very thin. What can you tell me by looking at this wire?’

‘The copper must be ductile,’ said Norah, ‘or it could not be drawn out.’

‘Quite right again,’ said Fred, ‘and it is very tough or tenacious, for we may pull, bend, or twist the wire about almost as we please, and it will not break.’

‘I want now to show Norah this rusty copper nail,’ said Willie. ‘See, it is covered with bright green patches. These patches are the rust of copper. Copper rusts very easily, and the rust of copper is poison. It is called verdigris.

‘Copper is dug out of the earth as an

ore,' said Fred, 'like most other metals. Like iron-ore, it has to be smelted to remove the useless matter, and then it is made into many useful things, such as kettles, saucepans, scuttles, and other articles used in the house.'

'Does Norah know,' asked Willie, 'that brass is made by melting copper and zinc together? What a beautiful useful metal brass is!'

'Our cents are made with little other metal mixed with copper,' said Fred,



'and our five cents, or nickels, of nickel and copper.'

'Yes, and bells are made of bell-metal,' added Willie. 'Bell-metal is a mixture made by melting copper and tin together.'

Lesson XXXII

THE RABBIT AT HOME

‘Father says we may take Bunny out of the cage,’ said Fred, ‘and let it run



about in the garden for half an hour. While it has a run, we will sit down and chat about it.

‘We know that the rabbit is a timid, little animal. It has many enemies in its wild state, but it cannot fight them.

It has to get away from them as fast as it can. Its sharp eyes and ears are meant to give the rabbit warning, if any of these enemies are about. Its legs, too, help it to get away very quickly.'

'Then,' said Willie, 'it was made to live on roots and all sorts of plant food. Its chisel teeth are just fitted for gnawing off its food in pieces, and its grinders and jaws for chewing it.'

'Besides this,' added Fred, 'it has a thick, warm coat of fur, just fitted for an animal that is meant to live in the open air. Its whiskers, too, are useful for feeling its way, when it is too dark to see. Its strong claws are made for scratching and digging in the earth.'

'Shall I tell you all about the wild rabbit in its home, Norah?'

'Oh yes, do, please,' said his sister.

'Then listen, little girl, and you will see how well it is fitted for the life it has to lead. In all parts of the country rabbits live wild in the fields and woods.'

They are very timid creatures, and like to hide away out of sight in their homes. But where do you think those homes are? They are under the ground.

‘They choose a sandy spot, where it will be warm and dry, and here they dig long, winding tunnels, or burrows, with their strong feet and stout blunt claws.

‘They live together in great numbers,



and make their burrows side by side. A great many burrows close together form a warren. The burrows are just big enough for them. Foxes, and other wild

flesh-eaters, cannot make their way into these holes, so that the rabbit is safe there from all its enemies.

‘It is dark in the burrows of course, but the rabbit uses its whiskers instead of its eyes, and feels its way. At the end of the winding burrow is the rabbit’s home—a warm, snug nest made of grass, hay, and straw, from the fields around. Here the rabbit lives with his wife and children quite safe from harm.

‘All day the rabbits hide in their burrows. After dusk, and early in the morning, they come out to scamper in the fields, and find their food. They do much damage by gnawing the farmer’s crops, so they have to reckon the farmer with his gun as another of their enemies.’

Lesson XXXIII

LEAD

‘I had never thought till to-day,’ said Will, ‘what a useful metal lead is.’

‘Father has lent me these pieces of lead,’ said Fred. ‘Let us have a talk. Suppose we begin with this piece of sheet-lead.’

‘What does this sheet-lead tell you, Norah?’

‘It tells me that the lead must be malleable, because it has been hammered out into these thin sheets,’ said Norah.

‘Well, if it has not been hammered out, it has been rolled out,’ said Fred. ‘The truth is, malleable metals are more often rolled out than beaten flat with hammers. This sheet-lead was rolled flat between heavy steel rollers.’

‘Sheet-lead is sometimes made in another way. The lead is melted and poured out on a flat table covered with fine sand. While it cools and hardens, it is rolled with wooden rollers.’

‘Take the piece of sheet-lead, Will, and see how easily you can bend it.’

‘Lead is very flexible. See, too, how easily I can cut it with the knife. The

workman can bend it, cut it, and hammer it into any shape he pleases.

‘Sheet-lead is used for the roofs and gutters of houses, and for lining water cisterns ; and you can see now why it is useful for these purposes.

‘Here, look at this piece of lead pipe,’ he added. ‘This is used for gas and water. Lead is more useful for this purpose than any other metal, because it can be easily fused, bent, cut, and hammered, just as the workman pleases.

‘Teacher showed us that the very reasons, that make lead useful for these purposes, make it useless in another way. Why don’t we use lead wire?’

‘Lead is a soft metal and breaks easily,’ said Willie. ‘It is not ductile, so that it cannot be drawn out. It is not tenacious, so that it would not bear to be pulled.’

‘Do you see this spoon?’ said Fred. ‘It looks like lead, but it is not lead. It is made of pewter. Pewter is made by

melting lead and tin together. Pewter is used for making drinking vessels, and many useful things for the house.

‘You must remember that lead, like most metals, is found as an ore. It must be smelted, to remove the earthy matters before it can be of use.’

Lesson XXXIV

THE MONKEY

‘Oh, do come and see, boys,’ said Norah. ‘Here’s a man with a monkey. It is such a funny, little creature, and is playing such funny tricks.’

Off they all ran in a moment, and for a long time amused themselves by watching the antics of the strange, little animal. When he had gone away and the children were back again, Fred said, ‘That monkey, I think, will be the best thing for us to talk about to-night, while he is fresh in our minds.’

‘Now what did you think the strangest thing about the monkey, Norah?’

‘Why, he seemed to have no feet,’ said Norah. ‘His feet looked just like his hands.’

‘And quite right, too,’ said Fred.



‘His feet are hands. He has four hands. We call monkeys four-handed animals.’

‘You know your own hand has four fingers and a thumb. If you take hold of a stick and grasp it, you will see how useful the thumb is. You could not grasp the stick if you had no thumb. You could not do it with your foot.’

‘That monkey, too, seemed to have very long arms,’ said Norah. ‘They reached nearly to the ground.’

‘Yes,’ said Willie, ‘teacher says all monkeys have very long arms. Did you notice, Norah, he never stood quite upright? When he was on the ground he did not seem happy. He looked very awkward as he moved along. He was

always stooping. He seemed to be using his long arms to support himself.'

'The truth is,' said Fred, 'monkeys are quite out of place on the ground. Their proper home is in the trees. Their four hands are made for grasping the branches. Their long arms help them to swing themselves from one branch to another. Although they are so awkward on the ground, they are very sharp and nimble in the trees. They climb and spring from bough to bough, and are quite at home there.'



'Monkeys are not found wild in this country, but in some parts of the world they are as numerous as rabbits are here.'

They live in the dense woods and forests of the hottest countries of the world. Their home is in the trees, and they feed chiefly on fruits and nuts.'

Lesson XXXV

TIN

'Oh, boys,' said Norah, after tea was over one evening, 'I wish you would come and help me find my pretty tin mug. I have not seen it since I had it in the garden nearly a week ago. I'm afraid it will be covered with rust.'

'You may make your mind easy as to the rust,' said Fred. 'Tin does not easily rust.' Then they began the search.

'Look, here it is, under the seat. It is not at all rusty. A rub with the chamois will soon make it shine as brightly as ever. Tin has a very bright, metallic lustre, and can easily be polished when it gets dull.

'Suppose your mug had been made of iron instead of tin, Norah,' he added.

‘Ah,’ she said, ‘it would have been rusted all over ; wouldn’t it, Fred?’

‘Yes, it would,’ replied Fred. ‘But I say, Norah, what will you say when I tell you that your tin mug is not a tin mug at all. It is really made of iron. Very few of the things which we call tin-ware are really made of tin. They are made of sheet iron, covered with a coating of tin on both sides. It would be better to call them “tinned ware.”’

‘Let us see why the tin is put over the iron. The iron would rust very quickly, but the tin, although it will tarnish, does not rust. When it gets dull and tarnished, a rub will make it clean and bright again.’

‘But how do they put the tin coat on the sheet iron?’ said Norah.

‘Teacher melted some tin in the old iron spoon,’ said Fred, ‘to show us how easily it melts. It is the most fusible of all the metals. To make the “tinned ware” the sheet of iron is dipped into

melted tin, and when it is taken out the tin forms a coat all over it.

‘The tinman uses solder to join the pieces of tin together when he makes vessels for use. Solder is a mixture of lead and tin.



‘See what I have here,’ Fred went on. ‘It is a sheet of tin as thin as paper. It would take a thousand sheets like this, laid one upon another, to make a pile an inch high. It is called tin-foil. I took it off a packet of sweetmeats this morning. It is used for wrapping up

sweetmeats, fancy soaps, tobacco, and all articles that have to be kept from the air. See, it is so pliable that it folds closely over the things. Can you tell me how this tin-foil is made, Norah?’

‘It must be either beaten or rolled out,’ said Norah. ‘I suppose it was rolled out.’

‘Yes,’ said Fred, ‘it was. What does that tell us about tin?’

‘It tells us that tin is a malleable metal.’

‘Tin, like other metals, is always found as an ore. It must be smelted in a furnace, to remove the earthy parts, before it can be of use.’

Lesson XXXVI

THREE CLASSES OF MONKEYS

‘Teacher showed us some fine pictures of monkeys to-day, Norah,’ said Willie. ‘One was the Gorilla. We call him an ape. He has no tail. He is much bigger than a man, for he is nearly seven feet high, and has a great broad, powerful

body and a huge head. He is covered with coarse, iron-gray hair, and his face is jet black. He is a fierce, ugly, savage

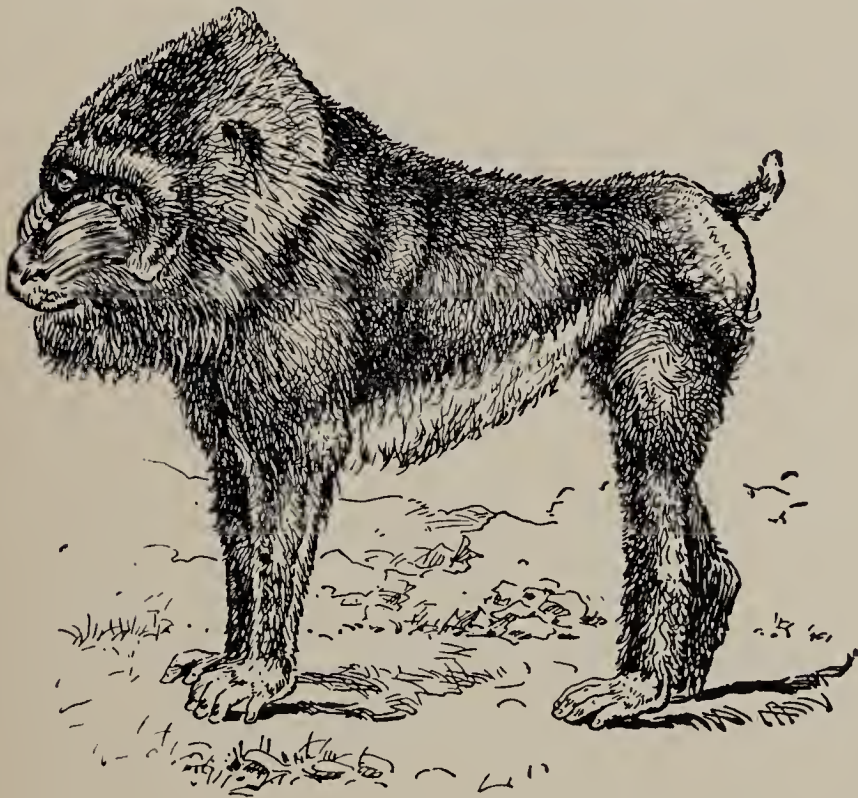


creature. A man would rather meet a lion than this great ape.

‘He lives in the dense forests of Africa. He and his mate make their nest in the

trees by twining the branches together. They live on roots, fruits, and berries.

‘Then we saw pictures of the baboons. They have short tails. Some baboons are nearly as tall as a man. They are all very fierce and strong. Teacher



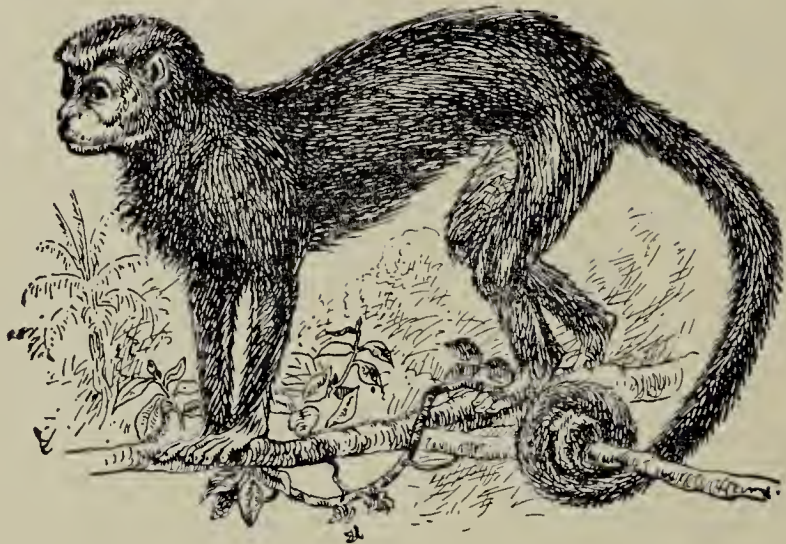
showed us one with a face marked with lines of scarlet, purple, and blue. He is called a Mandrill.

‘Now, Fred, suppose you tell us about the monkeys.’

‘Well,’ said Fred, ‘the monkeys are

smaller than either the apes or the baboons. They all have long tails.

‘Monkeys are found in the forests of Asia and Africa, and also in America. The monkeys of America are not like those of Asia and Africa. They have either no thumb at all or a very small



one, but to make up for this, the tail is very long, and the creatures use it as a sort of fifth hand. They are very clever climbers.

‘The monkeys of Asia and Africa have shorter tails, but the thumbs are better fitted for grasping. You could easily tell them by their cheek pouches. Teacher

showed us their loose wrinkled cheeks. The wrinkles form bags or pouches, and the monkeys stow away in them the nuts and fruit which they gather in the forests.



‘I am going to ask father to take us to the Zoo, to see the monkeys and baboons,’ Fred added. ‘Teacher says we can’t see the dreadful gorilla there. He is such a furious, savage beast that he will not live in a cage. He refuses

his food and dies rather than live a prisoner. Perhaps father will take us to the Museum, to see the stuffed bodies of the dead gorillas.'

Lesson XXXVII

ZINC

'Father has given me these pieces of zinc,' said Fred ; 'so suppose we have a chat about zinc to-night.

'Let us begin with this piece. It looks new, and has a bright surface. We may say that zinc is a bluish-white metal, with a high metallic lustre.

'Now look at this piece. Can we call this bright?'

'No,' said Will and Norah together, 'it is dull and tarnished.'

'It is not only tarnished,' said Fred, 'it is rusted. There is a thin coating of rust on the surface. But teacher asked us to remember that, when zinc once becomes covered with a thin coat of rust, it will not rust any further. The rust

does not eat into the metal, as it does into iron. Take it in your hand, Norah, and scrape it lightly with the knife, and you will find it quite bright inside.'

Norah did so, and found it just as Fred said.

'But I say, Fred,' she cried, 'how light it seems.'

'Yes,' said Fred, 'it is light. It is the lightest of all the metals. ?'

'This piece,' he added, 'is sheet zinc. How was that made?'

'It was rolled or hammered out,' said Norah, 'so zinc must be malleable.'

'Yes,' said Fred, 'it is like lead and tin in this respect. And, like them too, it is not good for making wire. It is neither ductile nor tenacious.'

'It is mostly used as sheet zinc. The reasons are that it is malleable, and can be easily rolled out; it is lighter and harder than lead, and, at the same time, cheaper, and it bends easily.'

'It is largely used for the roofs and

gutters of houses, and for rain-water pipes, as well as for baths, cans, and vessels of all kinds for holding water. The reason is that water and air do not rust zinc, except on the surface.'

'Do you know, Norah, that zinc saws are always used for sawing up blocks of salt?' said Fred. 'Iron or steel saws would rust; but zinc does not rust.'

'Now look at mother's new pail. It looks exactly like zinc; it is the color of zinc. But it is not zinc. It is made of iron. We call it galvanised iron.'

'It was made just as the "tinned ware" was made. The iron was dipped into melted zinc, and this formed a coat all over it, to keep the iron from rusting.'

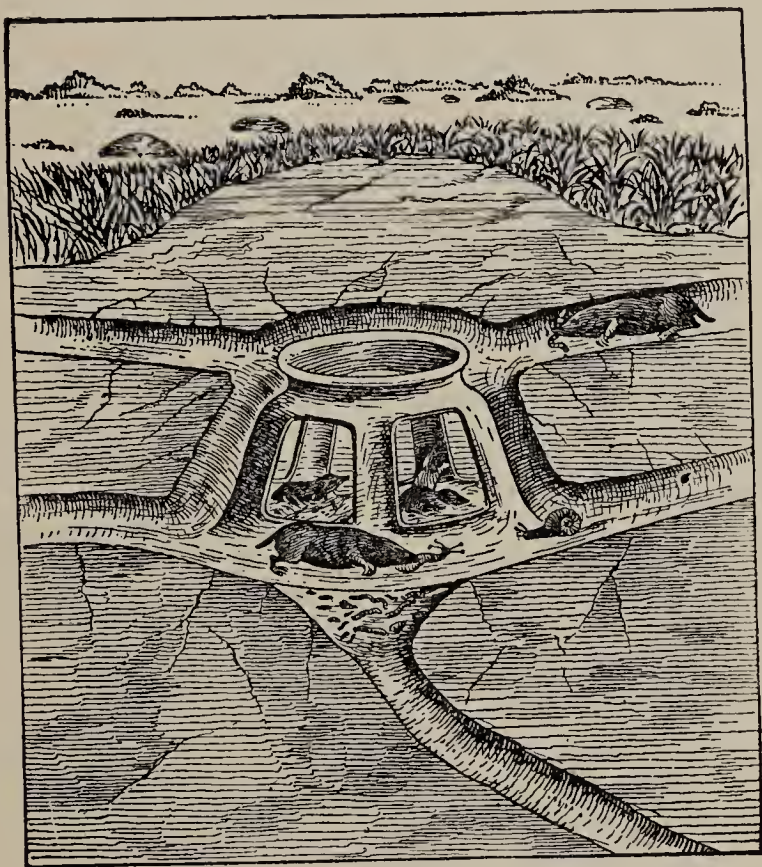
Lesson XXXVIII

THE MOLE

'Our lesson to-day,' said Willie, 'was about a very strange, little animal, the mole. It lives in most parts of the

country, and yet it is rarely seen alive, because it lives under the ground.

‘The rabbit too lives under the ground, but only to be safe from its enemies. It must come out to get its food. This



little animal, the mole, is born underground; he lives, eats, drinks, works, and, I daresay, dies there.’

‘How can he feed under the ground?’ asked Norah. ‘What does he live on?’

‘He is a fierce, hungry, little hunter,’ said Fred, ‘and rabbits’ food would not

do for him. He catches little animals and eats them.'

'But what animals can he find in the earth?' asked Norah. 'Oh, I suppose you mean worms and beetles and things



of that sort. I have found them in my garden when I have been digging.'

'That's right,' said Willie, 'they are the mole's food.'

'Now look what I've got,' said Fred. 'This is a mole that has been dried and stuffed. Father got it for us.'

'Look at the shape of his body. It is

short, thick, and rounded, with a pointed snout and very short legs, just the sort of body for boring tunnels in the earth.

‘Now look at the front paws. They are like broad flat shovels. They have strong claws, which turn outwards and backwards. They are his digging tools.’

‘How soft and smooth his coat is,’ said Norah.

‘Yes,’ said Fred, ‘and it does not matter which way it is rubbed, it is always smooth. If you rub pussy’s fur the wrong way it looks rough. The mole’s fur is never rough ; it bends easily either way. But the best point about it is that it will not allow any of the earth to stick to it. It all shakes off easily, so that although he lives in such a home, he is never dirty, while his thick coat keeps him warm in the damp cold earth.’

‘Some people say,’ added Fred, ‘that the mole has neither eyes nor ears.’

‘The truth is that the eyes and ears

are so hidden up by the thick fur, that they cannot be seen.

‘Of course, down in that underground darkness, eyes are all but useless to the mole. But his ears are very sharp, and so is his sense of smell. His hearing and smell help him to find his prey.

‘I suppose, now, when we speak of his prey, you would like to know something about his teeth. They are long, sharp, and pointed. They are just fitted for seizing his victim and tearing its flesh—not for chewing. He catches and kills frogs, field-mice, and small snakes, as well as earth-worms and beetles.’

Lesson XXXIX

SILVER

‘You remember, Norah, that silver and gold do not rust?’

‘Oh yes,’ said Norah. ‘We call them precious metals.’

‘I want you to look at mother’s silver spoon. What can you tell me about it?’

‘It is white,’ said Norah, ‘and has a very high polish.’

‘Yes,’ said Fred, ‘and now let us put the spoon by the side of these pieces of tin and zinc. The whiteness of the silver is not the yellowish-white of the tin, nor the bluish-white of the zinc. Silver is pure white.

‘I must not let you scratch mother’s nice spoon,’ he added, ‘but you could easily do it with a knife, for silver is a very soft metal. Pure silver would not be fit for use. It is too soft and would wear away. This spoon itself is not all silver; neither is this shilling. Some copper is always mixed with the silver to make it hard enough.’

‘Don’t let us forget those thin leaves of silver that teacher showed us,’ said Will. ‘Why, they were so thin you could blow them away, Norah. They were ever so much thinner than the tin-foil. You know that a thousand leaves of tin-foil, one on the other, make a pile an inch

high. But you would want just ten thousand of these silver leaves to make a pile that height.'

'Then,' said Norah, 'what a very malleable metal silver must be.'

'It is,' said Fred; 'teacher says it is



more malleable than any of the common metals. It is so easily malleable, that it



can be beaten into any shape, for making spoons, forks, trays, cups, tea and coffee-pots, and many other things for use and

ornament, as well as the money, with which we buy what we want.

‘Look now at this very thin silver wire,’ added Fred. ‘I pulled it out of an old piece of fringe. What do you learn by looking at the wire, Norah?’

‘I learn,’ replied his sister, ‘that silver must be very ductile, or it could not be drawn out into fine wire like this.’

‘Quite right,’ said Fred. ‘This silver wire is used for making lace and fringe.

‘We said just now that silver does not rust,’ he went on, ‘but the fumes of our fires and gas will soon cause silver to tarnish. Sulphur too will quickly tarnish it, and turn it dull and black, like a dirty piece of lead. But a rub with the chamois soon cleans it again, and brings back its beautiful white lustre.’

Lesson XL

GOLD

‘Come here, Norah, and see how rich I am,’ said Fred.

‘Just look, Willie,’ cried Norah. ‘Fred

has got a bright, new eagle. How beautiful it looks. Where did you get it, Fred? Did you find it?’

‘No,’ said Fred, ‘I did not find it. It is not mine. Father lent it me. We are going to have a chat about gold to-night. We must take care of it, though.’

‘Now suppose we begin. You shall tell us what you can find out about gold, by looking at the eagle, Norah.’

‘Well,’ said his sister, ‘the first thing



I can see is that gold is a yellow metal, with a very bright polish or lustre.’

‘Yes,’ said Fred, ‘and we might say that it is the only yellow metal we have.’

‘But,’ said Norah, ‘isn’t brass a yellow metal too?’

‘It is yellow, dear, but, if you remember, brass is not a pure metal. It is a mixture of copper and zinc.’

‘Then too,’ he added, ‘polished brass has a very high lustre, but just look at this brass candlestick. It was left out in the tool-house and forgotten. See, it is covered with patches of green rust.’

‘Yes, but gold never rusts,’ said Willie. ‘It does not even tarnish. It remains quite unchanged by air or damp.’

‘Now take the eagle in one hand and this quarter in the other, Norah.’

‘I know what you mean,’ said she. ‘The gold eagle is heavier than the silver quarter of a dollar.’

‘Yes, dear, it is,’ said Fred. ‘Gold is the heaviest of all the metals I have shown you.’

‘I suppose,’ said Willie, ‘you remember those thin leaves of silver, we talked about the other night?’

‘Yes,’ said Norah. ‘It takes ten thousand of them to make a pile one inch high.’

‘What would you think, then, of gold leaves so thin that twenty-eight of them,

one above the other, would not be thicker than the one leaf of silver? It is true, though; and, teacher says, it takes 282,000 leaves of gold to make a pile an inch in height. How very thin the gold must be beaten.'

'That tells us that gold is much more malleable than silver,' said Norah.

'It is the most malleable of all the metals,' said Fred. 'It can be beaten, rolled, cut, and twisted, or worked up into any shape the workman wishes.

'It is for all these reasons, and also because gold is scarce, and therefore dear, that people like to use it for rings, chains, bracelets, watches, and other beautiful ornaments to wear.

'You should remember that gold, like silver, is too soft to be used alone. Some copper is mixed with it to make it harder.'

'Teacher told us too,' said Willie, 'that gold is mostly found not as an ore, but in little round grains, called nuggets. The nuggets are pure gold.'

SUMMARY OF LESSONS

LESSON I.—POROUS BODIES

Porous bodies absorb liquids. Turpentine rises through the pores of the cane and burns at the top. The wicks of the candle and the lamp are porous. The tallow and the oil rise through the pores of the wick and burn at the top.

LESSON II.—SPONGE—AND ITS USES

Sponge is useful because it is porous, elastic, soft, and smooth.

LESSON III.—THE SPONGE

The sponge is the skeleton of an animal, that lives on the rocks at the bottom of the sea. Its pores are its mouths. Divers go down to the bottom of the sea to get the sponges.

LESSON IV.—FILTERS

Filters are made of porous substances. They let the clear water pass through their pores, but keep back the little pieces of solid matter. Blotting-paper is porous ; it makes a good filter.

LESSON V.—THE POOR MAN'S FILTER

The earth is a great filter. It allows the clear spring water to trickle through its pores, but keeps back all the mud.

LESSON VI.—SOLUBLE

Things that dissolve are said to be soluble. When they dissolve they make a solution. If we dissolve a substance in water, we cannot pour away the water, and leave that substance at the bottom, as we can chalk. Chalk will not dissolve in water.

LESSON VII.—SOLUBLE SUBSTANCES

When a substance dissolves in water, it breaks up into little morsels, which find their way into the pores of the water. The water cannot dissolve any more after the pores are all filled.

LESSON VIII.—STARCH

Starch is not soluble in cold water. Like chalk, it sinks to the bottom, and we can pour the water away. We can dissolve starch in boiling water.

LESSON IX.—WHAT STARCH IS

The flour, from which our bread is made, contains starch, and so does the potato. We can wash the starch out of some flour in a basin of water. The starch is in the form of tiny grains or bags, too small to be seen with the naked eye. Boiling water bursts these bags, and so dissolves the starch.

LESSON X.—STARCH FOR FOOD

Our bread, puddings, cakes, and potatoes all contain starch. Sago, arrowroot, and tapioca are nearly all starch. Sago is made from the pith of the Sago Palm, which grows in hot lands. Arrowroot is made from the underground stem, tapioca from the root, of a plant.

LESSON XI.—SOLUBLE AND INSOLUBLE

Flint, wood, and iron, like chalk and starch, will not dissolve in water. They are insoluble. Water is a solvent for sugar, salt, and other things, because it dissolves them. Soda is a solvent for fat and oil.

LESSON XII.—SOAP

Soda dissolves tallow, suet, fat, oil, and grease of all kinds, and makes soap.

LESSON XIII.—GRAIN

The grain that grows in the grain-fields is a grass. It has a hollow, jointed stem, and long, narrow leaves. The kernels grow in long ears at the top of the stem.

LESSON XIV.—KINDS OF GRAIN

Wheat is the best of all the kernel grains. Its ears are full and the kernel plump. Wheaten bread forms the chief part of our food. Barley has spiked ears, not like the ears of wheat. It does not make good bread. Oats hang in bunches. Oatmeal is made into cakes and porridge. Rye-flour makes dark, coarse, heavy bread.

LESSON XV.—ADHESIVE

Adhesive substances make other things stick together. We might call them sticky substances. Mucilage, paste, and sealing wax are adhesive substances for sticking paper. The adhesive substance on an envelope and on the back of a postage stamp is starch gum. It is made of starch.

LESSON XVI.—CEMENTS

Cements are adhesive substances that stick things together. Glue is a cement for wood ; mortar is a cement for bricks and stone.

LESSON XVII.—WHEAT AND RICE

Wheaten-flour contains gluten ; rice-flour contains no gluten—only starch. Gluten is the best part of the flour ; it makes our flesh and bones. Rice-flour would not be fit for bread.

Rice, like wheat, is a grass, with tall hollow stems, and long pointed leaves. It grows in very hot moist lands. It would not grow here.

LESSON XVIII.—FUSIBLE

Wax melts in a spoon over the fire—the solid becomes a liquid, and flows about. Lead, too, melts in the same way. We say it is fusible. Iron, copper, tin, zinc, silver, and gold will all melt or fuse, like the lead. They are metals.

LESSON XIX.—CORN

Indian corn is also called maize. The plant is a great tall grass, with a hollow, jointed stem, and long pointed leaves. The ear is called a cob. It contains a great number of large grains, set close together. Corn grows in warm lands. It contains very little gluten. The starchy part of the grain is made into corn-flour.

LESSON XX.—ABOUT METALS

Metals have a bright, shining surface, which we call their lustre. We say they are lustrous—that is, full of lustre. Metals sometimes rust and lose their lustre. Gold and silver do not rust. We call them precious metals. Malleable means ‘able to be hammered out.’

LESSON XXI.—SOME MORE ABOUT METALS

Some metals can be drawn out into wire. We say they are ductile. They must be very tough or tenacious, to hold together while they are being drawn out.

LESSON XXII.—IRON ORE

Iron is the ‘king of metals.’ Iron-stone or iron-ore is dug out of the earth. It is first mixed with coal, and roasted in great heaps. Then it is smelted in the blast furnace with coal, coke, and lime. The enormous heat melts the iron of the ore, and it sinks to the bottom of the furnace as a thick, red-hot liquid. All the useless parts of the ore float on the top of the liquid iron.

LESSON XXIII.—IRON

The red-hot, liquid iron is run off from the bottom of the blast furnace, just as we might run off water, or any other liquid, from a tap. It flows into sand moulds on the floor, and when it is cold it forms great blocks or pigs of cast-iron. The pig- or cast-iron is again melted in great pots, in the puddling furnace, and left to cool; after which it is heated till it is red-hot and plastic, and in that state it is beaten for a long time with immense hammers, and cut up into bars while it is soft. It is then called wrought iron.

LESSON XXIV.—THE COW

The cow chews the cud. Like the sheep, it has a hard pad, instead of teeth, in the front of the upper jaw, and great broad teeth for grinding or chewing. It has four stomachs. It fills its paunch with grass, which it swallows mouthful by mouthful, without chewing it. The paunch passes the food into a second stomach, and this sends it up into the mouth, in cuds, to be chewed ; after which it is swallowed again. The cow has a cloven hoof, exactly like that of the sheep. It touches the ground with only two toes in walking.

LESSON XXV.—CAST-IRON

Cast-iron melts with less heat than other iron. It is poured, in the liquid state, into moulds, and takes their exact shape. Cast-iron is very brittle. It is neither malleable nor ductile.

LESSON XXVI.—MILK, BUTTER, CHEESE

The cream of milk is a mass of tiny cells or bags of fat. The little bags are broken in the churn, and the fat in them forms butter. The curd of milk is made into cheese.

LESSON XXVII.—WROUGHT IRON

Wrought iron is tough, flexible, malleable, and ductile. When it is made red-hot in the furnace, it becomes plastic ; it can then be welded at the anvil. Wrought iron will bear any amount of tugging and straining. Chains, bridges, arches, and engines are made of it.

LESSON XXVIII.—THE HORSE

The horse has sharp, cutting teeth in both jaws, and large, broad teeth for grinding. He does not chew the cud. His hoof is not cloven ; it is really a single toe, covered with a horny case. His eyes are at the side of the head, and his ears are erect and very sharp. The cart-horse draws heavy loads ; the hunter carries his master ; the race-horse is a very fleet runner.

LESSON XXIX.—STEEL

Cast-steel is easily fusible, like cast-iron ; but it is malleable, and can be worked up at the forge like wrought iron. Cast-steel is used for making machinery and great guns.

Shear-steel is used for making cutting tools and springs. It is very elastic.

LESSON XXX.—THE RABBIT

The rabbit has two large chisel teeth, in front of each jaw, for gnawing. Its upper lip is cleft. It has large grinding teeth at the back of the jaws. The jaw moves from side to side, as well as up and down. It is a timid animal ; its eyes are at the side of the head ; its ears are very sharp. Its front legs are short ; and its toes and claws are strong.

LESSON XXXI.—COPPER

Copper is a red metal, with a bright lustre. It is very tough, malleable, and ductile. It rusts easily, and the rust of copper is poison. Copper gives out a ringing sound when it is struck. Brass is made from copper and zinc. Bronze is made from copper, tin, and zinc. Cents are made of copper, and nickel and copper.

LESSON XXXII.—THE RABBIT AT HOME

The wild rabbit makes its home in a burrow under the ground. Its blunt, strong claws are its digging tools. It feels its way in these dark tunnels with its whiskers. It comes out into the fields, morning and evening, to feed on the farmer's crops.

LESSON XXXIII.—LEAD

Lead is a soft metal, and may be fused, bent, cut, or hammered with ease ; but it is brittle, not ductile, and will not make useful wire. Sheet-lead is used for many purposes. Pewter is made from lead and tin.

LESSON XXXIV.—THE MONKEY

Monkeys have four hands. They are meant to live in the trees. Their arms are very long, to help them to swing from branch to branch. They have hands instead of feet, to grasp the branches.

LESSON XXXV.—TIN

Tin is a white metal, with a bright lustre. It is very fusible and malleable. 'Tinned ware' is made of sheet-iron dipped into melted tin. The tin forms a coat over the iron. The iron itself would rust; tin does not easily rust, and can be rubbed up when it gets dull.

LESSON XXXVI.—THREE CLASSES OF MONKEYS

Apes have no tails. The gorilla is a fierce, ugly, savage ape, bigger than a man. He lives in the forests of Africa.

Baboons have short tails. They are nearly as big as a man, and very fierce.

Monkeys have long tails. The monkeys of Asia and Africa have cheek pouches; their tails are not so long as those of the American monkeys.

LESSON XXXVII.—ZINC

Zinc is a bluish-white metal. It rusts very slightly, and only on the surface. It is the lightest of the metals. It is malleable. Sheet-zinc is used for many purposes, but it is neither ductile nor tenacious. Iron that has been dipped in melted zinc is called galvanised iron. It will not rust.

LESSON XXXVIII.—THE MOLE

The mole lives under the ground. His strong, front paws are his shovels for digging. He makes a fine house underground. He feeds upon worms, grubs, and beetles, which he finds there. He has sharp teeth for tearing and cutting flesh, but no chewing teeth. His fur is thick and warm, and does not ruffle up. His ears are very sharp.

LESSON XXXIX.—SILVER

Silver is a pure-white metal, with a very high, metallic lustre. It does not rust. It is a precious metal. It is very malleable, ductile, and tenacious. It is made into money, and many beautiful articles for use and ornament.

LESSON XL.—GOLD

Gold is a yellow metal, with a very high lustre. It is a precious metal ; it never rusts, or even tarnishes. It is the most malleable and ductile of all the metals. As it is scarce, it is used for money, and beautiful articles for use and ornament.

THE END

