

The Child with PKU

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✚ N S P K U ✚

The National Society for Phenylketonuria (United Kingdom) Ltd.

THE CHILD WITH PHENYLKETONURIA

Your child has been found to have the condition phenylketonuria, commonly known as PKU. This booklet has been written to help you understand PKU so that you will be able to help your baby grow into a healthy child, teenager and adult.

WHAT IS PKU?

PKU is caused by a biochemical abnormality which is inherited by a child from both parents. At birth the baby appears to be quite normal, but the condition will be discovered before the age of 1 month by a screening blood test which is taken from all babies born in the UK. If this special test is positive and a further blood test shows the baby to have PKU, treatment is started as soon as possible.

A positive blood test shows that there is too much of a substance called phenylalanine in the baby's blood. Before early screening and treatment became available and high levels of phenylalanine were allowed to continue in the blood, the normal growth and development of the baby's brain was affected and in some cases the children became severely mentally abnormal.

Phenylalanine is a natural part of all protein foods and is essential in any normal diet. In PKU, the aim of treatment is to stop the build up of phenylalanine by using a special diet. When the diet is monitored carefully, it will allow the baby's brain to grow and develop so that a normal lifestyle, apart from the dietary restrictions, can be expected.

Treatment for phenylketonuria has only been available since the late 1950's so that, even today, doctors, dietitians, biochemists and other health professionals are still learning about PKU, particularly the way it is inherited and the long term outlook for treated adults with the condition. There are likely to be many questions you will want to have answered and the people looking after your baby will be able to answer most of them but there may be some which at the moment, cannot be answered with any certainty due to our incomplete understanding of PKU.

WHAT IS PHENYLALANINE?

OUR NORMAL DIET IS MADE UP OF 3 MAIN TYPES OF FOOD:

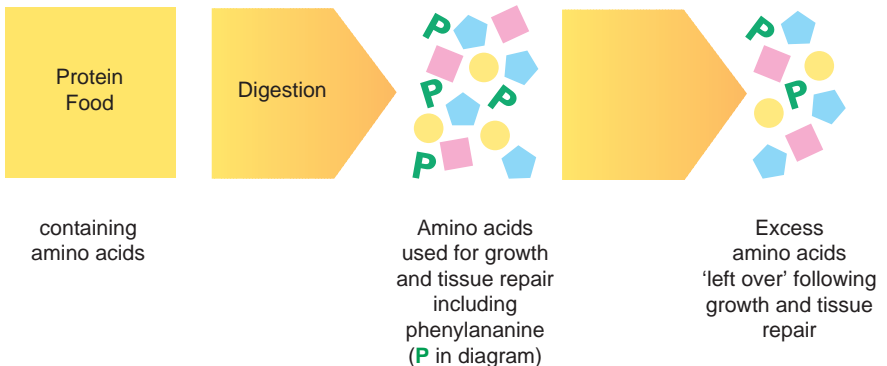
PROTEINS FATS SUGARS
(CARBOHYDRATES)

In children with PKU the protein food cannot be used properly. Foods which supply most of the protein in our diet include meat, fish, poultry, egg, milk and cheese but reasonable amounts of protein are found in certain cereals and vegetables such as wheat, rice, peas, beans and lentils. All of these proteins are made up of substances or 'building blocks' called amino acids. There are many different types of amino acid and each protein food contains these in varying amounts. This is why each protein food looks and tastes different from another eg milk does not look and taste like meat.

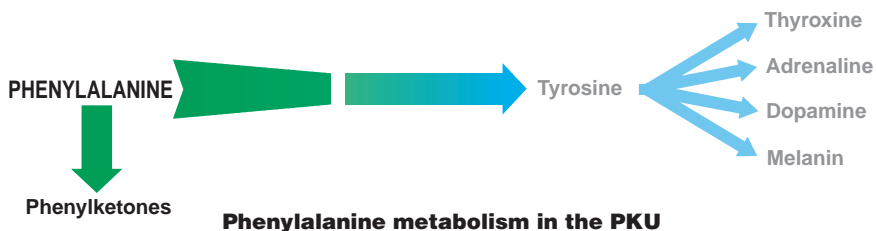
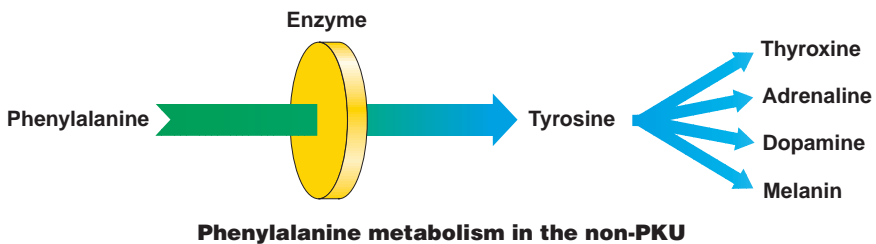
Phenylalanine is one of these amino acids and it is this particular one which the PKU child cannot deal with properly.

The problem is as follows:

Whenever protein foods such as meat or milk are eaten, digestion begins in the stomach. The first step in this process is to break down the links joining the amino acids together.



Each of the individual amino acids, including phenylalanine, is then absorbed into the bloodstream and used for different purposes such as growth and maintenance of various parts of the body (tissue repair). In young children a considerable amount of these amino acids, including phenylalanine, is used for growth. However, in any normal diet, there are more than enough amino acids in the diet for growth and maintenance. These extra amino acids are changed into other substances by special chemicals called enzymes. Each amino acid needs its own specific enzyme to change it into another substance. Normally, the excess phenylalanine is changed into another amino acid called tyrosine by an enzyme called phenylalanine hydroxylase. Tyrosine is needed by the body to make many important substances such as hormones, chemical messengers for the brain and the brown pigment melanin. In phenylketonuria, because the enzyme phenylalanine hydroxylase is absent or working very poorly, the body cannot change phenylalanine into tyrosine. It is this that results in high concentrations of phenylalanine in the blood and a deficiency of tyrosine and some of the important chemicals made from tyrosine. Some of the phenylalanine can be changed into substances called phenylketones which are excreted in the urine, but this happens only when there is a very high level of phenylalanine in the blood and tissues. In these circumstances the phenylketones can be detected in the urine and it was this finding of phenylketones in the urine that gave the name phenylketonuria to the condition.



THE LOW PHENYLALANINE DIET

To treat PKU, we must reduce the amount of phenylalanine in the diet so that the body has just enough for growth and tissue repair but no excess. All protein foods contain considerable amounts of phenylalanine, so they must be severely restricted. Nevertheless everyone, including those with PKU, needs to eat a certain amount of protein.

In the PKU diet, special products usually called protein substitutes which have little or no phenylalanine, have been developed. These will provide the protein which a PKU child needs. Your dietitian / doctor will recommend the most appropriate one for your child. This product will contain some extra tyrosine and all of the other amino acids needed for normal growth. The amount required will be carefully tailored by the dietitians and doctors to meet your child's specific needs.

WHAT HAPPENS AFTER THE DIAGNOSIS OF PKU HAS BEEN MADE?

As soon as the diagnosis has been confirmed, your baby will be given a special low phenylalanine feed until the high levels of phenylalanine fall back to normal. Usually this will take only a few days. Once the levels of phenylalanine are within the acceptable range (your doctor or dietitian will let you know what this is), a small amount of your own breast milk or ordinary baby milk will be introduced to provide the limited amount of phenylalanine essential for normal growth. Remember that small amounts of phenylalanine can be dealt with in the normal way by people with PKU and indeed, phenylalanine is essential for *everyone* including those with PKU. The small amount of phenylalanine required by your baby will be provided from your own breast milk or a normal baby milk if you decide not to breast feed.

When you are breast feeding, your milk will provide the necessary phenylalanine. To make sure that less phenylalanine is taken by your baby, very small amounts of the special low phenylalanine feed will be offered from a bottle before most of your breast feeds. This will cause your baby to take less of the phenylalanine containing breast milk. If you are not breast feeding, a small measured amount of normal infant formula will be given at each feed along with sufficient of the low phenylalanine milk to satisfy appetite and allow normal growth. You will be given constant guidance and support by a team of medical experts including your doctor and dietitian.

They are there to help you understand and manage the condition. It may also be possible to speak to other parents with PKU children and to young adults with PKU so that you can be reassured about your ability to manage the diet and about your child's future.

In summary, during the first few months of life, the low phenylalanine diet consists of either:-

1. a) a small measured amount of low phenylalanine special formula feed - then
b) breast feeds on demand
or
2. a) a small measured amount of normal babymilk - then
b) low phenylalanine special formula fed 'to appetite'.

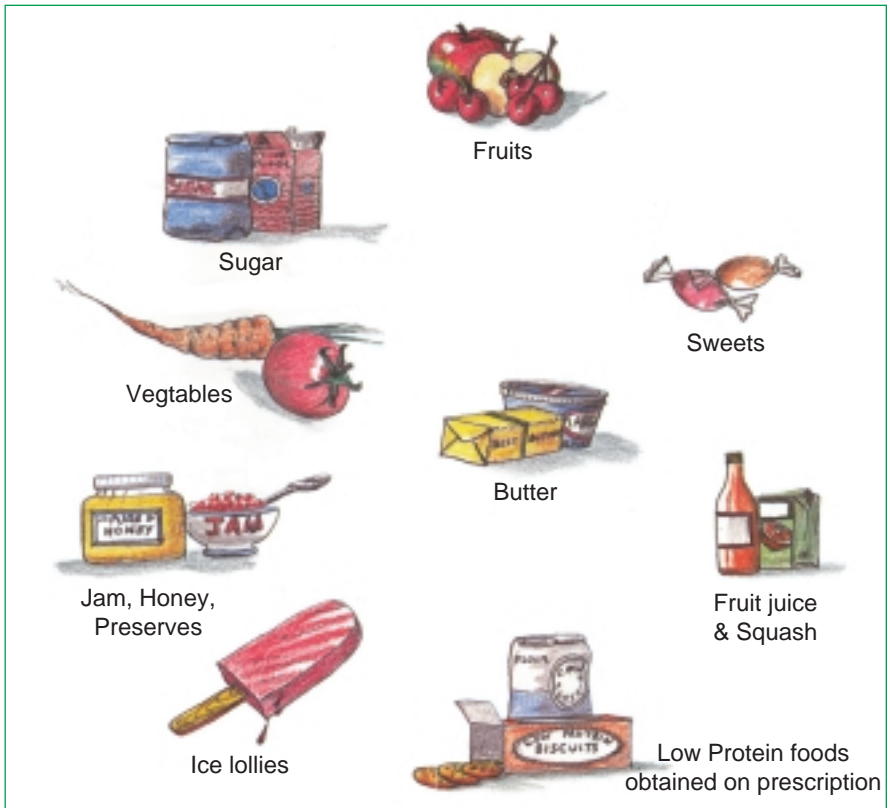
The baby's intake of natural protein, and therefore phenylalanine, from either breast milk or normal babymilk will be reduced, but adequate protein and other nutrients will be supplied from the low phenylalanine formula.

MONITORING PROGRESS

You will be given advice about sending samples of your baby's blood to the hospital laboratory at regular intervals to check that the phenylalanine level is being kept within certain limits. If you need to make any changes to the diet as a result of phenylalanine levels which are too high or too low, your dietitian will contact you and explain what to do. There will be times when because of rapid growth of your child or because of illness such as colds, the phenylalanine will be below or above the prescribed limits. These occasions can be discussed with your doctor/dietitian but you need not worry about the phenylalanine being too high or low for short periods of time.

WHAT FOODS CAN BE EATEN?

Solid foods can be introduced at the usual weaning age, around 4-6 months. Your dietitian will give careful guidance at this stage but in general, all fruits, most vegetables and some baby foods can be used. As more solids are taken, the diet will be gradually expanded to include a large range of low protein foods which are available on prescription. Many of these foods such as special bread, biscuits, pasta etc are shown in figure 3. It may be possible for you to see a selection of the low protein foods which you will get from your chemist on prescription.



During weaning the small amount of essential phenylalanine may continue to be provided from breast or baby milk until a time is reached when this supply will be replaced by measured amounts of everyday foods such as cereals and potatoes. Your dietitian will give you very detailed information about the specific foods allowed.

CAN THE DIET BE DISCONTINUED?

From what is currently known and understood about the condition, there is no doubt that children with PKU must continue with a strict low phenylalanine diet throughout their developing years. For teenagers and adults, the present evidence would suggest that some restriction of phenylalanine intake should continue throughout life.

Until fairly recently, it was thought that the low phenylalanine diet could be discontinued safely at around the age of 10 - 14 years. However, many older PKU teenagers and adults who have been eating a normal diet, have been found to have abnormalities on brain scans. We are uncertain about the significance of the changes seen on these brain scans but it is possible that they are the result of stopping the low phenylalanine diet as some scans have improved after reintroduction of the diet.

Some adults with PKU have been found to have nervous system disorders such as hand tremor or poor coordination of hand, arm and leg movements. The cause of these features is unknown but they also are most likely to be related to high blood phenylalanine levels. Older children and adults report that they feel better able to think and to concentrate when their blood levels of phenylalanine are near to normal values. For these reasons our current advice is that there should be some dietary phenylalanine restriction throughout life.

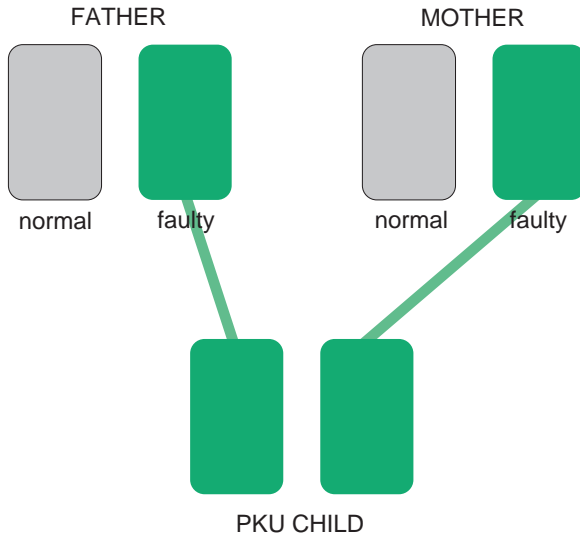
WHY DOES OUR BABY HAVE PKU?

The simple answer is that your baby has inherited PKU from both of you. Your immediate response may be that neither you nor your partner have any knowledge of anyone in your families having PKU. In order that you can understand how PKU is inherited, we have to explain the way in which characteristics are passed on from parents to children.

We all know that children tend to have features such as the colour of hair and eyes which make them resemble one or other parent. All of our inherited characteristics are controlled by the store of information contained within the cells of our bodies. These information stores are called genes and these genes have been copied from the set of father's genes contained in the sperm and the set of mother's genes contained in the ovum or egg. Therefore, from the original sperm and ovum which made your baby there will be a father's gene and a mother's gene controlling each inherited characteristic. Usually we need only one gene to control one activity in the

cell and in the body, so that if a gene inherited from one parent is defective, the gene from the other parent will allow the cell and body to work normally. In PKU both genes which control the production of the enzyme phenylalanine hydroxylase are faulty ie, the child with PKU has inherited one faulty gene from the father and one from the mother (green in dia.).

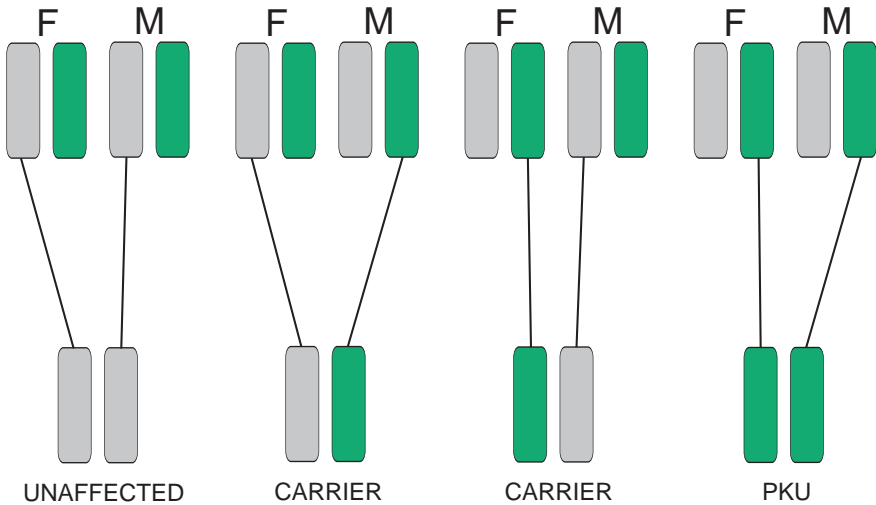
WHY DON'T PARENTS HAVE THE CONDITION?



It is important for you to understand that everybody carries abnormalities in some of their genes. It is therefore normal to carry abnormal genes. As parents of a child with phenylketonuria, you have one faulty gene for the enzyme phenylalanine hydroxylase and one normal gene. You do not have the disease, because one normal gene is enough and allows your phenylalanine hydroxylase to work normally. When this happens, you are known as “carriers” of the disease. Approximately 1 person in 50 has one abnormal gene for PKU ie, is a carrier. The chance that two carriers of the abnormal gene will meet is extremely small at about 1 in 2,500. This is why so few children are born with PKU. Approximately 70 children with PKU are born in the UK each year.

WILL ALL YOUR CHILDREN HAVE PKU?

The answer is “no”. Each parent has one gene for PKU and one normal gene. Each child inherits one gene from each parent. Each child can therefore inherit either a normal or a PKU gene from each parent.



This diagram shows the different possibilities for the genes from each parent forming an unaffected child, a carrier or a child with PKU. From this figure you can see that there is a one chance in 4 of any future children having PKU, two chances in 4 that they might be carriers like yourselves and one chance in 4 that the child will be unaffected. **These chances remain the same for every pregnancy.** The fact that you have already had one PKU child does not change the “odds” for future pregnancies. The combination of genes which are passed on to the child at each conception depends purely on chance, just as it is possible to throw a succession of 6’s on a dice, it is possible to have a run of affected or unaffected children. There are some families who have had 2 or more children, all of whom have had PKU. Equally there are families where both parents are carriers but who remain completely unaware of this because none of their children have PKU.

The chance of your child with PKU having a partner who is a carrier of the PKU gene is about 1 in 50, so that the overall risk of their producing a PKU child (a PKU grandchild for you) is around 1 in 100 unless the partner is from a family where PKU is already known to exist. This would increase the chances of you having a PKU grandchild. If your child's partner also has PKU then all of their children will be born with PKU.

CAN YOU CHOOSE WHETHER OR NOT TO HAVE ANOTHER PKU CHILD?

Most parents are happy to extend their family knowing that because the treatment for PKU is quite successful, they are prepared to run the risk of having to manage the diet of a second child with PKU. On the other hand, some parents would rather not have another child with PKU and until recently, the only way in which they could guarantee this was to have no further children.

It may be possible in some families to have a test in early pregnancy to find out if the developing baby has PKU. It is not possible in this small booklet to explore all the ins and outs of these complex problems. You will have the time and opportunity to discuss these matters with your doctors and with other parents who have faced similar problems.

CAN PEOPLE WITH PKU HAVE CHILDREN?

YES. Both males and females with PKU are as physically capable of having children as anyone else and unless the other partner, either male or female, is a carrier, none of the children will have PKU (see 'Why does our baby have PKU' p7).

There is however a quite separate problem for women with PKU who wish to have children. Babies born to PKU mothers with high phenylalanine levels may be mentally and physically damaged in the womb due to the effect of the high phenylalanine levels during the pregnancy. The effects are permanent, and occur from the very early days of pregnancy onwards. This risk of damage to the baby can almost certainly be prevented if the mother returns to a low phenylalanine diet **before** pregnancy starts and continues this until the baby is born. This will ensure that her phenylalanine levels are low when she conceives and remain low throughout pregnancy, allowing the fetus / baby to grow and develop normally.

It is essential for PKU females to be aware of this problem, and to keep in touch with medical advisors. Good dietary control must be established **before** starting a planned pregnancy. Very strict dietary control, frequent blood testing and supervision is required throughout the pregnancy. If an unplanned pregnancy should occur, advice must be sought as soon as possible.

THE HISTORY OF PKU

PKU was first described in 1934 by a Norwegian doctor named Asbjorn Folling. A mother with two mentally handicapped children aged 7 and 4 years told Dr Folling that her children had a peculiar smell and encouraged Dr Folling to investigate her children in detail. He found a substance in the urine of both children and finally identified it as a phenylketone. As already mentioned, it was this finding that gave the name phenylketonuria to the condition. It was more than 20 years later that Dr Horst Bickel first tried a low phenylalanine diet on a two year old girl in Birmingham Children's Hospital in England. In 1964/65 the blood screening test for phenylketonuria introduced by Dr Bob Guthrie from the USA, was first introduced into the United Kingdom. The combination of the screening test and the low phenylalanine diet has changed entirely the outlook for the PKU child and family. In 1992 Dr Savio Woo working in Houston, Texas found the gene for phenylalanine hydroxylase in phenylketonuria and opened up the possibility of gene therapy. For further information on this exciting possibility keep reading your NSPKU Newsletters.

The NSPKU produces various leaflets which provide information about phenylketonuria for those with PKU and also for parents / guardians and others who should be aware of the issues involved in the management of the condition.



Produced by the National Society for Phenylketonuria
and its Medical Advisory Panel.



The National Society for Phenylketonuria (United Kingdom) Ltd.

The Society is a registered charity.
It offers support to PKUs and their families by producing various publications
including a quarterly newsletter, organising formal and informal meetings
and conferences.

Further information and details can be obtained by contacting:-
The NSPKU Helpline on: 01908 691653
or writing to:
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