Inborn Errors of Metabolism

Phenylketonuria

PKU

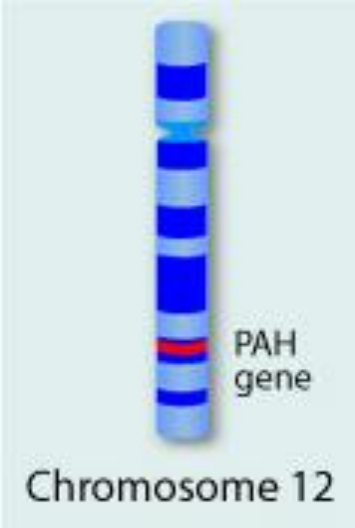
What is Phenylketonuria (PKU)?

Phenylketonuria:

- Is a rare metabolic disorder that
  - Affects the way the body metabolizes Phenylalanine.

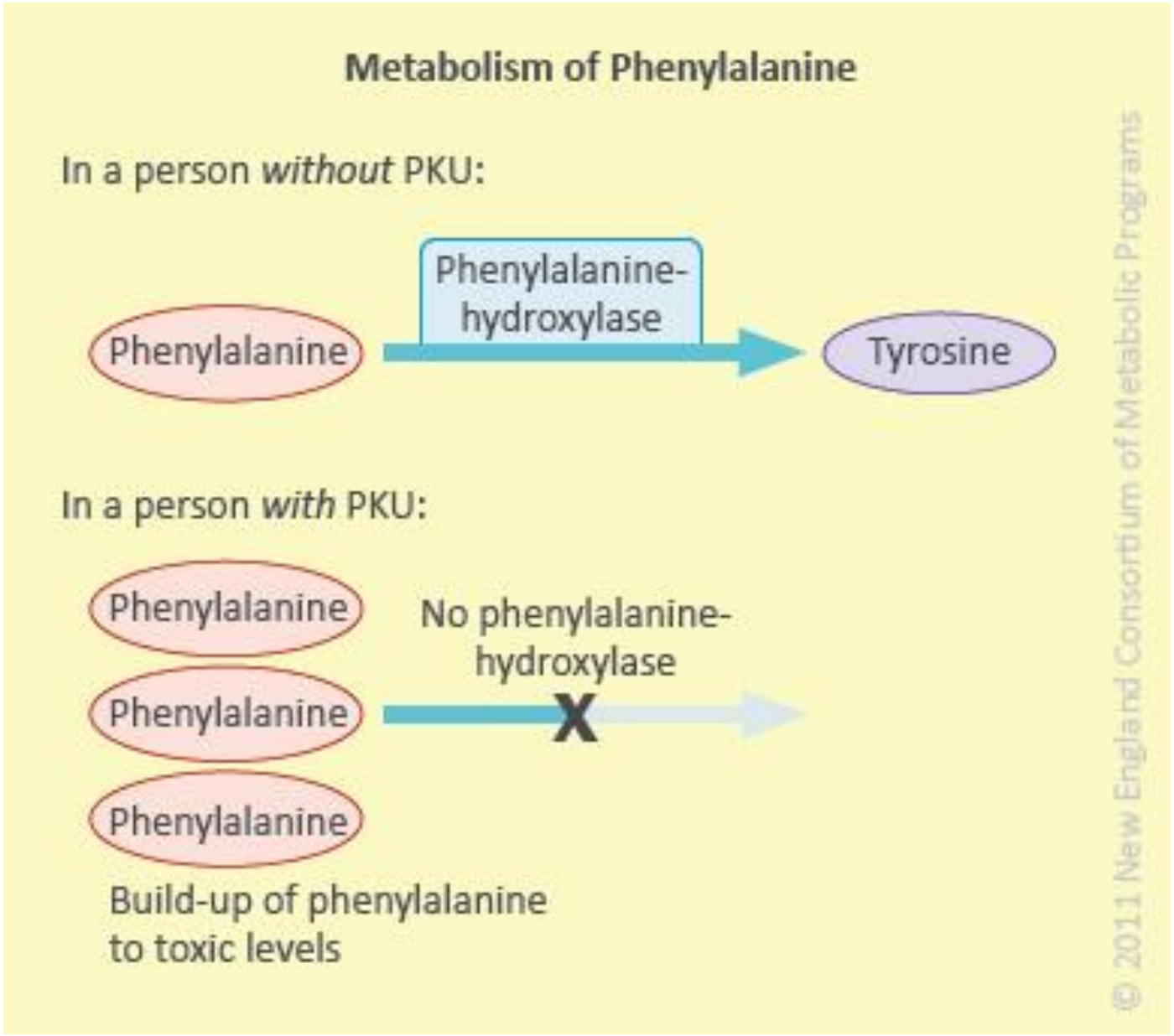
- If not treated shortly after birth:
  - PKU can destroy the nervous system,
  - Causing intellectual disability.

What Causes Phenylketonuria (PKU)?



- PKU is caused by a mutation in a gene on chromosome # 12.
- The gene codes for a protein called PAH (phenylalanine hydroxylase), an enzyme in the liver.
- This enzyme breaks down the amino acid phenylalanine into tyrosine
- When this gene is mutated, the shape of the PAH enzyme changes and it is unable to properly break down phenylalanine.
- Phenylalanine builds up in the blood and destroys nerve cells (neurons) in the brain.

Metabolism of Phenylalanine



How do People get PKU?

- PKU is an autosomal recessive disorder,

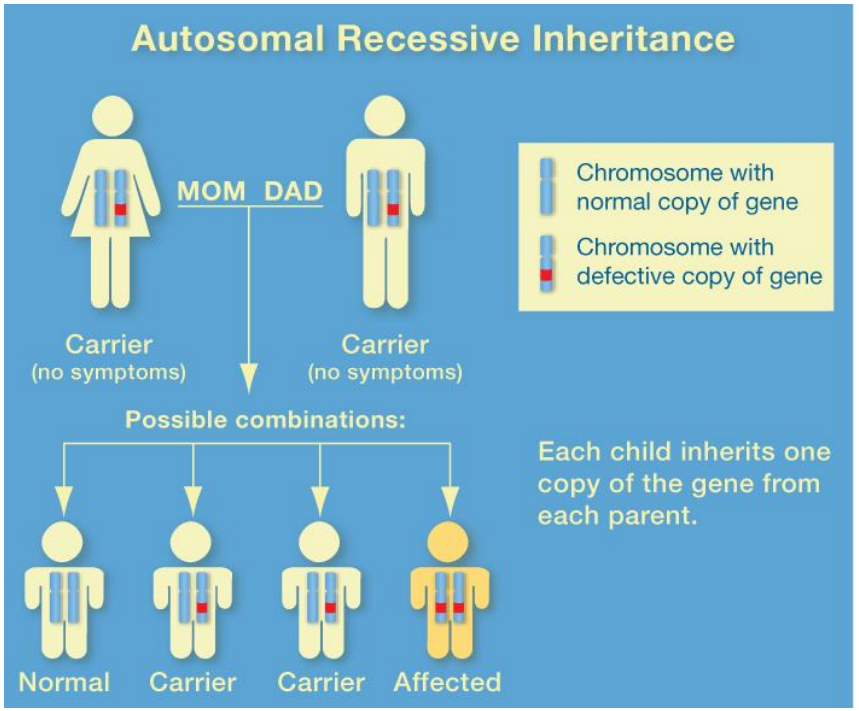
  meaning that you need to inherit mutations in both copies of the gene to develop the symptoms of the disorder.

- A carrier does not have symptoms of the disease

  but can pass on the defective gene to his or her children.

- If both parents carry one copy of the faulty gene

  each of their children have a 1 in 4 chance of being born with the disease.

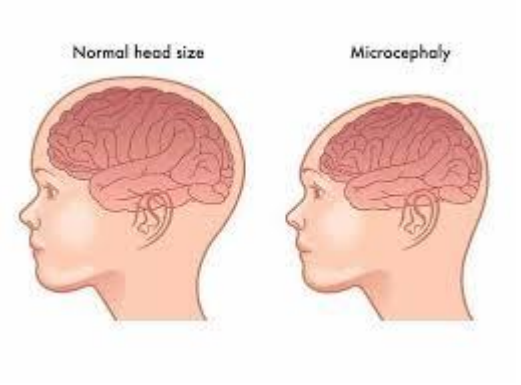


What are the Symptoms of PKU?

- Babies born with PKU usually have no symptoms at first.

- But if the disease is left untreated, babies experience severe brain damage (irreversible).

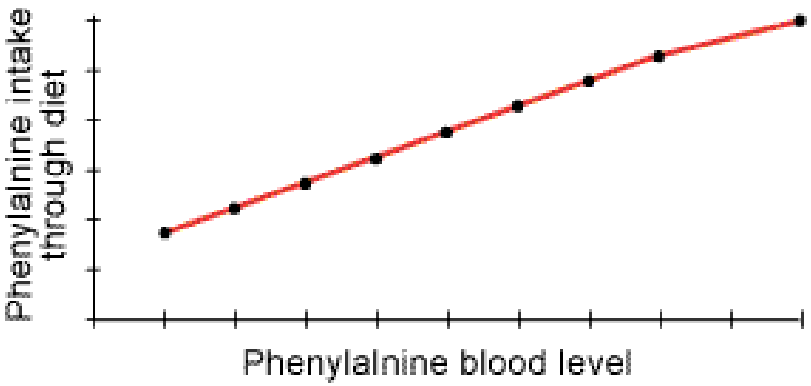
  - This damage can cause epilepsy, behavioral problems, and stunted growth.



- Other symptoms include
  - Eczema (skin rash),
  - A musty odor in breath, skin, and urine (from too much phenylalanine in the body)
  - A small head (microcephaly), and
  - Fair skin because melanin biosynthesis needs phenylalanine hydroxylase and tyrosine.

PKU Detection

- A PKU test is done a day or two after the baby's birth.
- The test isn't done before
  - the baby is 24 hours old or
  - the baby has ingested some protein in the diet to ensure accurate results.
- A nurse or lab technician collects a few drops of blood from the baby's heel or arm.



As the amount of phenylalanine eaten is increased, so is the blood phenylalanine level

HOW IS PKU MONITORED?

- PKU is monitored with three main tools:

1. Monthly blood test for Phe level,
2. Regular visits to the PKU Clinic,
3. Monthly food records.

Regular Measurement of Phe Blood Level

Can be done through:

1. A blood draw in a hospital or clinic, which directly measures Phe level in blood.

2. A collection of a blood sample on a filter paper at home, which is mailed to the laboratory for analysis.

Monthly Blood Tests

- Monthly blood tests help people with PKU track their progress with the diet.
- These blood tests measure Phe build-up in the blood.
  - High levels indicate too much Phe from food or too little Phenyl-Free foods.
- People with PKU should keep their blood Phe levels in the safe range, between 1 and 10 mg/dl.
- Levels of 1-6 mg/dl are ideal, and especially important for infants and young children.

Importance of the Regular Visits to the PKU Clinic

- *Regular visits to the PKU clinic* are an important opportunity for people with PKU to meet with the PKU team.

- During these visits, everyone on the team works together to give the best possible care and guidance for people with PKU.

- The visit should include:
  - A blood draw,
  - A short exam by a physician, and a
  - Chance to discuss ways to manage the low-Phe food pattern.

- Nutrition education for patients (children and parent) and significant others in patient's life, is an important component of the clinic visit.

Diet for PKU Patients

Must contain:

- ✓ Enough energy,
- ✓ Enough protein,
- ✓ All essential amino acids in required amounts except Phe which should be as minimal as required based on blood tests for Phe level,
- ✓ All vitamins,
- ✓ All Minerals.

What is Not Included in a Low Phenylalanine Food Pattern?

- Foods that contain large amounts of Phe must be eliminated from a low Phe diet.

  ✓ These foods are high protein foods, such as milk, dairy products, meat, fish, chicken, eggs, beans, and nuts.

  Why?

  ➢ These foods cause high blood Phe levels for people with PKU.

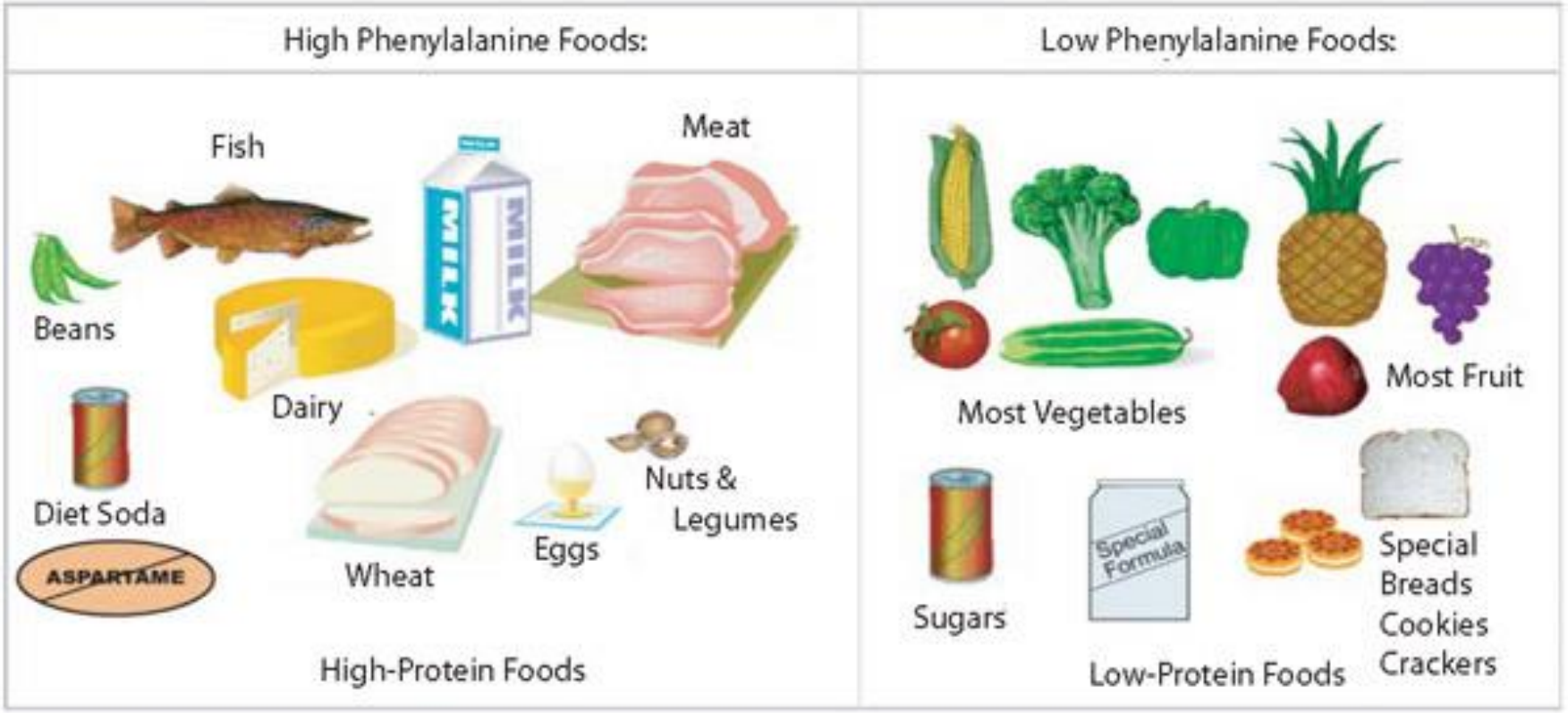
What is Included in a Low Phenylalanine Food Pattern?

- The diet for PKU consists of a phenylalanine-free medical formula (the right mix of amino acids), and

- Carefully measured amounts of fruits, vegetables, bread, pasta, and cereals.

  - Many people who follow a low phenylalanine (Phe) diet eat special low protein breads and pastas.

  - ❖ Special low protein foods are nearly free of Phe, allow greater freedom in food choices, and provide energy and variety in the food pattern.



PKU Infant Formula

- Food for special medical purposes for use in the dietary management of Phenylketonuria (PKU)
- Phenylalanine-free protein supplement - for infants from birth
- Contains the right mix of amino acids, carbohydrate and fat, vitamins, minerals and trace elements in adequate amounts

For 1-6 year old children

Phenylalanine-free amino acid based protein supplements for use in the dietary management of Phenylketonuria (PKU)

PKU Formula for children from 7 to 14 years of age, (XPhe junior)

- Phenylalanine-free amino acid based protein supplements for use in the dietary management of Phenylketonuria (PKU)

PKU Formula for Older Children, Teens and Adults, including Pregnant Women.

XPhe Maxamum:

- A phenylalanine-free powdered medical food for the dietary management of phenylketonuria (PKU)

- Is best prepared with chilled water and consumed immediately after preparation.

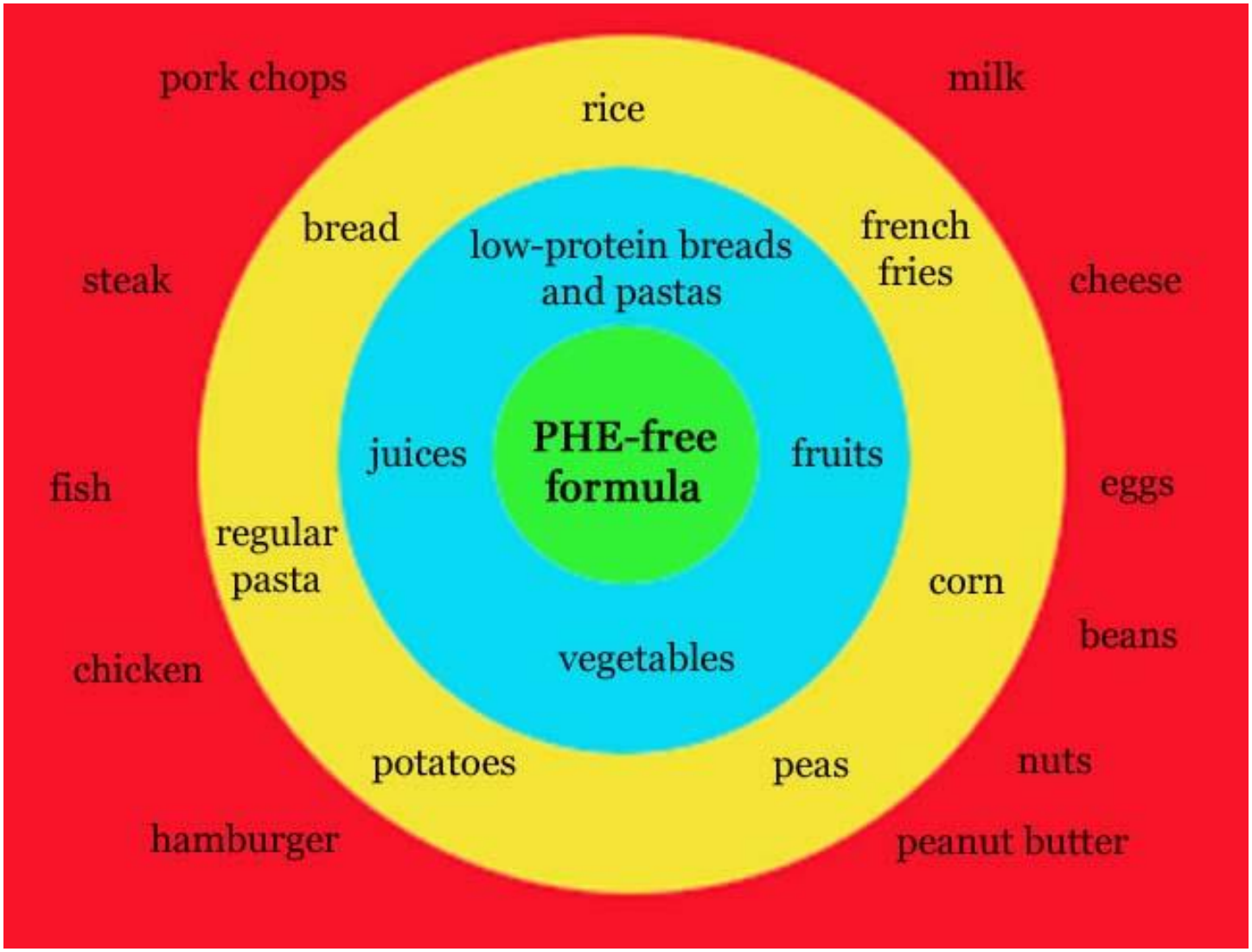
- Reconstituted drink mix should be stored in the refrigerator and used within 24 hours.

TARGET DIET
AIM FOR HEALTHY FOOD CHOICES

The Target Diet is an easy way to visualize the foods allowed on the diet for PKU.

- The phenylalanine-free formula, such as Phenyl-Free*, is the center of the target diet.
- As the foods get further away from the center, they are higher in phenylalanine.
- The foods outside the target are not included in the low-phenylalanine meal plan.

Target Your Food Choices
Choose the Foods Closest to the Center (Bull's-Eye)



Dietitians ask for Food Records

- Food records are usually a 3 day diary of: all foods & beverages eaten + the amounts consumed.

- These diaries should be accurate records of foods eaten.

- Dairies will help the PKU clinic team:
  - To interpret blood Phe levels and
  - Make adjustments to the food and formula prescription.

An example for a "One Day Food Record"

Breakfast:
8 oz. Phenyl-Free 2* or other phenylalanine-free formula

1 cup puffed rice
1/4 cup Coffee with cream and sugar
1 peach (80 g)

Lunch:
2 cups Vegetable soup (Vegetarian)
2 low protein crackers
1 apple (100 g)
12 oz. orange Juice

Snack:

8 oz. Phenyl-Free formula

Dinner:
8 oz. Phenyl-Free formula
1 cup cauliflower
1 cup broccoli
1 baked potato with

2 Tbsp. whey and

dairy free margarine
12 oz. cranberry juice

Snack:

8 oz. Phenyl-Free formula
1 cup fruit ice

How to make formula:
According to Instructions

e.g.

200 grams Phenyl-Free powder
add water to make 32 oz.

Sample Diet Prescription for PKU Patients (2 wk of age): weight 3.25 kg

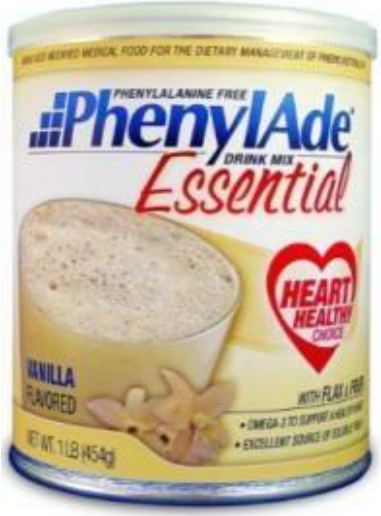
PRESCRIPTION	Amount / kg	TOTAL
Phenylalanine	55 mg	179
Tyrosine	302 mg	980
Protein	3.0 g	9.8
Energy	120 kcal	390

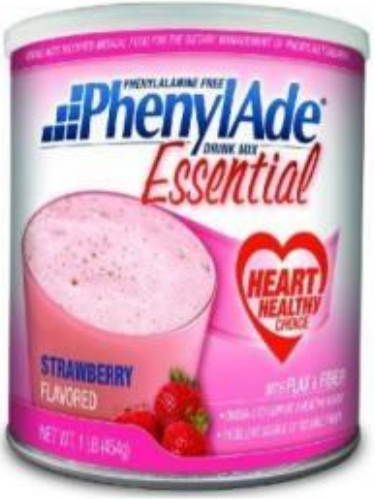
Example of Phenyl-free Medical Food

Medical Food	Amount	Phenylalanine (mg)	Tyrosine (mg)	Protein (g)	Energy (kcal)
Phenex-1	41g	0	620	6.2	197
Table Sugar	0.5 Tbsp	0	0	0	23
Water to mix	600 ml	0	0	0	0
Total			620	6.2	220

- ✓ Aspartame must be avoided by people with PKU because aspartame's breakdown in the body produces phenylalanine.
- ✓ The artificial sweetener aspartame (Equal, NutraSweet), is added to many medications, diet foods & diet sodas.

Examples of Phenyl-free Medical Food





Other Special Foods for PKU

PKU Lophlex Sensation

A phenylalanine free* semi-solid protein substitute containing a balanced mix of

- the other essential and non-essential amino acids, carbohydrates, vitamins, trace elements, minerals, mixed fruit...