

**Introduction to Maternal Infant Young Children Nutrition**  
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**Health and Nutrition**  
**Indian Institute of Technology, Bombay**

**Lecture - 8**  
**Session - 2**

**Importance of ratio of omega 3 and omega 6 & Choline**

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## LC-PUFA (DHA & EPA)

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### Lipids-Fats

- ❑ The brain is a lipid-rich organ that consumes 20% of the body's energy, but it only comprises 2% of the body's mass
- ❑ Over half of the brain's dry weight is comprised of lipids, and it is especially enriched in long-chain omega-3 (*n*-3) polyunsaturated fatty acids (PUFAs)
- ❑ DHA makes up the 90% PUFA in the brain & 10-20% of total lipids
- ❑ It is concentrated in grey matter particularly in frontal lobes which mediates attention, planning, problem solving, inhibition, and impulsivity thus affecting social, emotional and behaviour aspects
- ❑ It is also required for retina

NPTEL

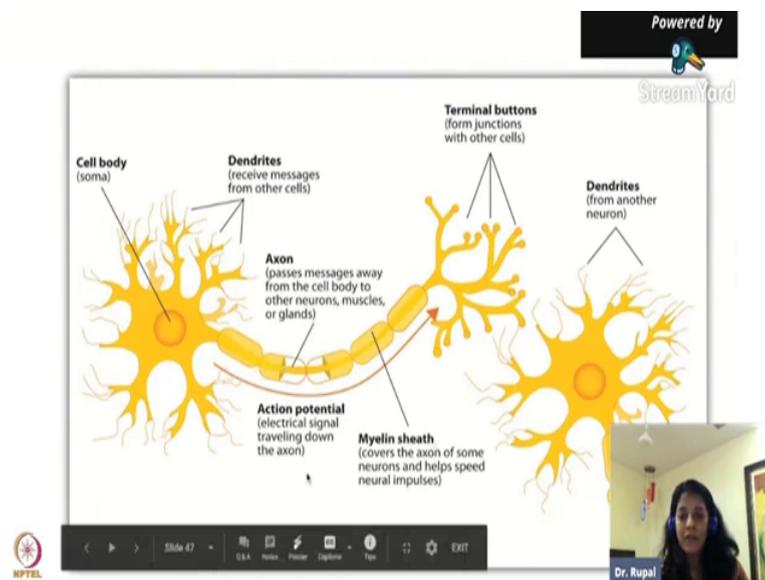


Now, DHA and EPA, slowly and steadily DHA EPA absolutely important, lacking in most of us, most of us are not eating fatty fish, unfortunately. So, extremely important for our brain,

90 percent of PUFA, so DHA is made up of 90 percent of PUFA in the brain. Imagine, so your PUFA what you are having right now, you are not having DHA as a PUFA, what we are having is soya oil.

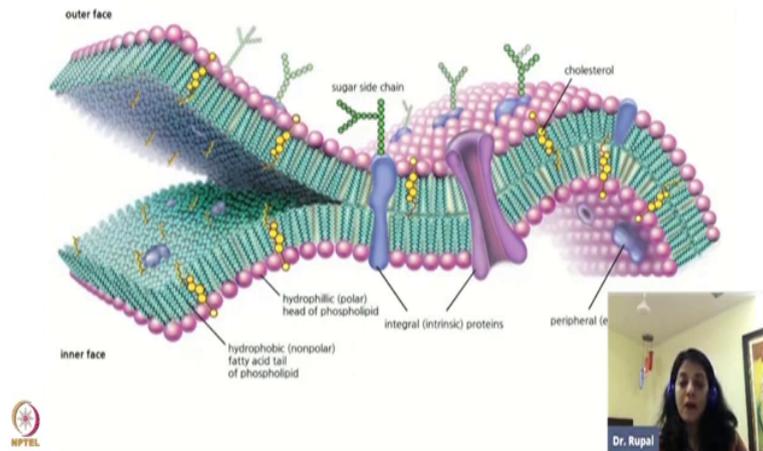
Soya oil, corn oil, canola oil, peanut oil, those are all high in Omega 6, those are not high in DHA. So, you want to make sure that if you want good PUFA in your brain, better have DHA. And look at this how it matters basically it is important for attention, planning, problem solving, inhibition. So, I think if a child mother is not a non-veg just got an offer a seafood or fish.

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This is your neuron; these are the myelin sheath that I was talking about, myelin sheet, very important. It speeds up the connection.

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This is your cell membrane. You remember your cell, these are your basically your lipid layers, phospholipid. Now this has to be absolutely fluid, it should not be very rigid. If you have a DHA, if you have EPA if you have omega 3 food in your diet, this will remain fluid, it will move, it will remain fluid.

But, if you have a diet which is high in Omega 6 this, so basically you will have a lot more omega 6 over here and it will become more rigid. It will have lot of inflammation; it will have lot of breaking of the cell membrane. So, like it is important that the ratio is good Omega 3 to omega 6, try to keep it 1 is to 1. So, if you are not having Omega 3, then avoid Omega 6.

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## LC-PUFA - DHA & EPA

- DHA is necessary for
  - Neuronal cell growth and neuronal cell differentiation
  - Membrane fatty acid composition and fluidity
  - Myelination & repair
  - Synaptogenesis
  - Gene expression that influences neurite outgrowth and learning and memory
  - Monoaminergic, cholinergic, and GABA-nergic neurotransmission
  - In particular, the visual system and areas of the prefrontal cortex
  - Under oxidative stress, DHA can promote repair and growth of neurons



## Effect of DHA

- ❑ DHA accumulates in the brain mainly during 3rd trimester and 1st 2 years of life and is very important to the cognitive development of the progeny
- ❑ Post-natal transfer of DHA is mainly through breast milk-1.4% of total lipids
- ❑ Biomagnification in which there is conversion from ALA to DHA in both mother and the baby thus baby has a higher level of DHA



So, this is again your DHA. Why is it important? You guys know about all this, look at this of course, for brain.

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## Requirement of DHA

- ❑ 250 to 500 mg EPA + DHA per day, minimum 200 mg of DHA by P&L mothers
- ❑ Average dietary intake is 100 mg per day, lesser in vegan and vegetarian
- ❑ The optimal dietary *n*-6 to *n*-3 PUFA ratio is 2:1 & current diet is typically in the range of 10:1 to 25:1
- ❑ Its deficiency has had a detrimental impact on development and aging, especially with regard to cognitive function
- ❑ The conversion from ALA to DHA is less 0.1% to 4%
- ❑ Preformed DHA is most effective in maintaining sufficient tissue stores
- ❑ The infant brain acquires five-times the level of lipids on a daily basis than an adult brain



Now what is the requirement of DHA, basically 3, 250 to 500 milligram of both EPA DHA per day, minimum 200 milligram by pregnant lactating mothers and the optimal dietary ratio I prefer 1 is to 1, 2 is to 1 is still too high for me, but 1 is to 1 ratio is good, but our current diet is typically 10 is to 1 is to, 10 is to 1, to sometime 25 is to 1.

And in Bengal people have this habit of eating lot of fried food and that fried food is made up of all the soya oil and corn oil. So, please avoid fried food, tell mother's she wants to fry chicken fry it in ghee. And here I mentioned about the conversion ALA to DHA is almost up

to 4 percent. Right now, we just I read one study they said up to 10 percent, but I feel probably just not more than 4 to 5 percent.

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Lancet, 2007 Feb 17;369(9561):578-85.

**Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study.**

Hibbeln JR<sup>1</sup>, Davis JM, Steer C, Emmett P, Rogers I, Williams C, Golding J.

- maternal seafood intake during pregnancy of less than 340 g per week was associated with increased risk of their children being in the lowest quartile for verbal intelligence quotient (IQ) compared with mothers who consumed more than 340 g per week
- Low maternal seafood intake was also associated with increased risk of sub-optimum outcomes for
  - prosocial behaviour
  - fine motor, communication
  - social development scores
  - Higher verbal IQ at age of 8 years of age

Br J Nutr, 2007 Aug;98(2):253-9. Epub 2007 Apr 10.

**Effect of supplementation of women in high-risk pregnancies with long-chain polyunsaturated fatty acids on pregnancy outcomes and growth measures at birth: a meta-analysis of randomized controlled trials.**

Horvath A<sup>1</sup>, Koletzko B, Szajewska H.

- supplementation with n-3 LC-PUFA in women with high-risk pregnancies reduced the risk of early preterm delivery by 31-61% in the fatty acid-supplemented group compared with the placebo group

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Now here again uptake of Omega 3 by mothers, so what they found that if she took food which was high in Omega 3, which is your seafood, those children have higher verbal IQ. Children, mothers who took less amount of Omega 3 through food those children had poor IQ. So, that is important.

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Cochrane Database Syst Rev, 2015 Jul 14;(7):CD007901. doi: 10.1002/14651858.CD007901.pub3.

**Supplementation with long chain polyunsaturated fatty acids (LCPUFA) to breastfeeding mothers for improving child growth and development.**

Delgado-Noguera ME<sup>1</sup>, Calvache JA, Bonfil-Coso X, Kotanidou EP, Galli-Tsinopoulou A.

- LCPUFA supplementation did not appear to improve children's neurodevelopment, visual acuity or growth or in child attention at five years of age
- Currently, there is inconclusive evidence to support or refute the practice of giving LCPUFA supplementation to breastfeeding mothers in order to improve neurodevelopment or visual acuity

**Serial circulating omega 3 polyunsaturated fatty acids and healthy ageing among older adults in the Cardiovascular Health Study: prospective cohort study**

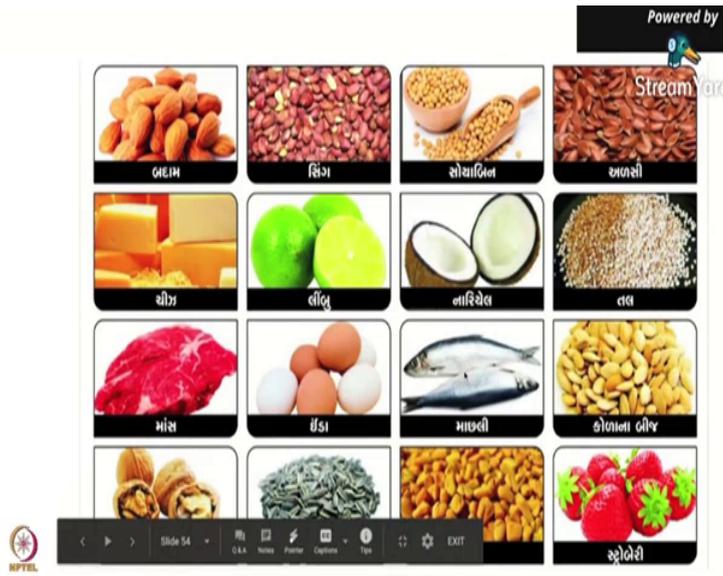
Heidi TM Lai,<sup>1</sup> Marcia C de Oliveira Otto,<sup>2</sup> Rozenn N Lemaitre,<sup>3</sup> Barbara McKnight,<sup>4</sup>

- 2622 adults with a mean (SD) age of 74.4 (4.8) and with successful healthy ageing at baseline in 1992-93
- Favorable effects on blood pressure, endothelial function, plasma triglycerides, heart rate, and potentially inf
- Potential benefits for anti-thrombotic, cardioprotective, bone mass, and neuroprotection
- Evidence for off-target effects, such as increased risk of cancer, is mixed.

BMJ: first pub

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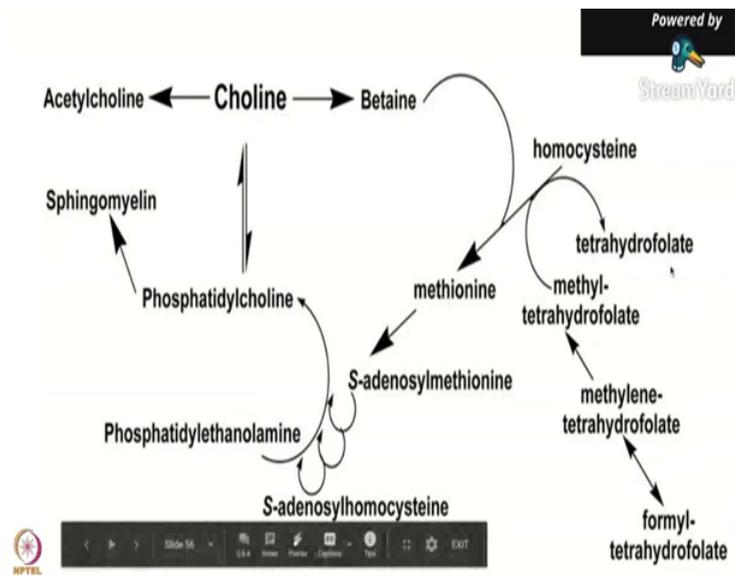


Here, some of the studies which are done, what they found it if mother to Omega 3 medicine, it did not appear to improve child neuro development. So, lot time what happens they said mother should take Omega 3 or the mother should take tablet, but it did not really help at 5 years of age.

Another thing is also lots of formula making company they said we have made the formula which says Omega 3 but it did not help with the IQ of children. So, it is a marketing gimmick. So, mother has most, mother's milk has most amount of DHA EPA, extremely important. So, please recommend mother's milk; that is why IQ is much higher.

And for adults, they did find some difference in blood pressure and plasma triglyceride level. But on cognition they did not see much of a difference. So, for adults if they are taking. These are some of the main thing is your fatty fish is important. Those are DHA EPA.

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## Function

- ❑ Neurotransmitter synthesis (acetylcholine)
- ❑ Cell-membrane signaling & essential component of all cell membrane (phospholipids, phosphatidylcholine, sphingomyelin)
- ❑ Biosynthesis of lipids & lipid transport (lipoproteins)
- ❑ Methyl-group metabolism (homocysteine reduction)
- ❑ It is the major dietary source of methyl groups
- ❑ Important roles in brain and memory development in the fetus and appears to decrease the risk of the development of neural tube defects



Choline, quickly I am going through choline, important for formation of acetylcholine, so neurotransmitters. Remember I talked about those cell membrane. So, for cell membrane you need phosphatidylcholine. You have, this sphingomyelin is important for brain. So, choline is really important for your brain formation. It is also methyl donor.

So, it is basically it donates a methyl and it converts homocysteine to methionine. Now homocysteine you do not want too much in your body because it is very inflammatory. So, choline is important basically to convert your homocysteine to methionine. And there are other micronutrients which are important, your folate and your vitamin B12 also. Again, important for all your, mainly your brain.

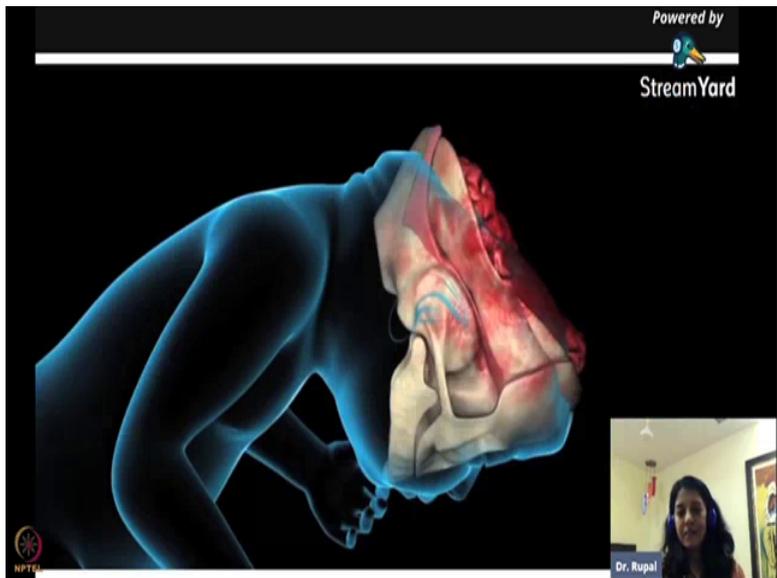
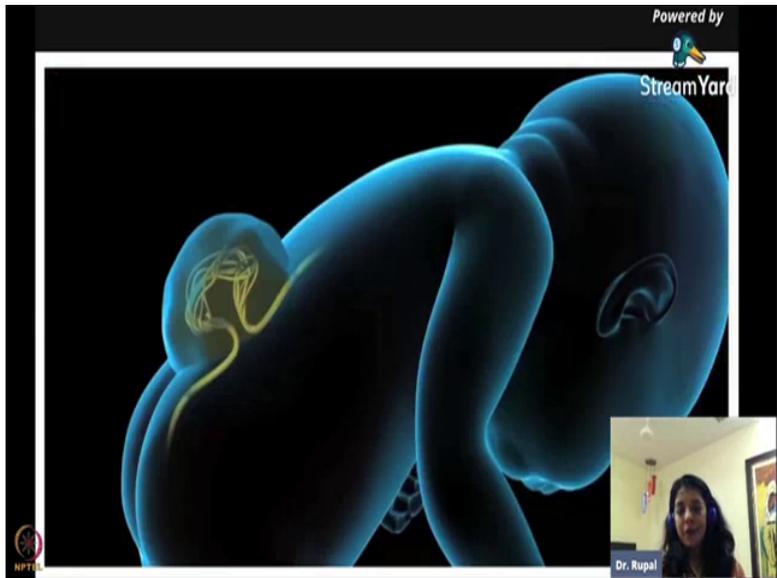
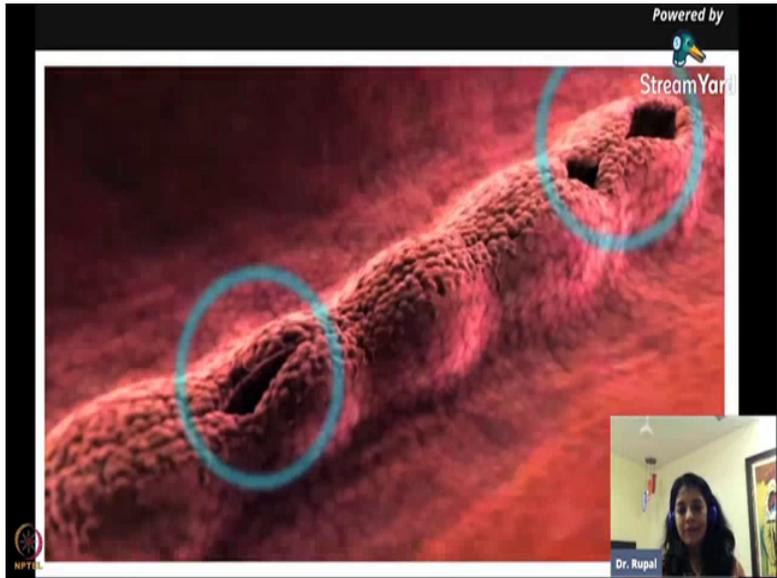
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Neural Tube Defects due to Deficiency  
of Folic Acid and Choline

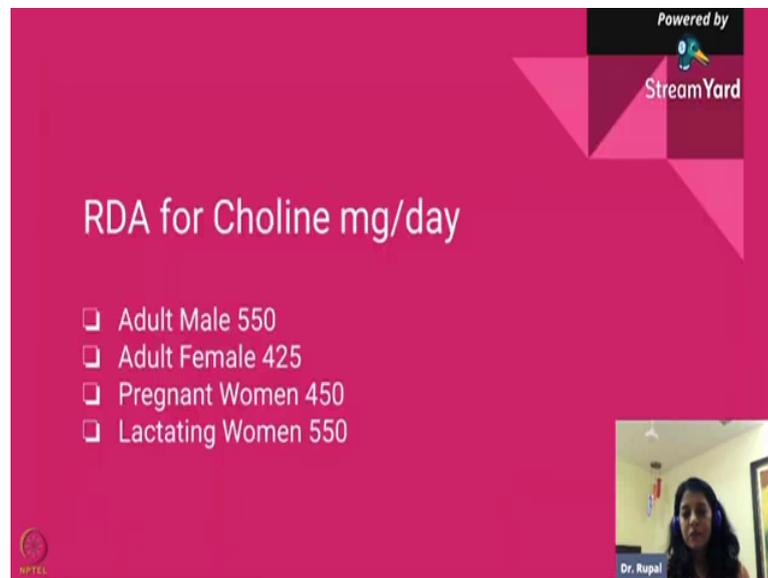
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What happens when you do not have choline? Same thing, look at the same thing. So, do not forget your choline with your folic acid. Mainly comes from food.

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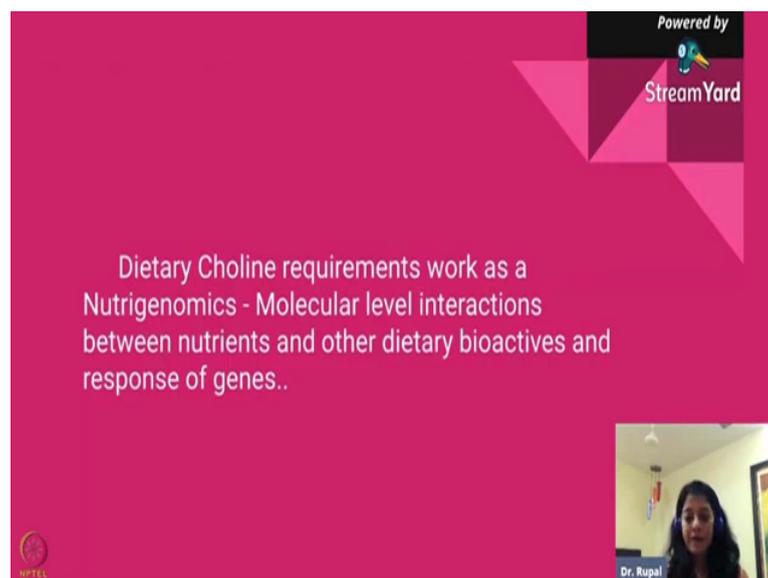
### RDA for Choline mg/day

- ❑ Adult Male 550
- ❑ Adult Female 425
- ❑ Pregnant Women 450
- ❑ Lactating Women 550

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This slide features a pink background with a geometric pattern of triangles in the top right corner. It lists the Recommended Dietary Allowance (RDA) for choline in milligrams per day for four categories: Adult Male (550), Adult Female (425), Pregnant Women (450), and Lactating Women (550). The slide includes a 'Powered by StreamYard' logo in the top right, an NPTEL logo in the bottom left, and a small video inset of Dr. Rupal in the bottom right.



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Dietary Choline requirements work as a Nutrigenomics - Molecular level interactions between nutrients and other dietary bioactives and response of genes..

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This slide features a pink background with a geometric pattern of triangles in the top right corner. The text explains that dietary choline requirements function as nutrigenomics, involving molecular-level interactions between nutrients, other dietary bioactives, and the response of genes. The slide includes a 'Powered by StreamYard' logo in the top right, an NPTEL logo in the bottom left, and a small video inset of Dr. Rupal in the bottom right.

What is your RDA for choline? For us 425, for men 550. Are we getting enough? I do not think so. Lactating mothers about 500. Now you, I am sure a lot of nutritionists are there and what is nutrigenomics? The dietary choline works as nutrigenomics, so it is important to have it in our diet.

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### Child Stunting is Associated with Low Circulating Essential Amino Acids

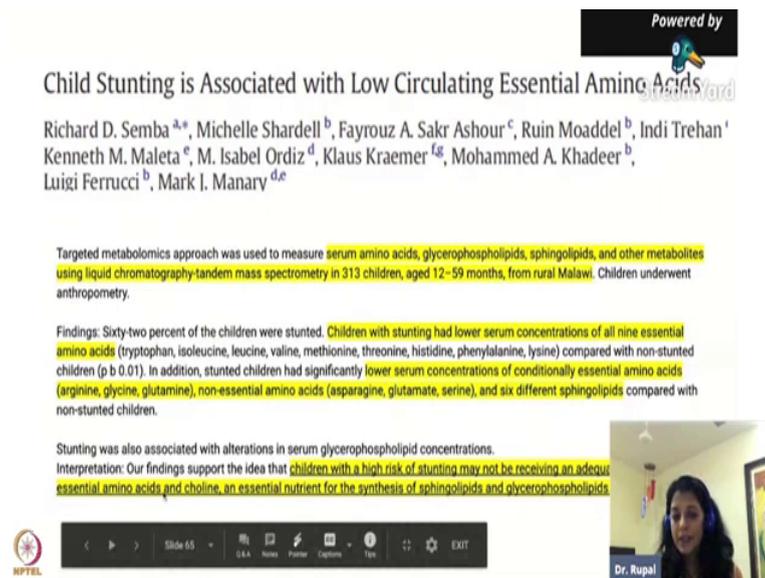
Richard D. Semba<sup>a,\*</sup>, Michelle Shardell<sup>b</sup>, Fayrouz A. Sakr Ashour<sup>c</sup>, Ruin Moaddel<sup>b</sup>, Indi Trehan<sup>d</sup>, Kenneth M. Maleta<sup>e</sup>, M. Isabel Ordiz<sup>d</sup>, Klaus Kraemer<sup>f,g</sup>, Mohammed A. Khadeer<sup>b</sup>, Luigi Ferrucci<sup>b</sup>, Mark I. Manary<sup>d,e</sup>

Targeted metabolomics approach was used to measure serum amino acids, glycerophospholipids, sphingolipids, and other metabolites using liquid chromatography-tandem mass spectrometry in 313 children, aged 12–59 months, from rural Malawi. Children underwent anthropometry.

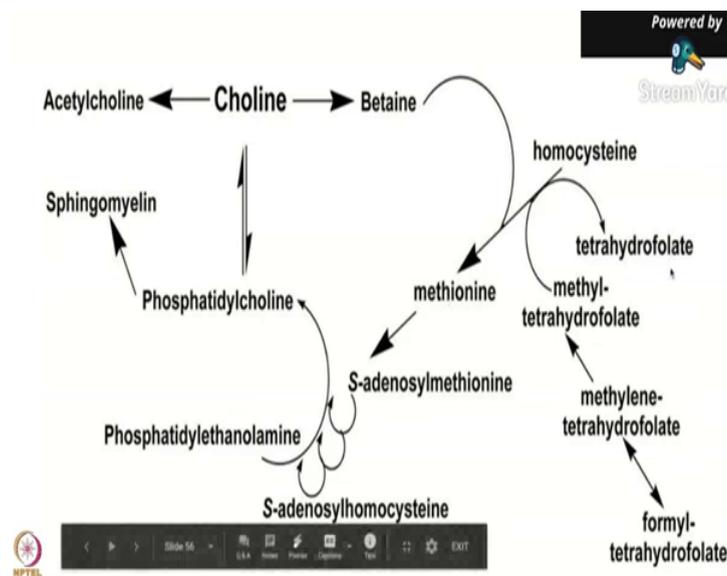
Findings: Sixty-two percent of the children were stunted. Children with stunting had lower serum concentrations of all nine essential amino acids (tryptophan, isoleucine, leucine, valine, methionine, threonine, histidine, phenylalanine, lysine) compared with non-stunted children (p < 0.01). In addition, stunted children had significantly lower serum concentrations of conditionally essential amino acids (arginine, glycine, glutamine), non-essential amino acids (asparagine, glutamate, serine), and six different sphingolipids compared with non-stunted children.

Stunting was also associated with alterations in serum glycerophospholipid concentrations.

Interpretation: Our findings support the idea that children with a high risk of stunting may not be receiving an adequate essential amino acids and choline, an essential nutrient for the synthesis of sphingolipids and glycerophospholipids.



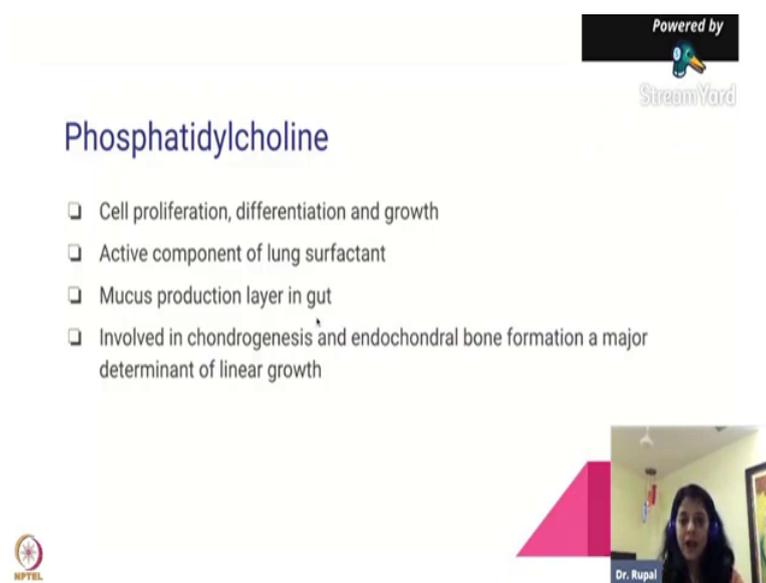
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Now there is this is very beautiful study, which was done by Mark Manary. He is another guru of malnutrition. And what he found, he did basically studies of 60 to many, many children about 313 children, stunted children. And what he found that children who were stunted, basically, they were not receiving amino acids, choline, mainly choline, which was important for sphingolipids and glycerophosphate.

So, the you know, the diagram that I showed, so if choline was absent, children were absent on this also, sphingomyelin and phosphatidylcholine, and phosphatidylethanolamine. So, that is why they said that it is important that children get not only essential amino acid type 2 nutrients and also the choline. So, that that is why I just wanted to put this choline picture.

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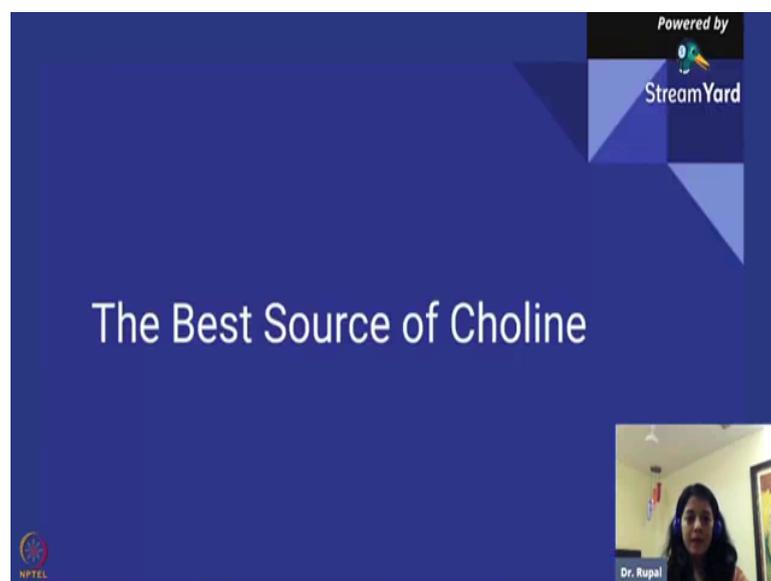
## Phosphatidylcholine

- ❑ Cell proliferation, differentiation and growth
- ❑ Active component of lung surfactant
- ❑ Mucus production layer in gut
- ❑ Involved in chondrogenesis and endochondral bone formation a major determinant of linear growth



This is for phosphatidylcholine what it does, you can see, it basically helps with lung function, gut, pretty much everything.

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## The Best Source of Choline





- Carotenoids
- Omega 3 EFA, DHA
- Vitamin A, D, E, K
- Vitamin B6 & B12
- Calcium
- Iron, iodine
- Zinc
- Thiamin
- Folic Acid
- Phosphorous
- Protein
- Potassium
- Choline
- Lecithin & Phospholipid
- Copper, Mn & Selenium
- Cholesterol



What is the best source of choline? Look at all this nutrient which are present in your eggs. Look at this, how can you beat egg with anything? Excellent carotenoids, Omega 3, A, D K, B6, B12. Even folic acid, calcium, everything, type 1, type 2, vitamin C, it is not there. We can just put some lemon in it.

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Selected Food Sources of Choline (milligrams per serving)

Food	Choline
Chicken, liver, cooked (3 oz)	247
Soy flour, defatted (1 cup)	201
Salmon, sockeye, smoked (3 oz)	187
Egg, whole, raw, fresh (1 large)	125
Quinoa, uncooked (1/2 cup)	60
Chicken, broilers or fryers, meat and skin, roasted (3 oz)	56
Turkey sausage, cooked (3 oz)	55
Wheat germ, toasted, plain (2 tbsp)	50
Milk, nonfat, fluid, with added vitamin A (8 ounces)	38
Cauliflower, cooked, boiled (1/2 cup)	24
Peas, green, frozen, cooked, drained (1/2 cup)	22
Bacon, pork, cured, cooked (2 pieces)	20
Almonds (1 oz)	15
Broccoli, cooked, boiled, drained (1/2 cup)	15
Frankfurter, beef (1)	15
Oat bran, raw (1/2 cup)	15
Pecans (1 oz)	15
Tomato paste, canned (2 tbsp)	12
Flaxseed (2 tbsp)	11



Which are the other food which are high in choline? This are chicken liver, soy flour, salmon. Chicken, turkey, mainly non-veg. Cauliflower, if you have half a cup, only 24 grams. So, if you have a mother who needs 500 grams of milligrams of choline, how is she going to get it if she is vegetarian? Think about it. And I think you should also do your dietary recall and see if you got choline or not, especially if you are planning to become pregnant.

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Eradication of 3 most prevalent micronutrient deficiencies - Iron, Zinc & Iodine - could increase the world IQ by 10 points

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Slide 71

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If you eradicate three most prevalent micronutrient deficiencies, your world IQ will be increased by 10 points, which are those: iron, zinc and iodine. Two of them are type 1, this is type 2.

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- ❑ Iron exhibits a U-shaped nutrient-health relationship because of functional impairment when inadequate and cytotoxicity when excessive
- ❑ In physiologic concentrations, iron functions in both oxygen transport and energy production
- ❑ In excess, however, iron is a pro-oxidant and produces reactive hydroxyl radicals and other reactive oxygen species (ROS) that damage DNA, proteins, lipids, other cellular molecules and stem cells
- ❑ Low Hb concentrations during pregnancy associate with increased risk of
  - ❑ low birthweight
  - ❑ small for gestational age
  - ❑ preterm births
  - ❑ maternal mortality
- ❑ In infants, Impaired cognition & brain development

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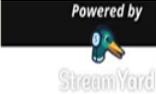
Dr. Rupal

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Iron again, we know nature's, iron is important. One thing I want to tell you about iron that if iron is absent in children, say when they are growing in first year of life, especially after 4 months of age, the children have cognition, and they have impaired cognition, and that is permanent. So, once your child is diagnosed with anemia that means a permanent damage has already been occurred.

After that, if you give any iron, whatever damage is done is done. So, main thing is your prevention. So, please prevent children from getting anaemia. In USA, what we do is, we check the children at around 9 months of age. And before we check them, we already start them on iron supplements. That is the protocol in the US.

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Am J Clin Nutr. 2017 Dec;108(Suppl 6):1688S-1693S. doi: 10.3945/ajcn.117.156067. Epub 2017 Oct 25.

### The effects of iron fortification and supplementation on the gut microbiome and diarrhea in infants and children: a review.

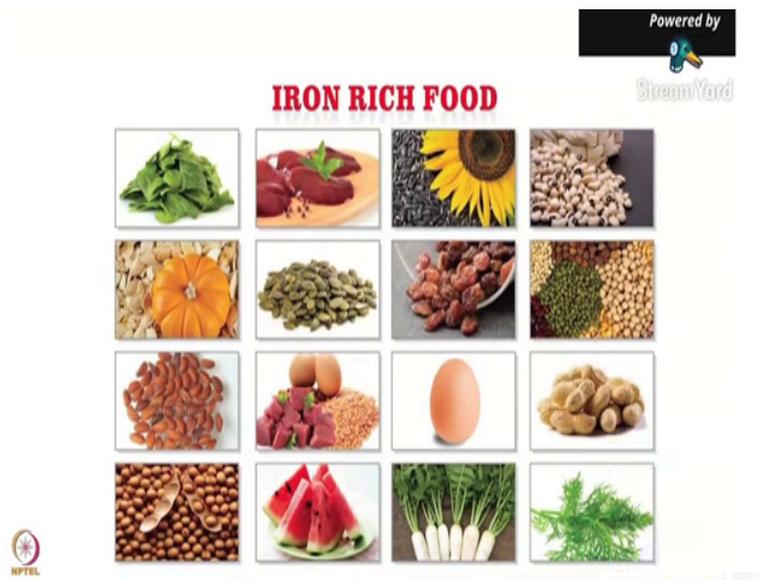
Paganini D<sup>1</sup>, Zimmermann MB<sup>2</sup>.

- ❑ Authors studied infants and young children on the effects of iron supplements and iron fortification with MNPs on the gut microbiome and diarrhea
- ❑ Iron-containing MNPs and iron supplements can modestly increase diarrhea risk, and in vitro and in vivo studies have suggested that this occurs because increases in colonic iron adversely affect the gut microbiome in that they decrease abundances of beneficial barrier commensal gut bacteria (e.g., bifidobacteria and lactobacilli) and increase the abundance of enterobacteria including enteropathogenic *Escherichia coli*
- ❑ These changes are associated with increased gut inflammation



But we do not want to give too much iron also in this children, better to get it from food, because what happens is, extra iron will effect, it is it acts like a free radical and then it can cause problem, it can also affect your gut microbiome. So it is important that we do not, just indiscriminately keep giving iron without understanding. It is like a double edged sword, so you do not want to go to too much.

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Just have food in iron, if child is non-veg please give them liver, very high amount of iron they will get, they will get all the nutrients. If they are vegetarian, give them egg, do not give them too much of milk because milk dairy is very poor in iron, so I do not like it. I like the black eyed beans or chawli beans are really good so all your pulses are good, make sure that they get it with vitamin C.

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## Importance of Choline

Spoken Tutorial Project

<https://health.spoken-tutorial.org>

YouTube Channel: Health Spoken Tutorial - IIT Bombay

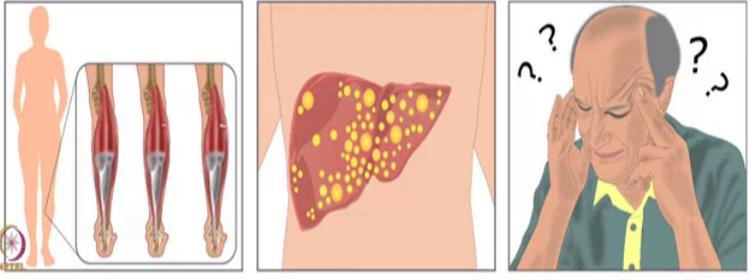
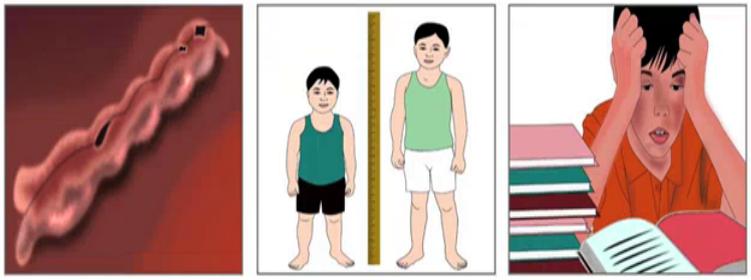
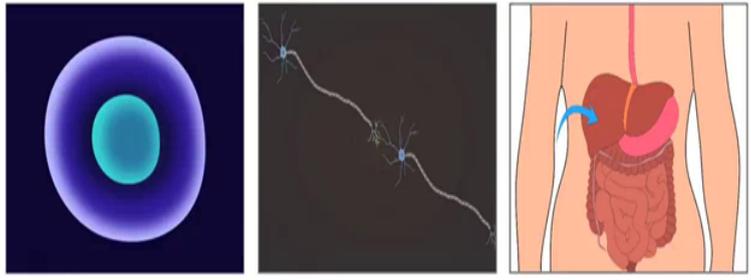
Script: S J Monika

Graphics and Animation: Debosmita Mukherjee

IIT Bombay

13 May 2021

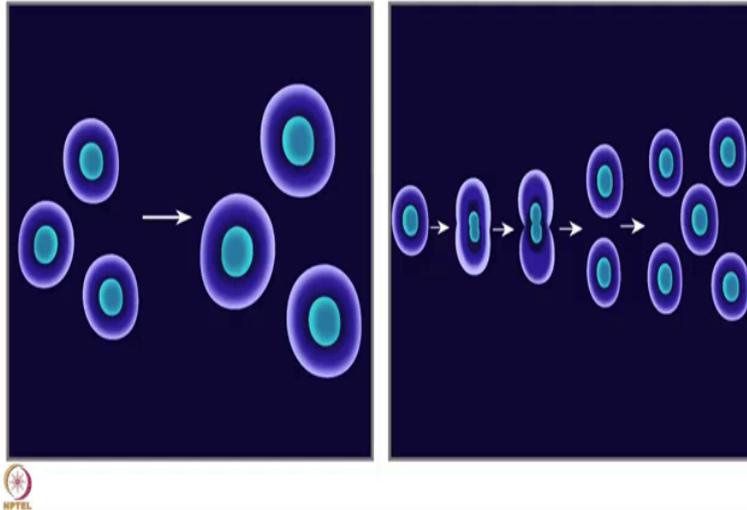
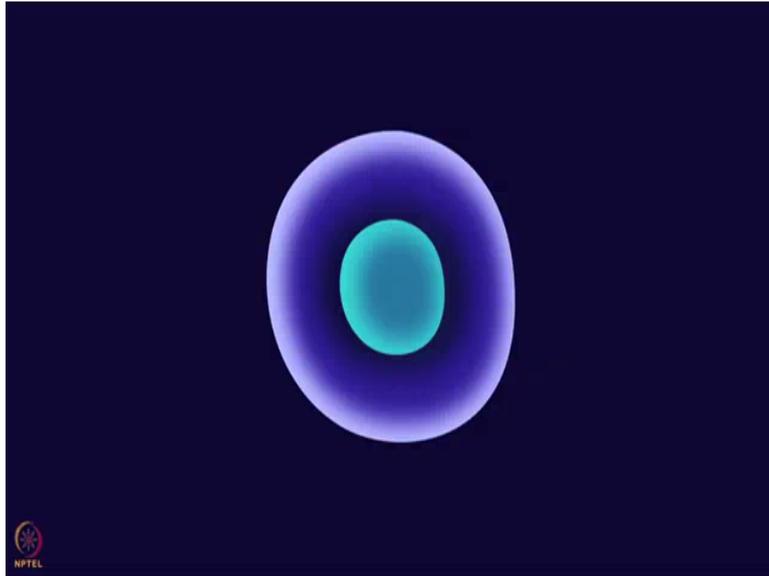




S J Monika - Welcome to the Spoken Tutorial on the importance of choline. In this tutorial, we will learn about primary functions of choline, causes and symptoms of its deficiency requirements for different age groups.

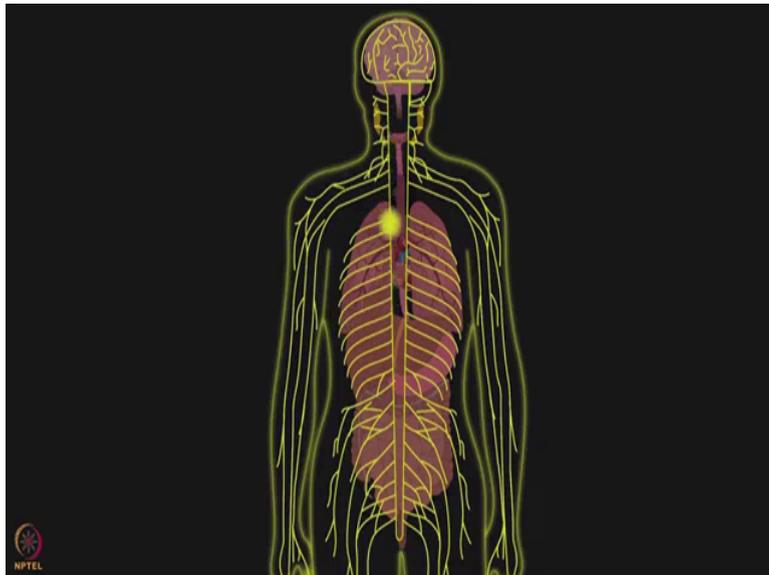
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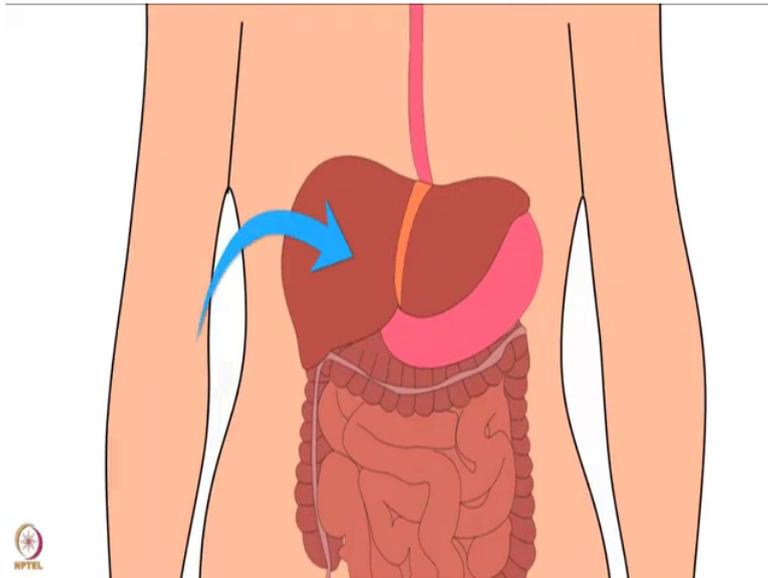




Choline is an essential nutrient, it is required for vital functions in the body and for overall health. Vital functions like maintaining the cell structure and functioning of cells.

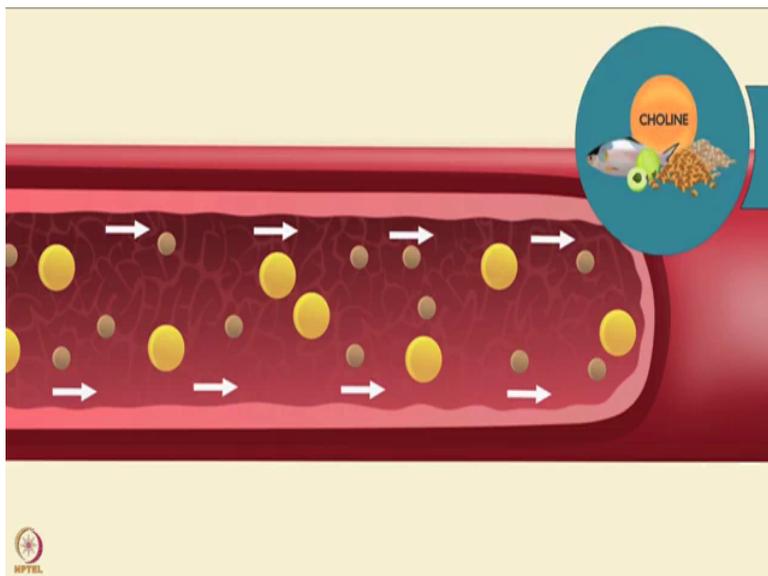
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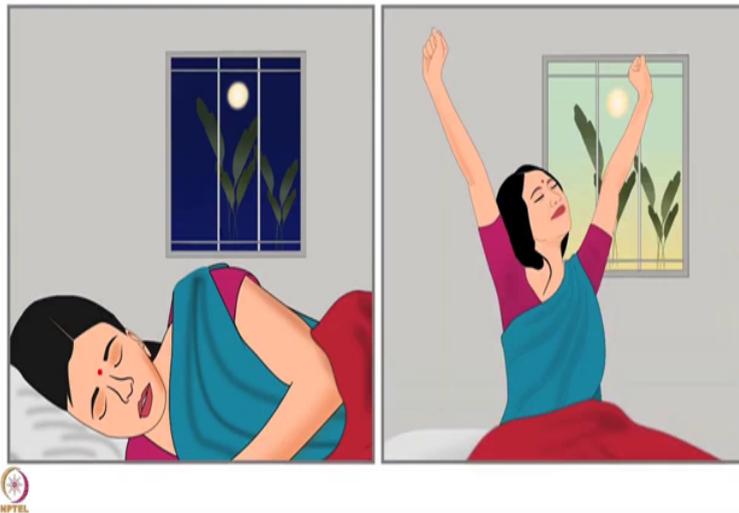
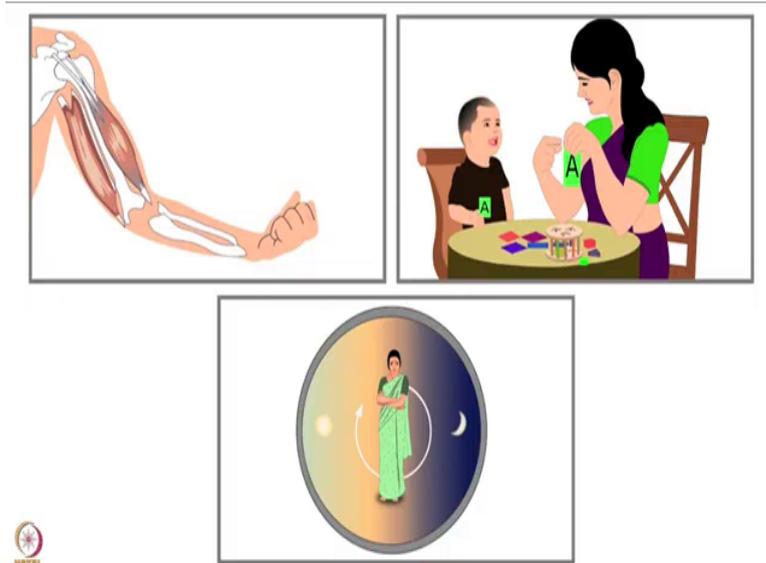




Choline helps in carrying the nerve impulses from neuron to neuron. It also helps in carrying impulses from neurons to organs. Choline plays a role in the normal functioning of the liver.

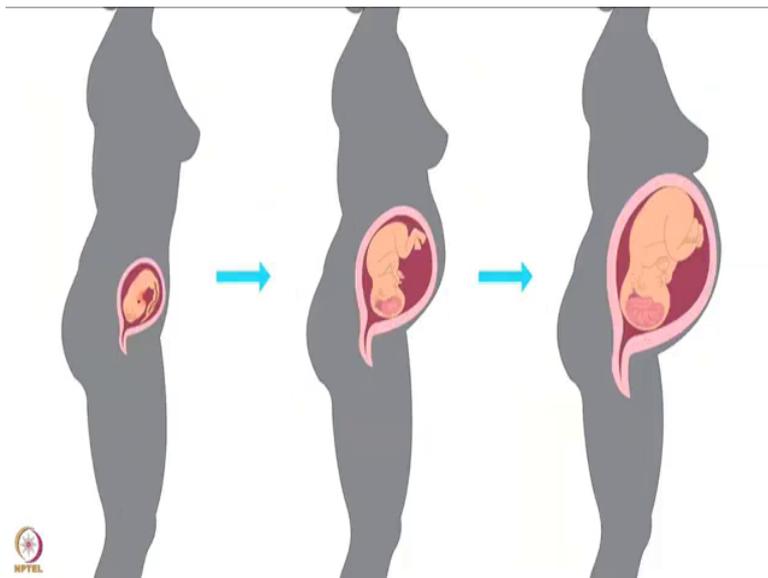
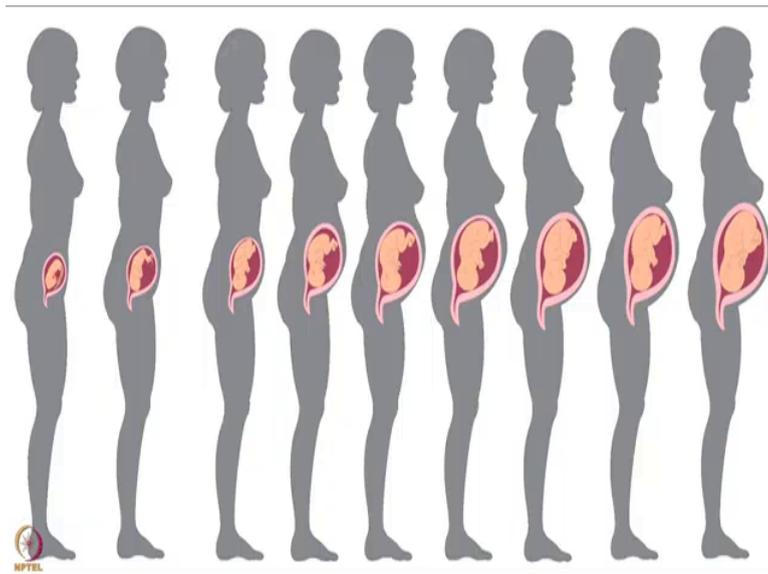
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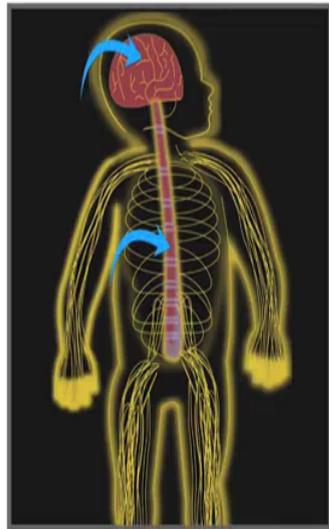
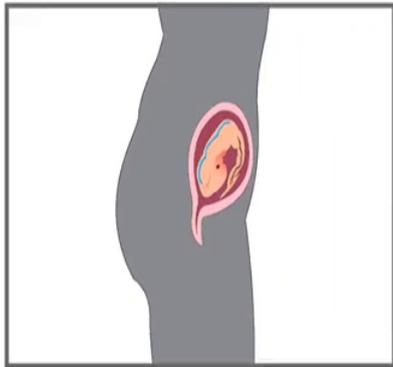
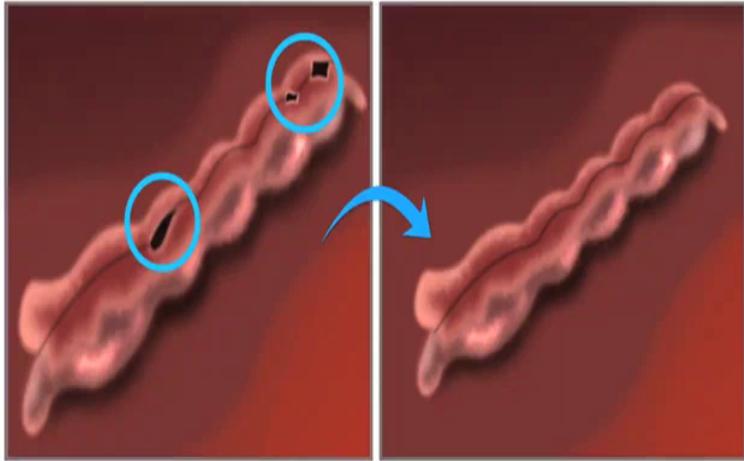
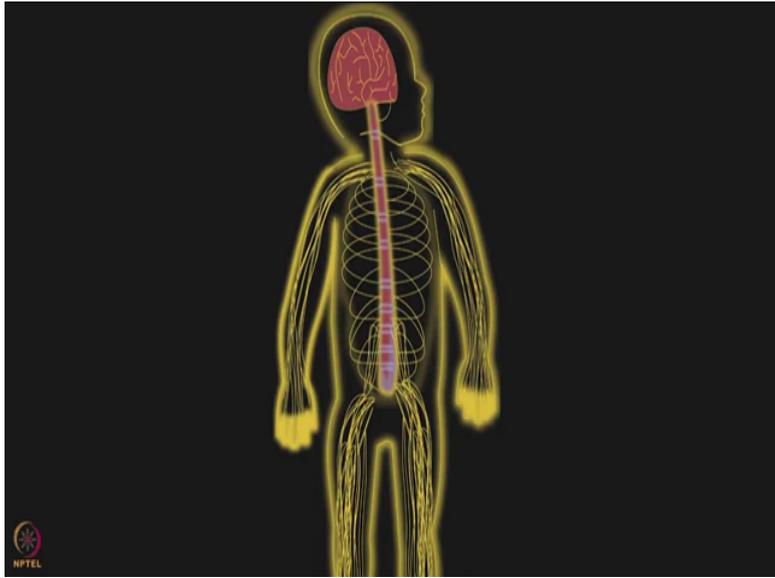




Transportation of fat and cholesterol also requires choline. It is involved in muscle control, memory and circadian rhythm. Circadian rhythm is a process that regulates our sleep and waking up cycle.

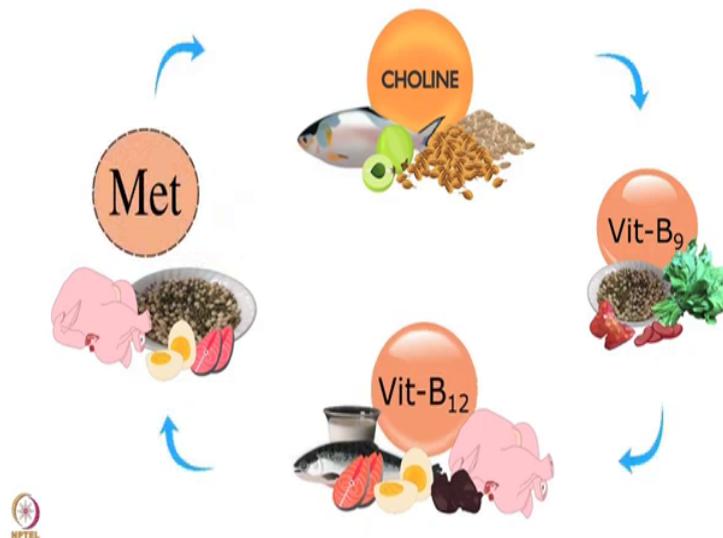
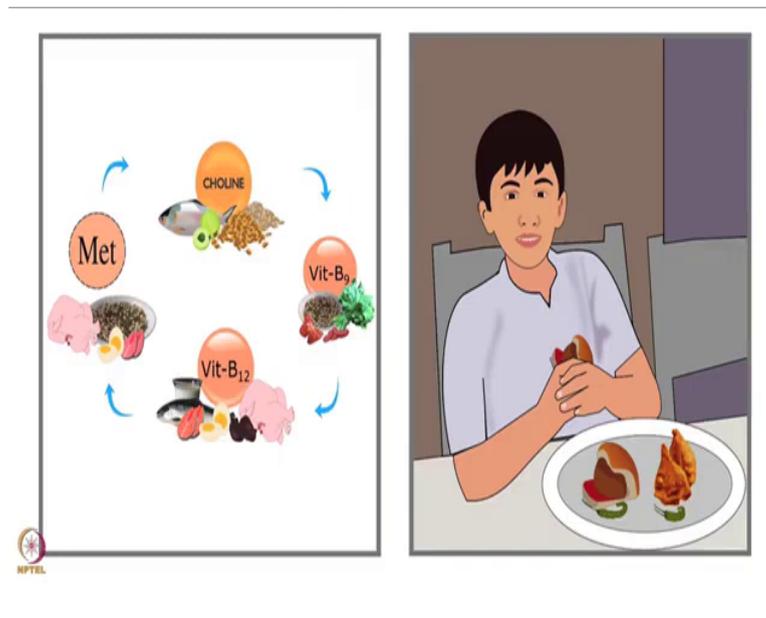
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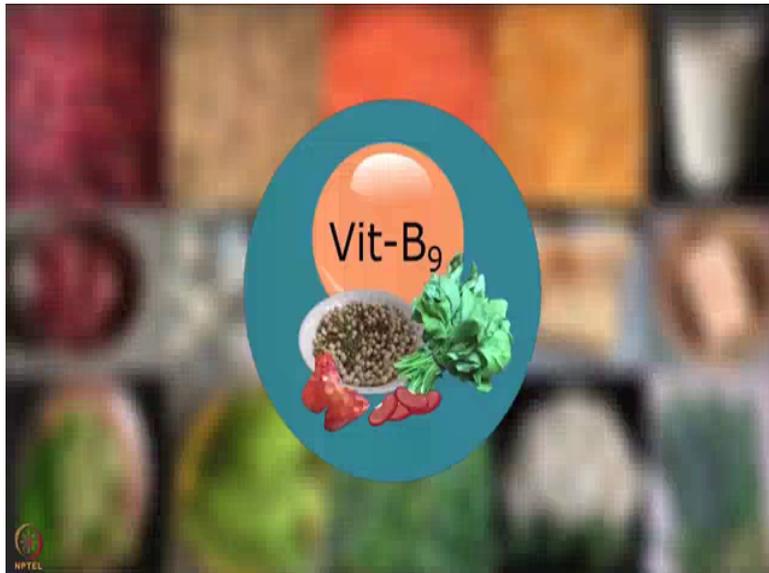
Choline is required during fetal development. It is required for brain and nervous system development of the baby. It influences the closure of the neural tube. Neural tube in the embryo forms the brain and spinal cord.

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There are various factors that can cause increase in the deficiency. The metabolism of choline, folate, vitamin B12, and Methionine are interrelated. If availability of one nutrient is disturbed, other nutrients are also affected.

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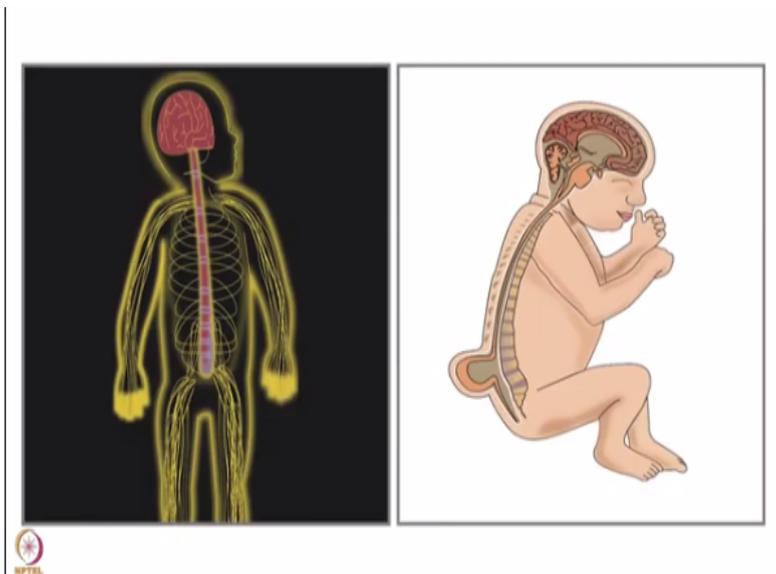
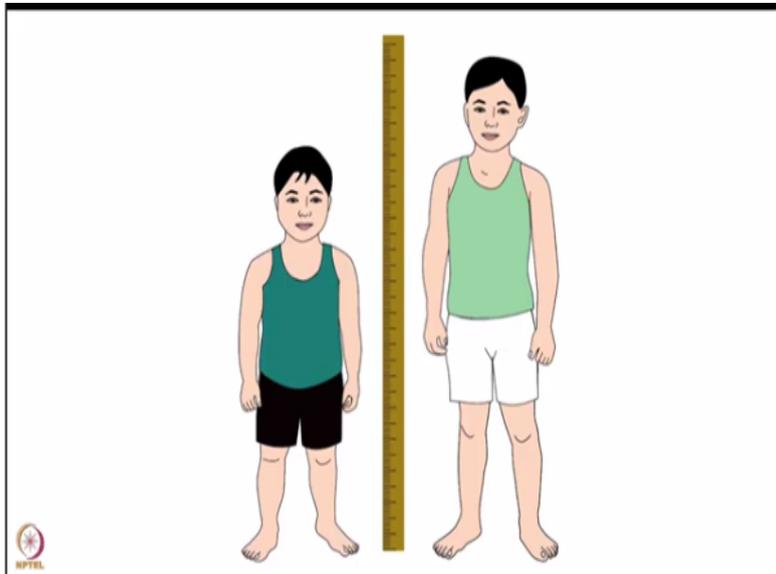
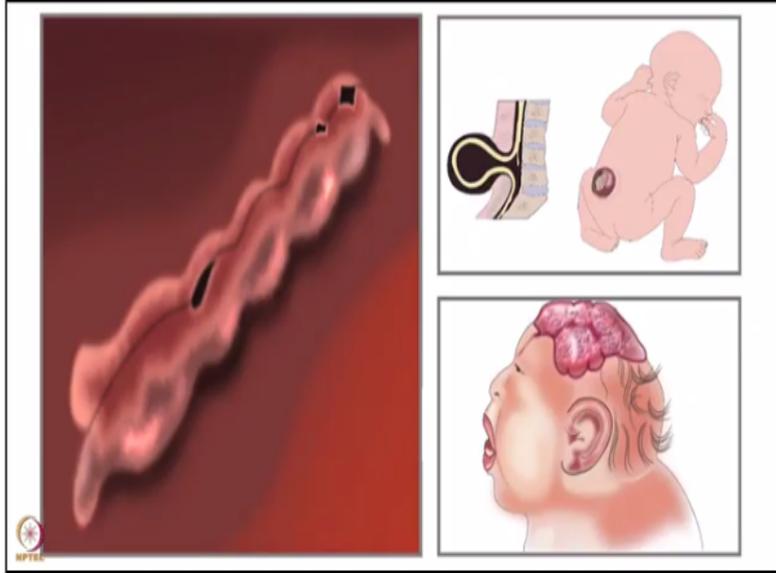




Inadequate dietary intake of folate and vitamin B 12 causes choline depletion. Apart from these having a poor diet can cause choline deficiency.

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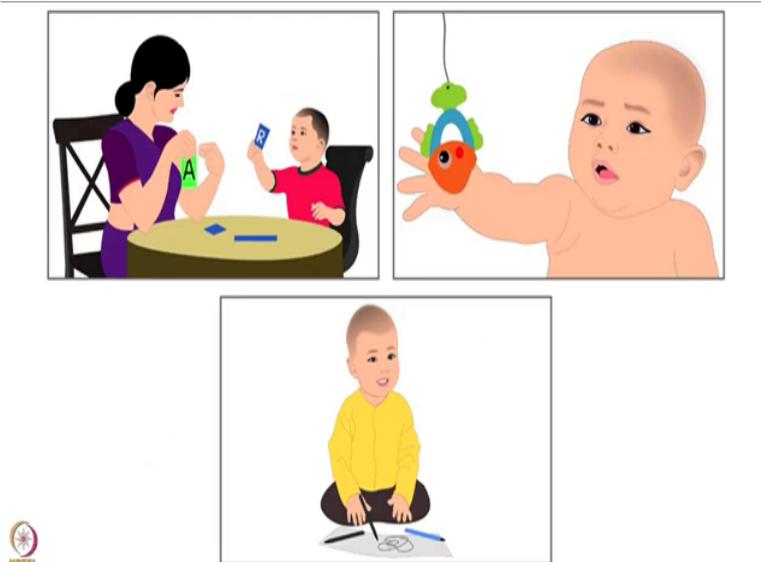


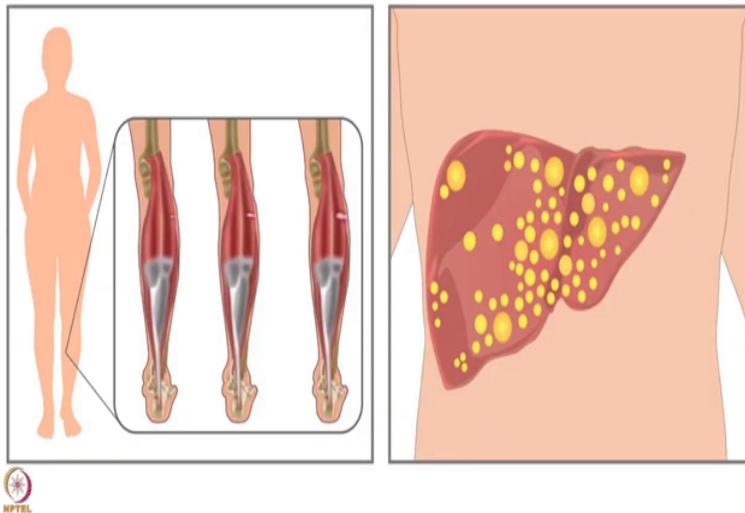
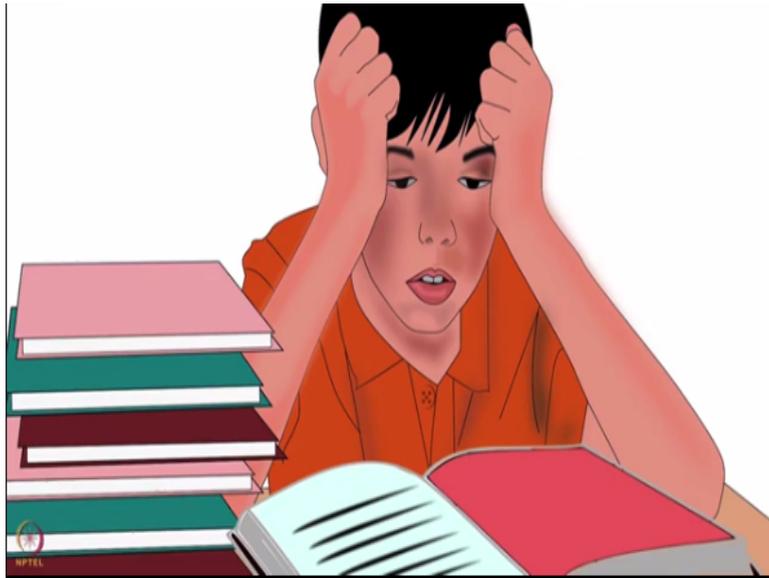




During pregnancy and lactation, the requirement of Choline increases. If these requirements are not met, then deficiency occurs. This can cause neural tube defects and stunting in children. Neural tube defects are birth defects that affect the nervous system and spine. It also affects the brain development.

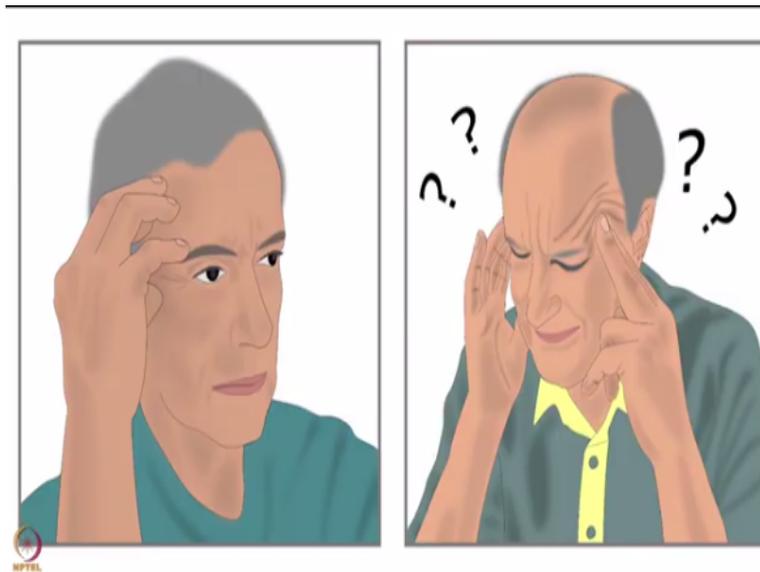
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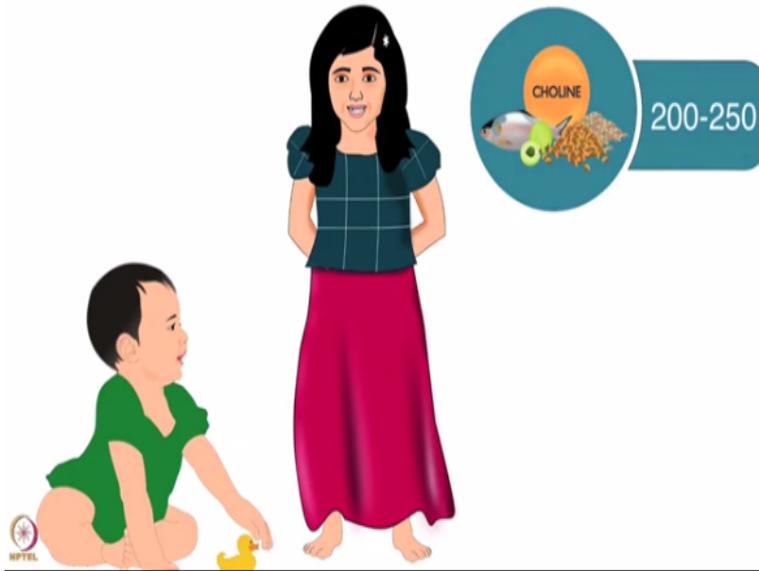




Intelligence and motor development also get affected. Deficiency in growing children leads to poor memory. They will also have difficulty in learning. In adults, choline deficiency can cause damage to the muscle and liver. Due to choline deficiency, fat does not move out of the liver. This leads to fat accumulation causing non alcoholic fatty liver disease.

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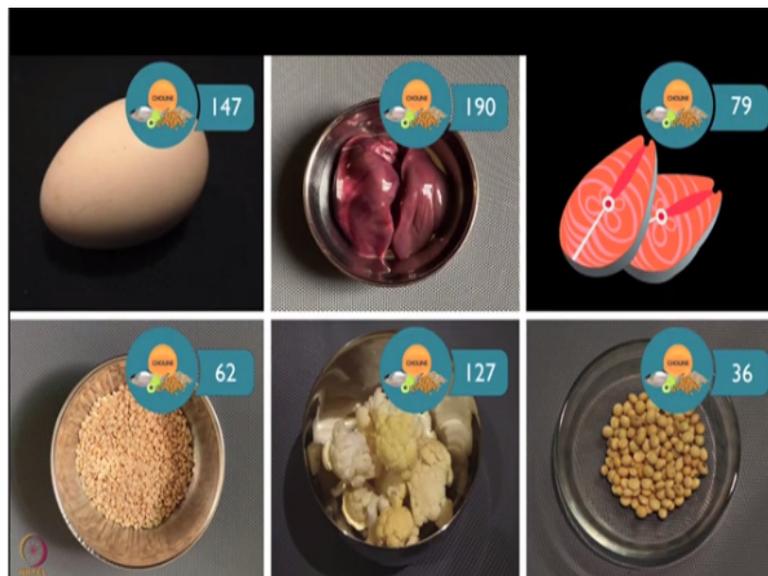




Choline deficiency can also lead to Alzheimer's disease. In Alzheimer's disease, memory and thinking skills are diminished. Adequate intake of choline varies for different age groups. For 0 to 13 month old infants it is 125 to 150 milligrams per day. For 1 to 8 years old children it is 200 to 250 milligrams per day. 9 to 13 years old require 375 milligrams per day. 14 to 18 years old need 400 to 550 milligrams per day.

Adult men require 550 milligrams per day. Adult women and pregnant women require 450 milligrams per day. Lactating women require 550 milligrams per day. Our body does not produce sufficient amounts of choline. Hence it has to be taken through food. Let us look at the food sources of choline. Eggs, chicken liver, fish, wheat germ, nuts, seeds, and legumes are good sources.

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Let us look at the amount of choline present in a few food items. 1 egg has around 147 milligrams. 100 grams of chicken liver has approximately 190 milligrams. 100 grams of salmon has nearly 79 milligrams. 30 grams of raw split black gram has around 62 milligrams. 100 grams of cauliflower has 127 milligrams. 30 grams of soybean has 36 milligrams. Include these choline-rich food in your daily diet for good health. This brings us to the end of this tutorial.

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## Choline rich non-vegetarian recipes

Spoken Tutorial Project

<https://health.spoken-tutorial.org>

YouTube Channel: Health Spoken Tutorial - IIT Bombay

Script: S J Monika

Graphics: Debosmita Mukherjee

IIT Bombay

30 October 2021



Welcome to the Spoken Tutorial on choline rich non vegetarian recipes.

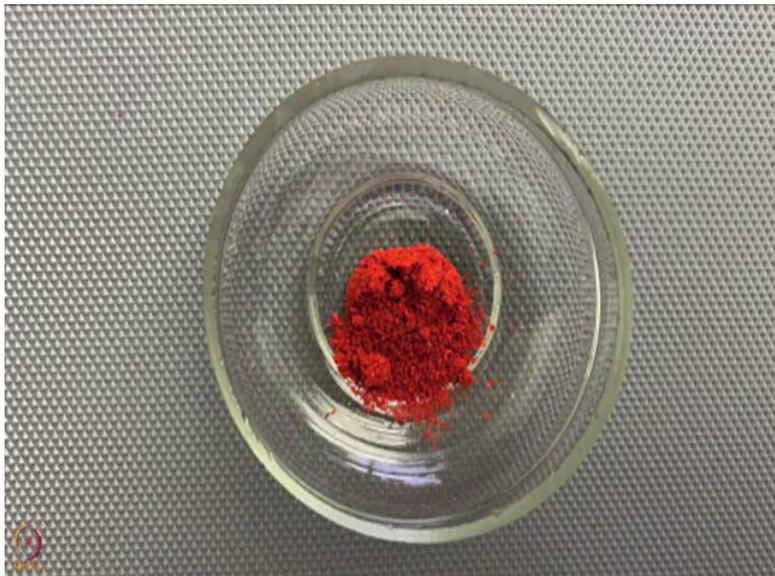
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In this tutorial, we will learn non-vegetarian recipes rich in choline. Choline is an essential nutrient required for overall health. It is also required for normal functioning of the liver. Transportation of fat and cholesterol also requires choline. The importance of choline has been explained in another tutorial. Please visit our website for this tutorial.

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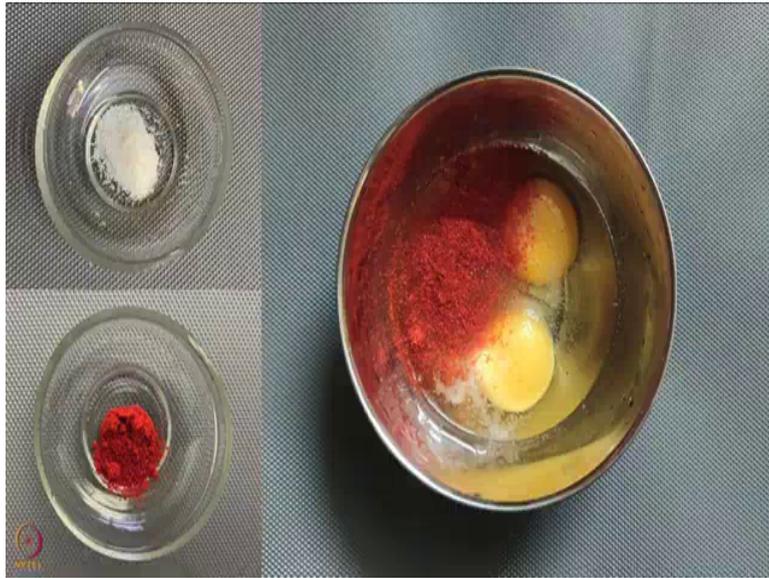






We will begin with our first recipe egg noodles. To make this recipe you will need two eggs half medium chopped onion, half medium chopped tomato, half teaspoon red chili powder, a pinch of turmeric powder, you will also need half teaspoon cumin seeds, handful of washed and chopped coriander leaves, salt to taste, two teaspoons of oil or ghee.

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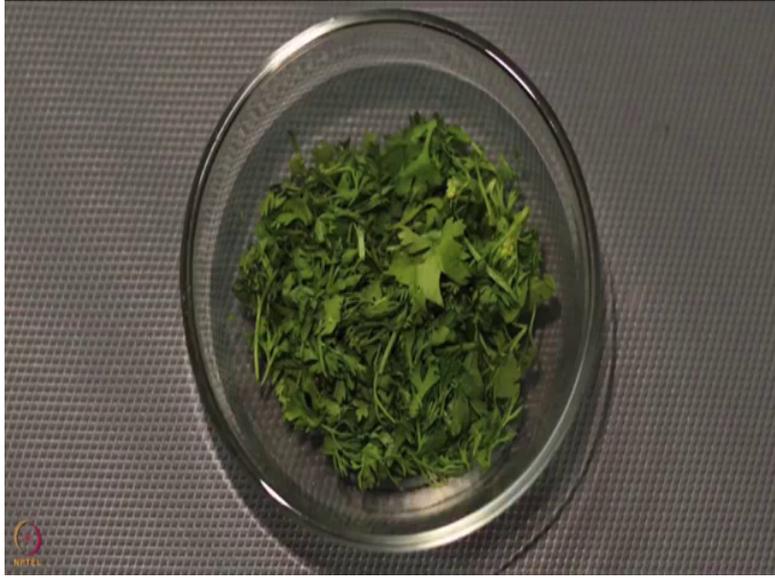
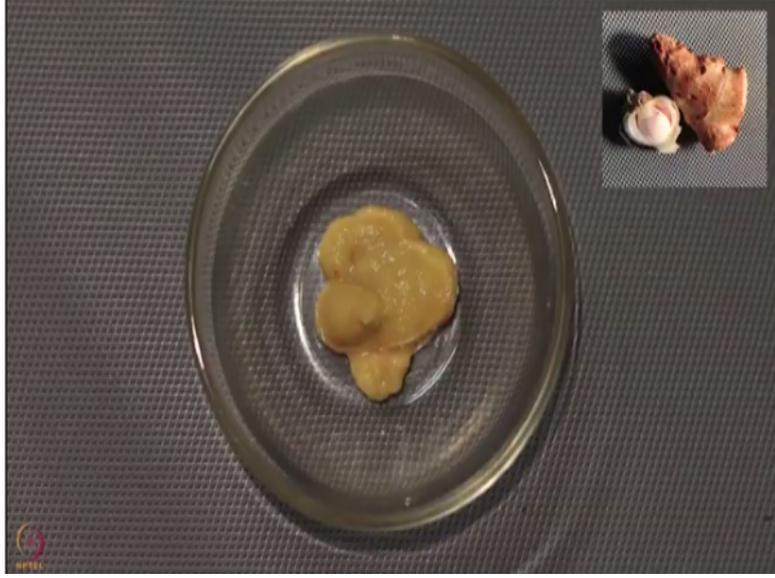


Procedure crack eggs in a bowl add salt and red chili powder, then whisk the eggs well. Heat oil in a pan and pour the eggs on the pan. On medium flame, cook the omelette on both sides until done. Keep this aside to cool, once cooled cut the omelette into thin long pieces.

Next heat oil in a pan and add cumin seeds, once the cumin seeds splutter, add onion sauté, the onion till it turns golden brown in color. Add tomato, turmeric powder and salt. Mix well and cook till the tomato turns soft. To this add the thin long pieces of the omelette makes well again and cook again for 5 minutes. Garnish with coriander leaves. Egg noodles are ready. One bowl of egg noodles has around 290 milligrams of choline.

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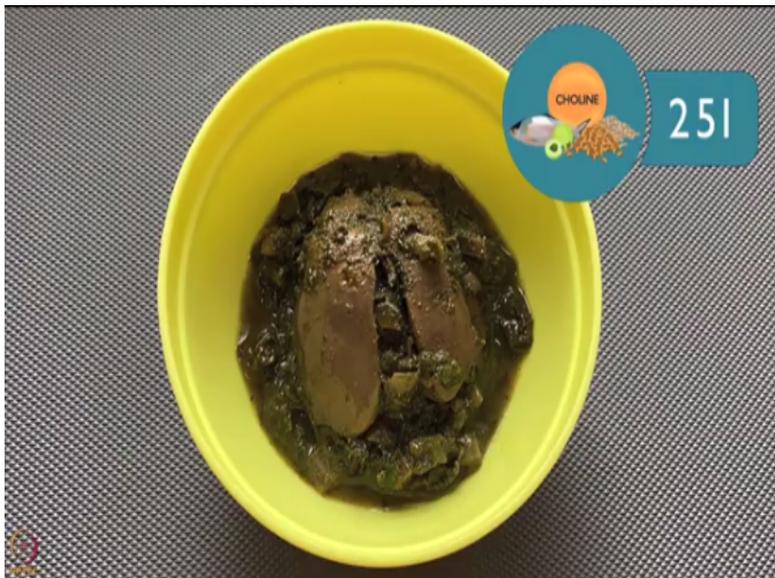




Our next recipe is chicken liver curry. To make this recipe you will need 50 grams of washed chicken liver, one medium chopped onion, one teaspoon ginger garlic paste, handful of washed and chopped coriander leaves, a handful of washed meant leaves, two green chilies you will also need one teaspoon turmeric powder, one teaspoon cumin seeds, juice of half lemon, salt to taste, two teaspoons oil.

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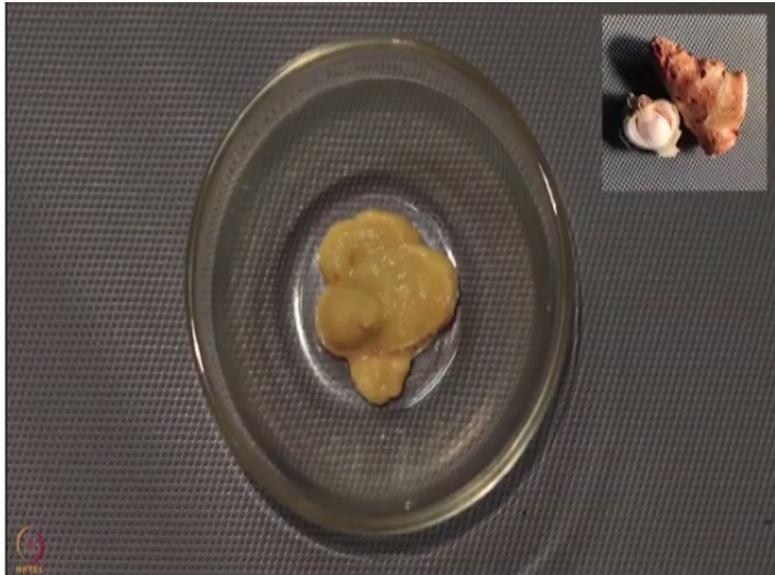
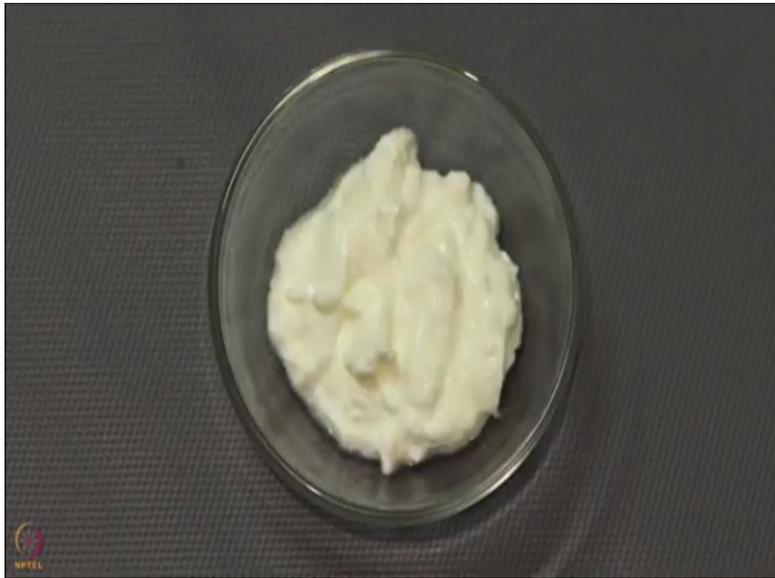


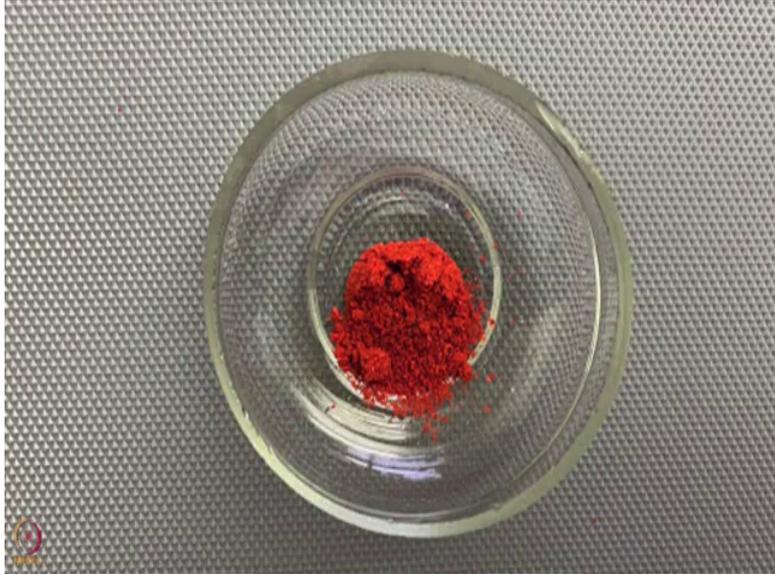
Procedure: apply ginger garlic paste and half teaspoon turmeric powder to chicken liver, leave this for 30 minutes. Grind the coriander leaves mint leaves and green chillies into a paste. Keep this aside for later use. Heat oil in a pan add cumin seeds and let it splutter add the onion and saute until it turns golden brown in color. To this add the paste that we made earlier now add the chicken liver, add turmeric powder and salt.

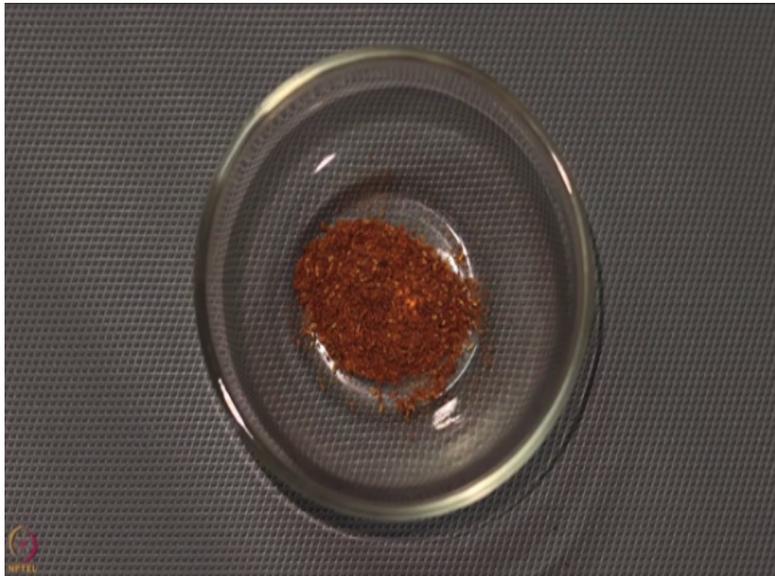
Mix it well and add half a glass of water. Close the pan with a lid and cook for 10 minutes or until the liver is cooked. Squeeze juice off half lemon and serve. Chicken liver curry is ready. Half bowl of chicken liver curry has 251 milligrams of choline.

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Our third recipe is prawns masala curry. To make this you will need 50 grams prawns, one medium chopped onion, puree of one medium-sized tomato, one fourth cup curd, one teaspoon ginger garlic paste you will also need one teaspoon red chili powder half teaspoon turmeric powder one teaspoon lemon juice, one teaspoon garam masala powder, one teaspoon cumin seeds, salt to taste, two teaspoons oil.

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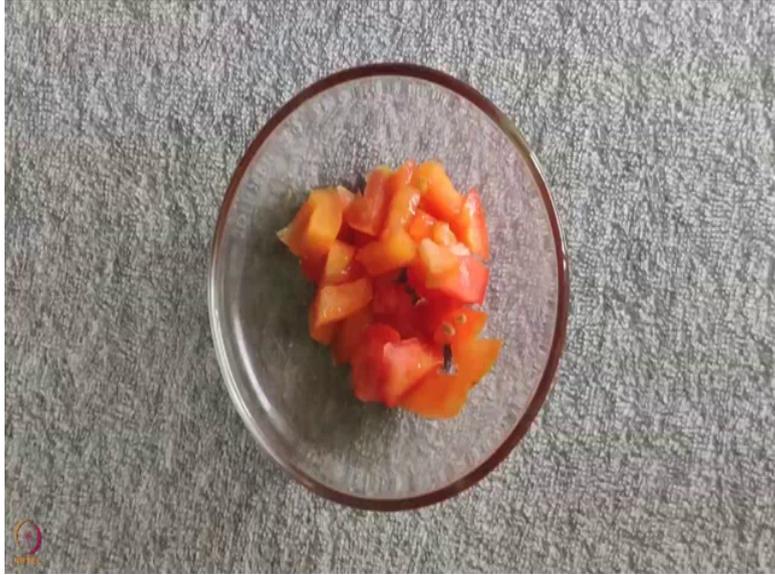


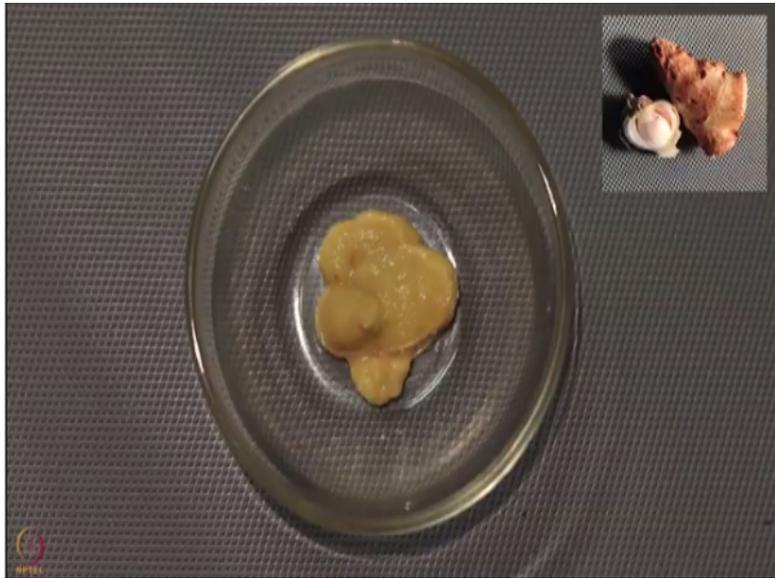
Procedure to make the curry clean and wash the prawns, make a slit on the backside of the prawns pull out the black thread from it. This black thread has to be removed from the other side also if found. Apply lemon juice ginger garlic paste and salt to the prawns, leave it for 30 minutes. Grind the tomato to make a puree.

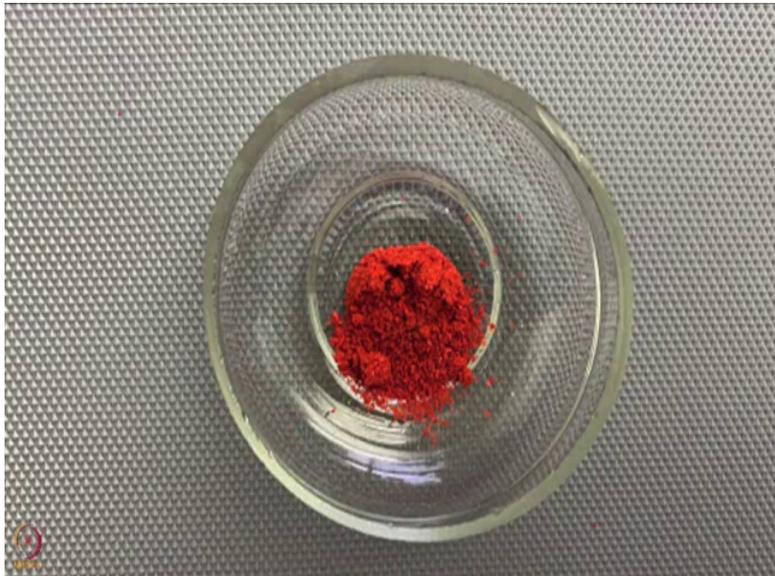
Next Heat oil in a pan and add cumin seeds, once the seeds splutter add chopped onions, sauté the onions till they turn light brown in color. Now add the tomato puree to this and cook for 5 minutes. Add spices salt, prawns and curd. Make sure to keep the heat low while adding curd. Mix well and add half a glass of water. Cover the pan and cook on low flame for 10 minutes or until the prawns are cooked. Prawns masala is ready. Half bowl of prawns masala curry has around 379 milligrams of choline.

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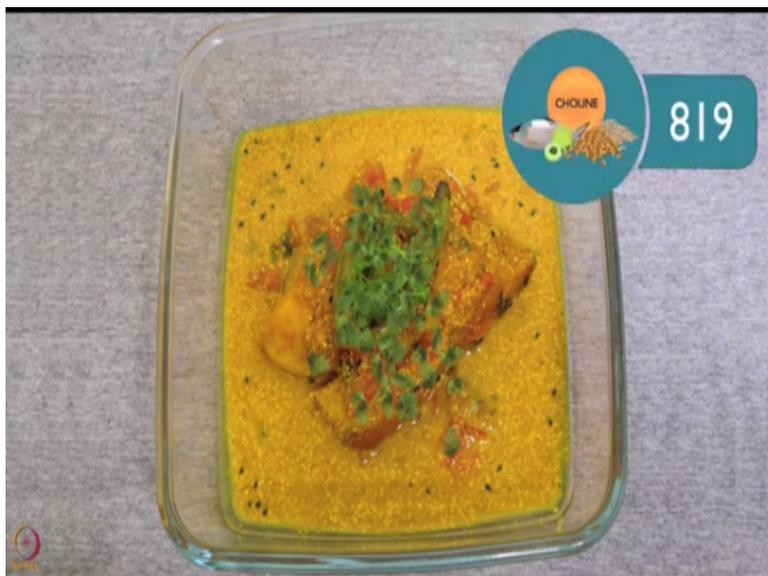




Our last recipe is fish curry. To make this recipe you will need 100 grams of washed Rohu. One medium chopped tomato, two teaspoons mustard seeds, one teaspoon coriander seeds, one teaspoon nigella, seeds one small piece of ginger, you will also need two green chilies, half teaspoon cumin seeds, one teaspoon red chili powder, half teaspoon turmeric powder, handful of washed and chopped coriander leaves, salt to taste, two teaspoons oil.

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Procedure apply salt and turmeric powder to the fish keep it aside for 30 minutes. Grind the mustard seeds into a paste by adding little water keep this aside for later use. Grind cumin seeds, coriander seeds and ginger into a smooth paste. Dilute the paste with three tablespoons of water. We will use this paste later. Heat oil in a pan and add nigella seeds. Once the seeds splutter add the fish to the pan.

For 5 minutes fry the fish on both sides then add the diluted seeds paste to it. Add the tomatoes, spices and green chili mix them well. Add salt along with half a glass of water. Mix again and cook this until tomatoes turn soft. Now add mustard paste and coriander leaves. Close the pan with a lid and cook for 5 minutes.

Fish curry is ready. One bowl of fish curry has around 819 milligrams of choline. Include these choline enriched recipes in your daily diet for good health. This brings us to the end of this tutorial. Thanks for joining.