Module 5

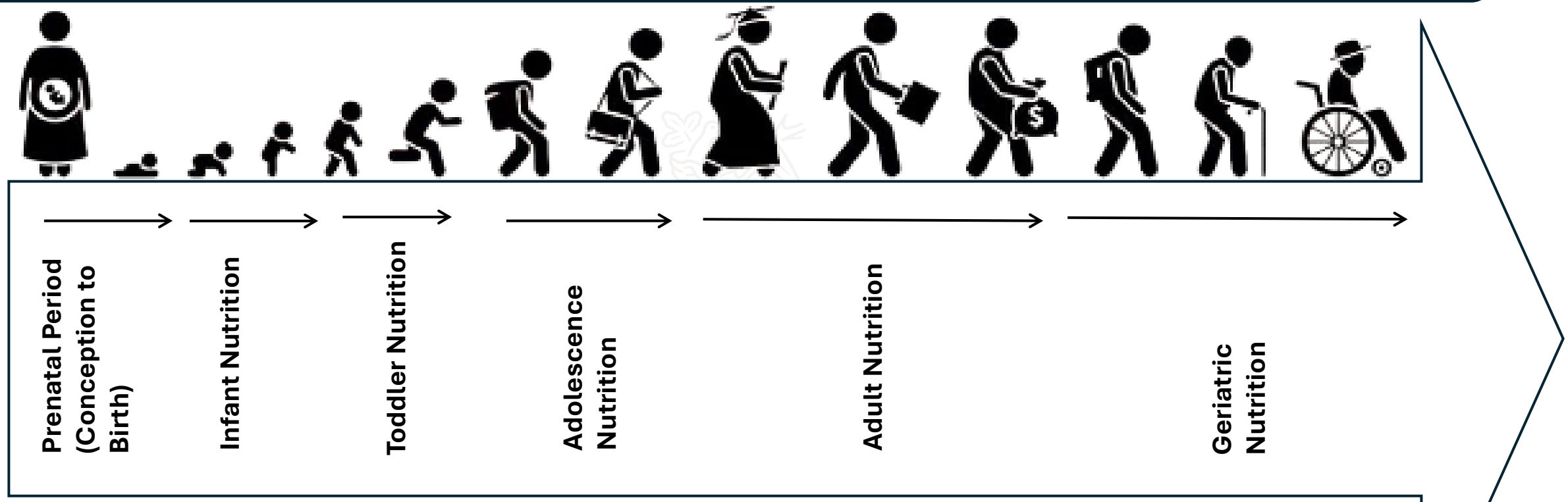
Nutrition throughout the life cycle

Module coverage

Topic	Sub-topics covered	Learning objectives
5) Nutrition throughout the life cycle	• Developmental milestones and physiological changes at each life stage. • Nutrition mapping basis requirements across each life stage – including impact of nutrition on immunity and concept of functional foods.	✓ Understand the changes in physiology at different stages in life. Identify changing nutritional needs at each life stage. ✓ Concept clarity for immunity and functional foods.

Nutrition throughout the life cycle

Nutritional needs change across different stages of human development, from infancy to old age, impacting growth, development, and overall health. [72]



Developmental stages refer to the different phases of life characterized by specific growth patterns, physiological changes, and nutritional requirements.

Image source: tarrantcounty
Source: 72) https://pmc.ncbi.nlm.nih.gov/articles/PMC9902887/

Prenatal period (conception to birth)

Pregnant Women (additional 350 Kcal/day)[11]

- Extra food and healthcare are required
  - Regular physical activity and sunlight, appropriate utilization of nutrients.
- Special focus should be given to:
  - Protein, Iron, Folic acid, Vitamin B12, Iodine.
  - Long chain n-3 poly unsaturated fatty acids (LCn-3PUFA).
- Reason:
  - The embryo rapidly draws nutrition from the mother.
  - Maintain the mother's health.
  - For nourishing the fetus, developing:
    - Immune system.
    - Brain.
    - Organs.

Image source: Canva elements
Source: 11) https://www.nin.res.in/dietaryguidelines/pdfjs/locale/DGI24thJune2024fin.pdf page 13

Prenatal Period (Conception to Birth)

Recommended food groups and raw amounts (g/day) to meet dietary requirements of normal and undernourished pregnant women

Food groups	Amount
	g/day
Cereals and millets	260
Pulses and legumes	90
Nuts & oil seeds	40
Vegetables	200
Roots & tubers	100
Green leafy vegetables	150
Fruits	150
Egg	50
Milk	400
Fats & edible oils	20
Energy requirement	

Image source: Canva elements
Source: 8) https://www.nin.res.in/dietaryguidelines/pdfjs/locale/DGI24thJune2024fin.pdf page 15

Prenatal Period (Conception to Birth)

Energy requirement of pregnant women

Category	Physical activity	Energy (Kcal/d)
Women	Sedentary	1660
	Moderate	2130
	Heavy	2720
Pregnant women**		Additional calories 350

**GWG-Gestational Weight Gain. Energy need in pregnancy should be adjusted for actual bodyweight, observed weight gain and activity pattern for the population.

Source: 8) https://drive.google.com/file/d/1GtjbaUlQ8HOPLfQjnfuXjwNZOt2hWFho/view page 20

Changing nutritional needs at each stages of life

Recommended Dietary Allowances (RDA) of Nutrients For Pregnant and Lactating Women, 2024															
Category/ Age group	Protein	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	Daily value	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Pregnant women **	0.83 (2nd trimester additional 9.5g/day)	1000.0	440.0	27.0	14.5	220.0	2.0	2.7	13.0	2.3	570.0	2.45	80	900	600
Pregnant women **	0.83 (2nd trimester additional 22g/day)	1000.0	440.0	27.0	14.5	220.0	2.0	2.7	13.0	2.3	570.0	2.45	80	900	600
Lactation 0-6m	0.83 (additional 17g/day)	1200.0	400.0	23.0	14.1	280.0	2.1	3.0	16.0	2.2	330.0	3.2	115	950	600
Lactation 7-12m	0.83 (additional 13g/day)	1200.0	400.0	23.0	14.1	280.0	0.2	2.9	16.0	2.1	330.0	3.2	115	950	600

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html; page: 30

Infancy (Birth to 1 Year)

Milestones:

- Motor skills: Rolling over, sitting, crawling, standing, walking.
- Sensory development: Vision, hearing, touch, taste, smell.
- Cognitive development: Object permanence, cause-and-effect.
- Social-emotional development: Attachment, social smiles, laughter.

Physiological Changes:

- Rapid physical growth: Babies typically double their birth weight by 4 to 6 months of age.
- Development of various functions like the digestive system and immunity
- Extra demand for nutrients to maintain nutrition reserves – iron stores

Energy requirement of Infants for the given body weights

Category	Age Group	Body weight (kg)	Kcal/d	Kcal/kg/day
Infants	0-6m	5.8	530	90.0
	6-12m	8.5	660	80.0

*rounded off to the nearest 10Kcal/d

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html

Infancy (Birth to 1 Year)

Infants should be exclusively breastfed (EBF) for the first 6 months to ensure child health and survival. [73]

Infants do not require water during breastfeeding; feeding water reduces the nutritional intake.

Ideal Nutrition

- Breast milk provides all the essential nutrients a baby needs for healthy growth and development

Immunity Boost

- Breast milk contains antibodies that protect babies from infections.
- Cognitive Development: Breast milk supports brain development and cognitive function.
- Reduced Risk of Chronic Diseases: Lowers the risk of obesity, type 2 diabetes, allergies, and asthma.
- Emotional Benefits: Breastfeeding strengthens the bond between mother and child and reduces stress.

Introduction of solid foods >6th month

- **Introduce a Variety of Foods:** Offer a diverse range of foods from all food groups to ensure balanced nutrition.
- **Continue breastfeeding:** Continue breastfeeding for as long as possible, as it provides essential nutrients and antibodies.
- **Portion Control:** Offering small portions to feed, develops the mastication and solid food intake.

Source:73) https://www.sciencedirect.com/topics/nursing-and-health-professions/exclusive-breastfeeding
11) https://nin.res.in/dietaryguidelines/pdfjs/locale/DGI_2024.pdf page 24
11) https://nin.res.in/dietaryguidelines/pdfjs/locale/DGI_2024.pdf page 26

Infancy (Complementary feeding)

Breast milk (mother's milk) alone or exclusive breastfeeding is not adequate for the growth and development of a baby post 6 months of age. Hence, breastmilk should be complemented with feeding semisolid foods to breastfed infants from 6 to 12 months.

Why and when?	What to include?	How to introduce?	**Suggested options (6-8months) - Examples**	**Suggested options (9-12 months) - Examples**
To meet higher nutrient requirements as volume and nutrient concentration of breastmilk reduces after 6 months of birth, prevent growth faltering and ensure protein & micronutrients are adequate.	Cereals, oil seeds, nuts, milk, vegetables and fruits + Protein sources like eggs, lentils, chickpea, kidney beans, cowpea, black gram	Start with thin but not watery porridge for 4-5 days, increase to slurry **consistency** gradually. Maintain **minimum dietary diversity** (5 – cereals/millets; pulses/egg/meat; nuts & oilseeds; breastmilk/milk/milk products/vegetables, GLVs/fruits) and **minimum meal frequency** – 2-3 time for breastfed children and >4times for the rest, in addition to milk.	Rice+Red gram Dal+Spinach+Oil/Ghee Steamed & mashed apple Wheat+Chana/Egg+Bottle gourd+Oil/Ghee	Rice+Red gram Dal+Spinach+Groundnut+ Oil/Ghee Cereals/Millets+Dal+ Groundnut+ Fruits Wheat+Chana/Chicken+Bottlegourd+Oil/Ghee+ Fruits

11) https://nin.res.in/dietaryguidelines/pdfjs/locale/DGI_2024.pdf page 26

Infancy (Birth to 1 Year)

Key micronutrients to focus on for 1-year-old

- **Iron:** Essential for healthy blood and brain development (9% of iron bioavailability is recommended for 0.5-1year infants).
- **Calcium:** Crucial for building strong bones and teeth.
- **Vitamin D:** Helps the body absorb calcium and supports bone health.
- **Zinc:** Important for immune function, growth, and development.
- **Vitamin A:** Supports vision, immune function, and cell growth.

Recommended Dietary Allowances (RDA) of Nutrients For Infants, 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Infants 0-6m	5.8	8.0	1.4	-	300.0	30.0	-	-	100.0	0.2	0.4	2.0	0.1	25.0	1.2	20	350	400
Infants 6-12m	8.5	10.5	1.2	-	300.0	75.0	3.0	2.5	130.0	0.4	0.6	5.0	0.6	85.0	1.2	30	350	400

Source: 9) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Toddlerhood (1 to 3 Years)

Milestones:

- Motor skills: Running, jumping, climbing.
- Language development: First words, simple sentences.
- Cognitive development: Symbolic play, problem-solving.
- Social-emotional development: Parallel play, sharing, empathy.

Physiological Changes:

- Slower growth rate and maturation of brain and nervous system.

Energy requirement of Toddlerhood (1-3 years) for the given body weights

Category	Age Group	Body weight	Energy (kcal/d)	kcal/kg/day
Children	1-3y	12.9 kg	1110	83

Recommended Dietary Allowances (RDA) of nutrients for Indian children (1-3y), 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vit B6	Folate	Vit B12	Vit C	Vit A	Vit D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Children 1-3y	12.9	12.5	1.0	15.0	500.0	90.0	8.0	3.3	90.0	0.7	1.1	7.0	0.9	120.0	1.2	30	390	600

Source: 9) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Early Childhood (4 to 6 Years)

Milestones:

- Motor skills: Increased coordination, balance, and fine motor skills.
- Language development: Complex sentences, storytelling.
- Cognitive development: Theory of mind, imagination.
- Social-emotional development: Cooperative play, friendships.

Physiological Changes:

- Steady growth.
- Development of motor skills and coordination.

Recommended Dietary Allowances (RDA) of Nutrients For Children, 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Children 4-6y	18.3	16.0	0.9	20.0	550.0	125.0	11.0	4.5	90.0	0.9	1.3	9.0	1.2	135.0	2.2	35	510	600

Source: 9) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Childhood Nutrition(7 to 9 Years)

Milestones:

- Motor skills: Refinement of both gross and fine motor skills occurs, leading to improved coordination and dexterity.
- Language development: Reading and writing skills become more sophisticated.
- Cognitive development: Attention span improves, concept of time begins to take root.
- Social-emotional development: Improved friendship, independence, body image/awareness.

Physiological Changes:

- Loss of milk teeth and development of permanent teeth begin.

Energy requirement of early childhood for the given body weights

Category	Age Group	Body weight	Energy (Kcal/d)*	Kcal/kg/day
Children	7-9	25.3 kg	1700	67

*rounded off to the nearest 10kcal/d

Recommended Dietary Allowances (RDA) of Nutrients For Children, 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Children 7-9y	25.3	23.0	0.9	26.0	650.0	175.0	15.0	5.9	90.0	1.1	1.6	11.0	1.5	170.0	2.2	45	630	600

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Late Childhood(10 to 12 Years)

Milestones:

- Motor skills: Improved coordination, strength, and endurance.
- Cognitive development: Logical thinking, problem-solving.
- Social-emotional development: Peer relationships, self-esteem.

Physiological Changes:

- Steady growth.
- Puberty begins in late childhood.

Recommended Dietary Allowances (RDA) of Nutrients For Children, 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Boys 10-12y	34.9	32.0	0.9	33.0	850.0	240.0	16.0	8.5	100.0	1.5	2.1	15.0	2.0	220.0	2.2	55	770	600
Girls 10-12y	36.4	33.0	0.9	30.0	850.0	250.0	28.0	8.5	100.0	1.4	1.9	14.0	1.9	225.0	2.2	50	790	600

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Adolescence (12 to 18 Years)

Milestones:

- Physical maturation: Puberty, and sexual maturation.
- Cognitive development: Abstract thinking, and decision-making.
- Social-emotional development: Identity formation, and independence.

Physiological Changes:

- Hormonal changes.
- Rapid physical growth spurt.

Recommended Dietary Allowances (RDA) of Nutrients For Children, 2024

Category/ Age group	Body weight	Protein		Dietary fiber	Calcium	Magnesium	Iron	Zinc	Iodine	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate	Vitamin B12	Vitamin C	Vitamin A	Vitamin D
	(kg)	(g/d)	(g/kg/d)	(g/d)	(mg/ d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Boys 13-15y	50.5	45.0	0.9	43.0	1000.0	345.0	22.0	14.3	140.0	1.9	2.7	19.0	2.6	285.0	2.2	70	930	600
Girls 13-15y	49.6	43.0	0.9	36.0	1000.0	340.0	30.0	12.8	140.0	1.6	2.2	16.0	2.2	245.0	2.2	65	890	600
Boys 16-18y	64.4	55.0	0.9	50.0	1050.0	440.0	26.0	17.6	140.0	2.2	3.1	22.0	3.0	340.0	2.2	85	1000	600
Girls 16-18y	55.7	46.0	0.8	38.0	1050.0	380.0	32.0	14.2	140.0	1.7	2.3	17.0	2.3	270.0	2.2	70	860	600

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html page 36

Early Adulthood (>18 to 30 Years)

Milestones:

- Career development.
- Family planning.

Physiological Changes:

- Peak physical performance.
- Gradual decline in some physiological functions.
- Immunity alterations based on lifestyle and exposures.

Micronutrient adequacy is critical for immunocompetence in young adults.

Key nutrients include:

- **Vitamins A, C, D, E, B2, B6, B12**, folic acid
- **Iron, selenium, zinc**

- **Suboptimal intake** of these nutrients is common even in industrialized nations due to li and dietary habits.
- **Adequate nutrition** helps reduce infection risk and prevents the onset of chronic health issues.
- **Bidirectional relationship**: Poor nutrition impairs immunity, and infections further deplete nutritional status.

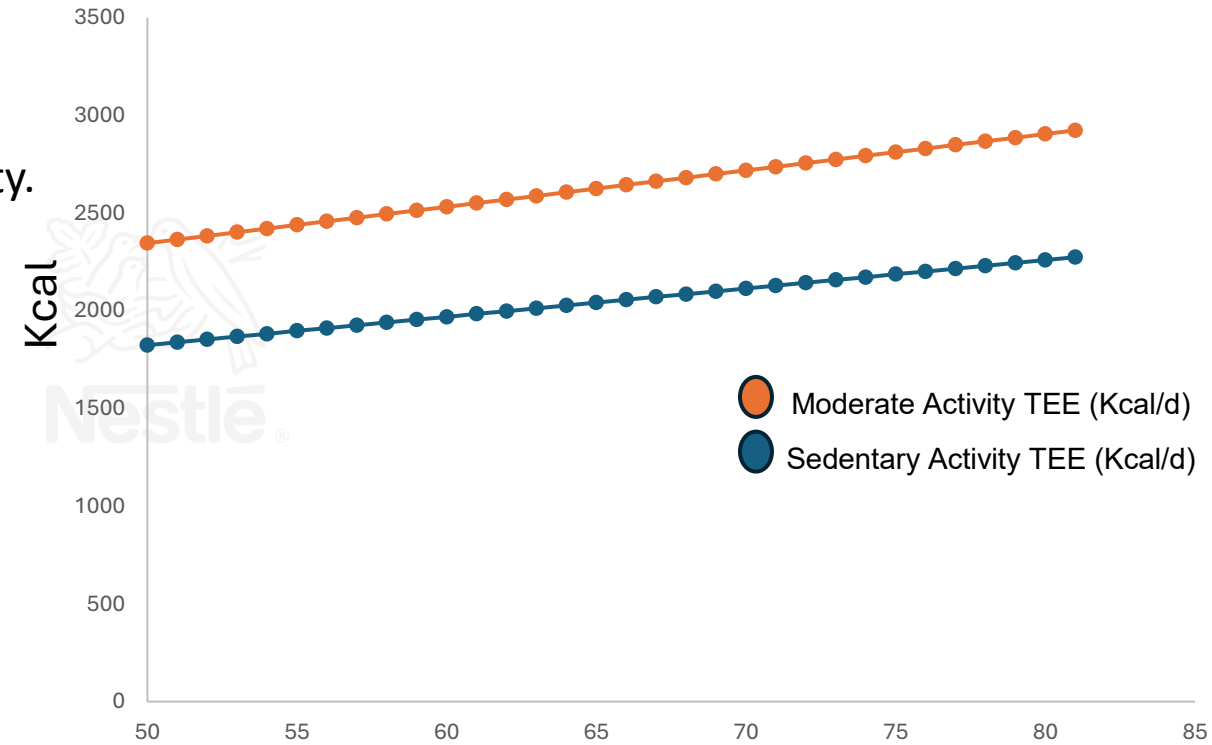
Source: 74) https://www.mdpi.com/2072-6643/10/10/1531

Adulthood (>30 to 60 Years)

Physiological Changes:

- Menopause in women.
- Andropause in men.
- Decline in muscle mass and bone density.
- Sensory changes.

Estimated energy requirement for Indian men to (to maintain normal BMI) as per body weight and age.



Optimum nutrition is necessary to support the rapid physiological changes

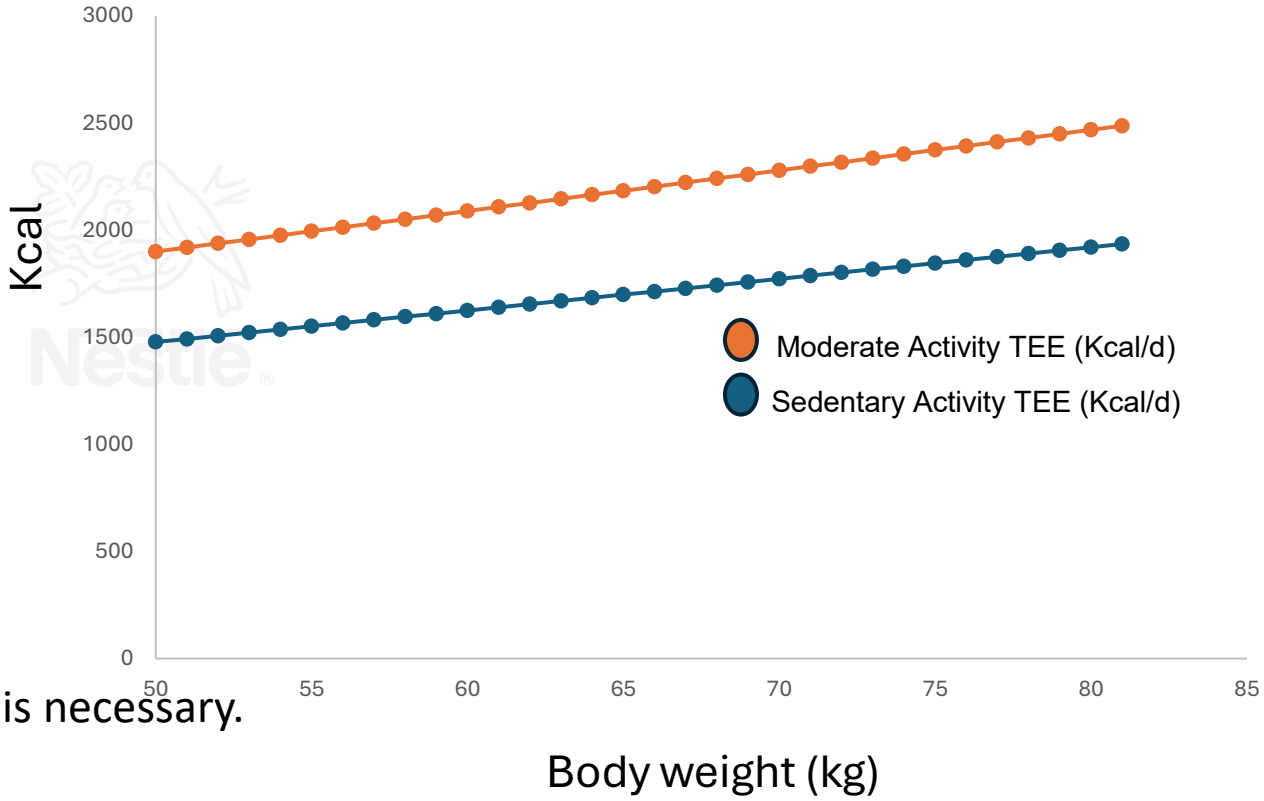
Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html page 7

Late Adulthood (>60 Years)

Physiological Changes:

- Decreased muscle mass and strength.
- Reduced bone density.
- Sensory decline
- Slower cognitive processing speed
- Increased risk of chronic diseases.

Estimated energy requirement for Indian men to (to maintain normal BMI) as per body weight and age



Health maintenance with nutrition support is necessary.

Source: 8) https://www.nin.res.in/RDA_short_Report_2024.html page 7

Impact of nutrition on immunity

Impact of Nutrition on Immunity Across the Lifespan

Nutrition plays a crucial role in supporting a robust immune system throughout our lives.

How dietary choices can influence immunity at different life stages:

Infancy and Childhood

- **Breastfeeding**
  - Breast milk is the ideal first food.
  - Providing optimal nutrients and antibodies to bolster a newborn's immune system.
- **Essential Nutrients**
  - A balanced diet rich in vitamins (especially A, C, D, and E), minerals (zinc, iron, and selenium), and protein is vital for immune development.
- **Healthy Gut Microbiome**
  - Probiotics and prebiotics found in fermented foods and fiber-rich vegetables promote a diverse gut microbiome, which is essential for immune function.

Suggested read: https://pmc.ncbi.nlm.nih.gov/articles/PMC9772031/

Impact of nutrition on immunity

Adolescence

- **Nutrient-Dense Foods**
  - Continued focus on a balanced diet with plenty of fruits, vegetables, whole grains, lean protein, and healthy fats.
- **Hydration**
  - Adequate water intake supports overall health and immune function.
- **Limiting Processed Foods and Sugary Drinks**
  - These can negatively impact immune health.

Adulthood

- **Balanced Diet:** A varied diet with plenty of fruits, vegetables, whole grains, lean protein, and healthy fats.
- **Hydration:** Staying hydrated is crucial for optimal immune function.
- **Moderate Alcohol Consumption:** Excessive alcohol intake can weaken the immune system.
- **Stress Management:** Chronic stress can suppress immunity. Stress-reduction techniques like yoga, meditation, and sufficient sleep can help.

Source: 77) https://pmc.ncbi.nlm.nih.gov/articles/PMC9772031/

Impact of nutrition on immunity

Adults

- **Nutrient-Dense Foods:** As nutrient needs change with age, focus on nutrient-rich foods to support immune function.
- **Protein Intake:** Adequate protein intake is essential for maintaining muscle mass and immune function.
- **Hydration:** Staying hydrated is crucial for older adults, especially as their sense of thirst may diminish.
- **Social Connection:** Social isolation can negatively impact immune function. Maintaining social connections is important for overall well-being.[75]

Source: 75) https://www.mdpi.com/2072-6643/16/1/1

Impact of nutrition on immunity

Specific nutrients and their impact on immunity

- **Vitamin C:** Helps white blood cells fight infections and protects cells from damage.
- **Vitamin D:** Keeps your immune system balanced and reduces harmful inflammation.
- **Zinc:** Helps build immune cells and heal wounds faster.
- **Selenium:** Protects your body from stress and helps fight viruses.
- **Omega-3 Fatty Acids:** Reduce inflammation and help immune cells work better.
- **Vitamin B6:** Supports the production of antibodies and helps immune cells communicate.
- **Vitamin B12:** Helps make new immune cells and keeps your energy levels up.
- **Vitamin A:** Keeps your skin and gut healthy — your first line of defense against germs.
- **Iron:** Helps immune cells grow and carry oxygen to fight infections.
- **Copper:** Supports enzymes that kill germs and helps maintain immune balance.[76]

Source:76) https://pmc.ncbi.nlm.nih.gov/articles/PMC9772031/

Importance of a balanced diet during different life stages

Maintaining a balanced diet is essential for achieving optimal nutrition and overall well-being. [77]

Life Stage	Why Nutrition Matters	Key Focus Areas
Infants (0–6 months)	Supports growth and development	Exclusive breastfeeding
Early childhood (6 months–2 years)	Builds immunity, brain, and body	Breast milk + nutrient-rich complementary foods
Children (2–6 years)	Supports steady growth and cognitive development	protein, calcium, iron, vitamins
Adolescents (10–19 years)	Fuels growth spurt and bone development	Iron, calcium, protein
Reproductive Age Adults	Meets extra nutritional needs for childbearing/rearing	Iron, folate, calcium, balanced macronutrients
Adults	Maintains health, productivity, and prevents diseases	Balanced diet for metabolism and muscle maintenance
Elders	Supports physical activity and healthy aging	Nutrient-dense foods to offset reduced absorption

Source: 77) https://pubmed.ncbi.nlm.nih.gov/33515033/

Concept of functional foods

The term functional foods is used to describe foods or food ingredients that provide health benefits beyond meeting basic nutrition needs due to their physiologically active food components (i.e. bioactive compounds or bioactive food components).[78]

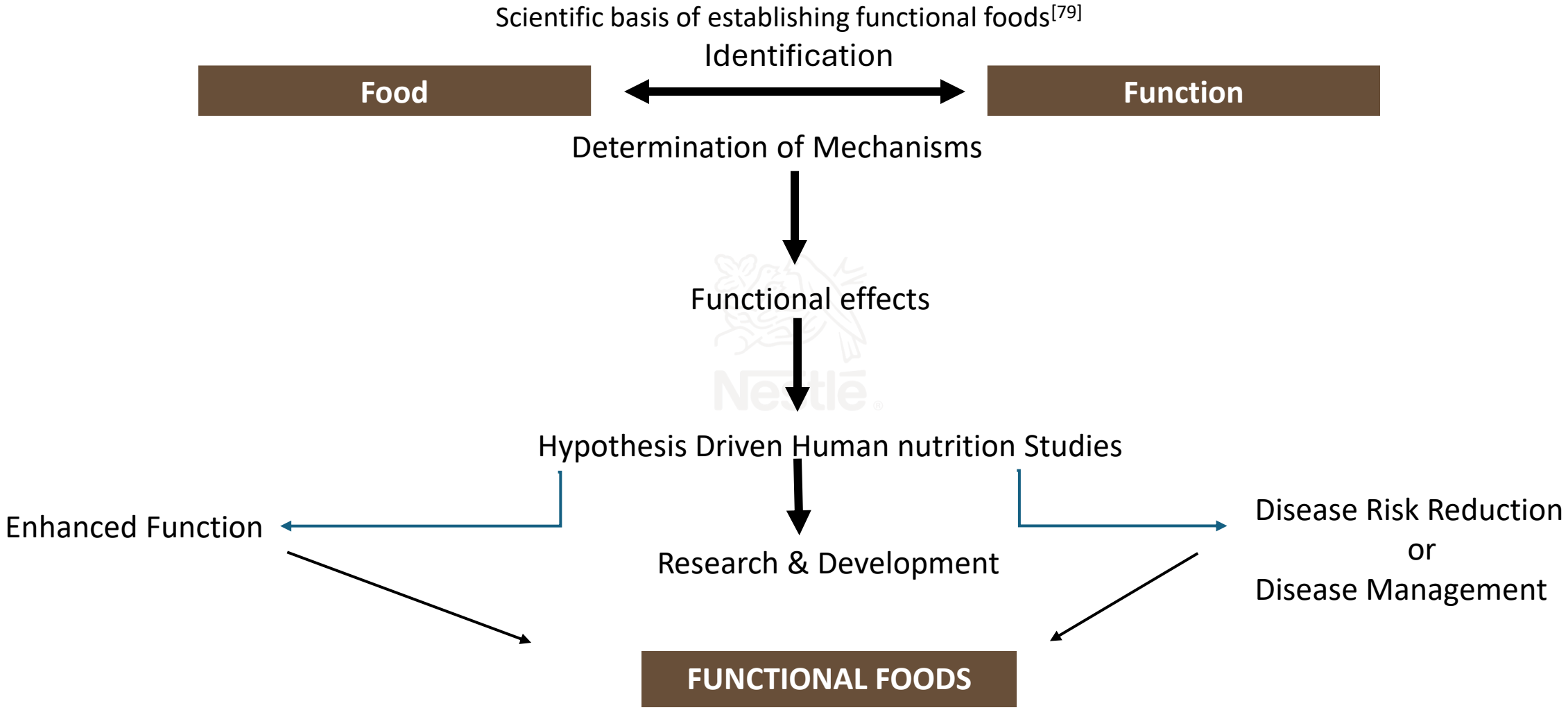
Categories of functional foods

Categories	Definition	Examples
Conventional Foods	Unmodified foods.	Whole fruits, vegetables, grains, nuts, seeds, legumes, dairy, fish, and meats.
Modified Foods	Foods that have been modified through enrichment, fortification, or agricultural, enzymatic, chemical, or technological means.	Calcium fortified orange juice Omega-3 fatty acid fortified products Fermented foods.
Food Ingredients	Isolated or synthesized food ingredients.	Indigestible carbohydrates (e.g. oligosaccharides and resistant starch) that provide prebiotic effects.

To be continued…

Source: 78) https://www.sciencedirect.com/science/article/abs/pii/B9781845695927500018

Concept of functional foods



Source: 79) https://extension.colostate.edu/resource/functional-foods-for-health/

Conclusion

- Nutritional requirements vary by life stage, caused due to
  - Physiological changes
  - Cognitive development
  - Activity levels

- Dietary components also vary by life stage due to changes in digestion/absorption capabilities of the body.

- Functional foods are tailored to provide specific nutritional benefits for each life stage.

Suggested read: 11) https://www.nin.res.in/dietaryguidelines/pdfjs/locale/DGI07052024P.pdf
https://pmc.ncbi.nlm.nih.gov/articles/PMC9772031/
Functional food and food supplements, Raffaella Boggia et al, Appl. Sci. 2020, 10, 8538

Upcoming…

Module 6

Understanding and managing dietary restrictions