



Smart Choices for Glycemic Health: From Metabolic Links to Evidence Based Dietary & Lifestyle Strategies

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Why is DM a serious issue??

Approximately 366 million people worldwide have been diagnosed with Type-2 Diabetes¹

- **Persons with T2DM in India**^{1,2}
- **32.7 million in 2000**
- **61.3 million in 2011**
- **89.8 million in 2024**
- **156.7 million in 2050**

Close association with other CDDs

1. <https://pubmed.ncbi.nlm.nih.gov/24878973/>

2. <https://diabetesatlas.org/data-by-location/country/india/>



What causes DM^{1,2}



1. <https://doi.org/10.1016/j.freeradbiomed.2022.03.019>
2. <https://doi.org/10.1016/j.mrgentox.2021.503437..>



Genetic predisposition,



Chronic inflammation,



Metabolic disturbances,



Oxidative stress,

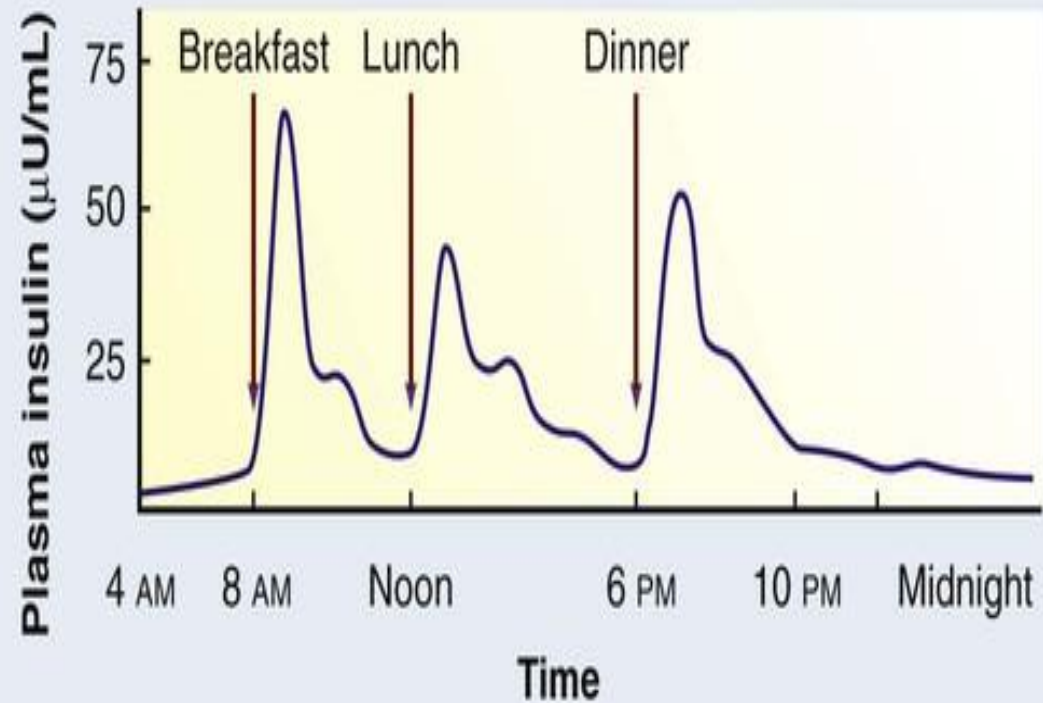


Altered gut microbiota,

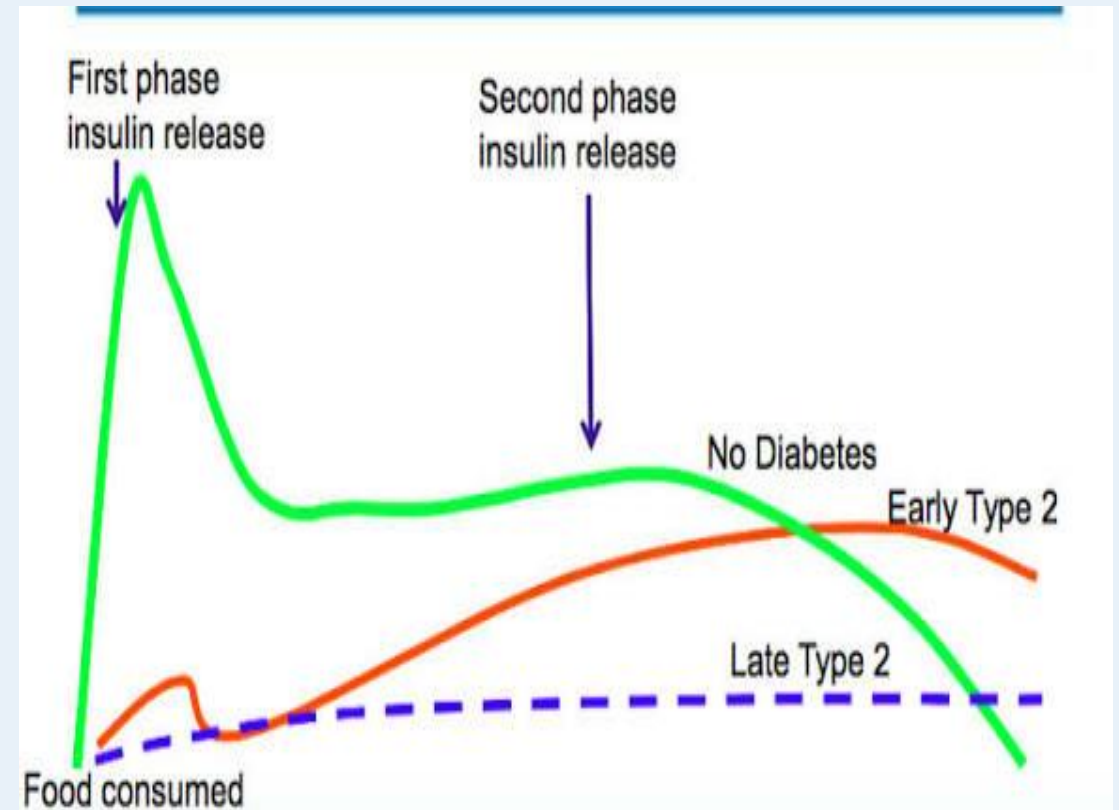


Ectopic fat deposition

The trajectory of Insulin production

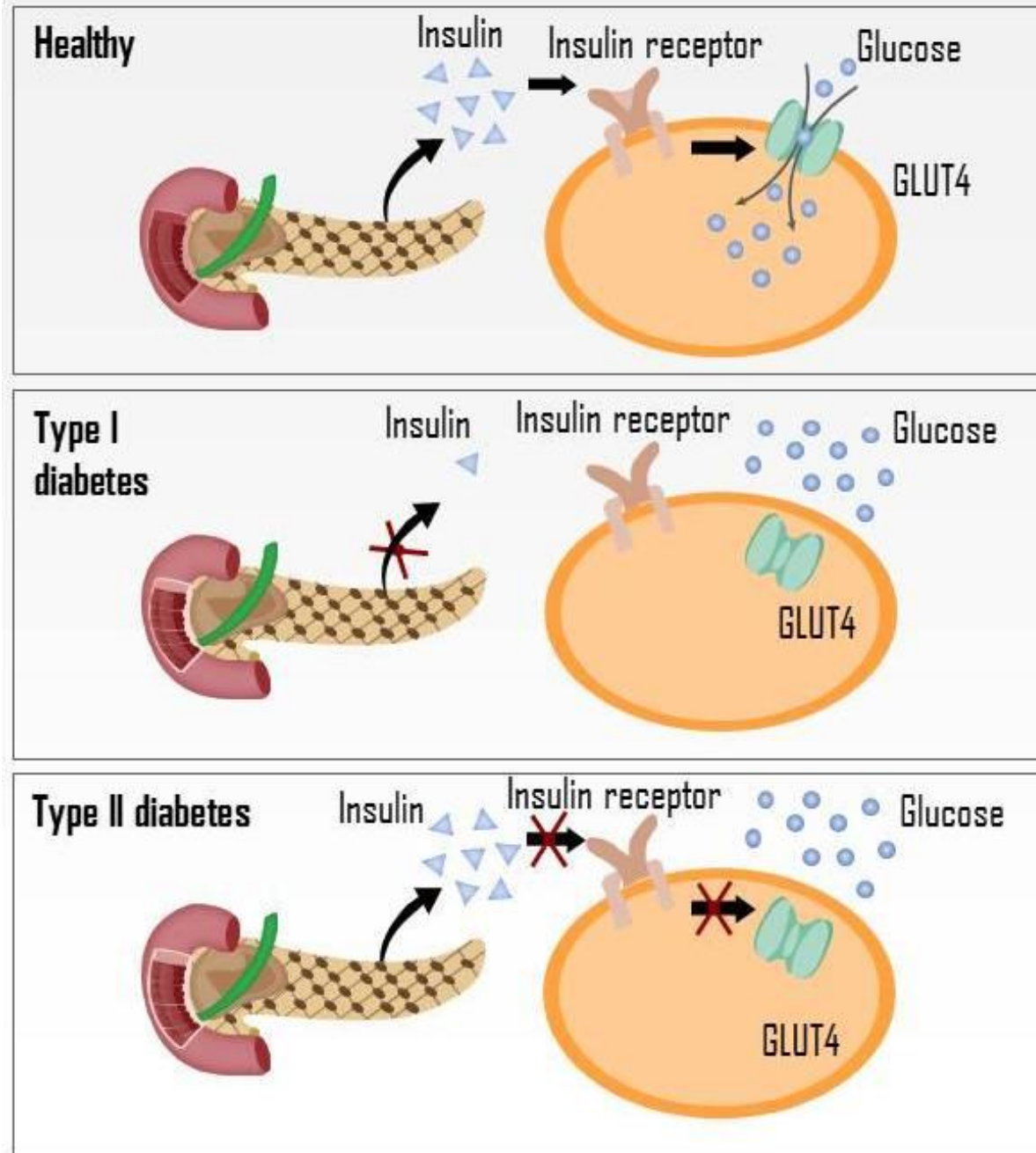


Phases of Insulin production in healthy individual



Phases of Insulin release in healthy individuals & in persons with T2DM

**Insulin,
Glucose &
Cells:
A Dynamic
Metabolic Link**



Diagnostic criteria for Hyperglycemia & Diabetes

Healthy Individuals: FBG-<99mg/Dl:: PPBG-<140 mg/dL²

Hyperglycemia¹

- **Fasting: ≥ 125 mg/dL**
- **Post Prandial: 180 to 200 mg/dL**

Prediabetes²

- **Fasting BG-100 to 125 mg/dL**
- **Post Prandial BG-140 to 199 mg/dL**

Diabetes ¹:

- **Fasting BG ≥ 126 mg/dL and/or 2-h**
- **Post Prandial BG ≥ 200 mg/dL using 75-g OGTT**
- **HbA1c $\geq 6.5\%$ ** or**
- **Random plasma glucose ≥ 200 mg/dL in the presence of classical diabetes symptoms**

1. Chawla R, Madhu SV, Makkar BM (2020)
2. <https://www.ncbi.nlm.nih.gov/books/NBK430900/>

The effective strategies should...

Increase insulin production

- Support appropriate insulintropic responses

Adjust to available insulin

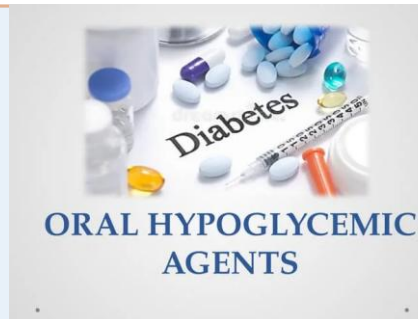
- Match dietary and lifestyle strategies to insulin availability

Delay carbohydrate digestion & absorption

- Moderate the rate and magnitude of glucose entry

Improve insulin sensitivity

- Enhance peripheral glucose utilization



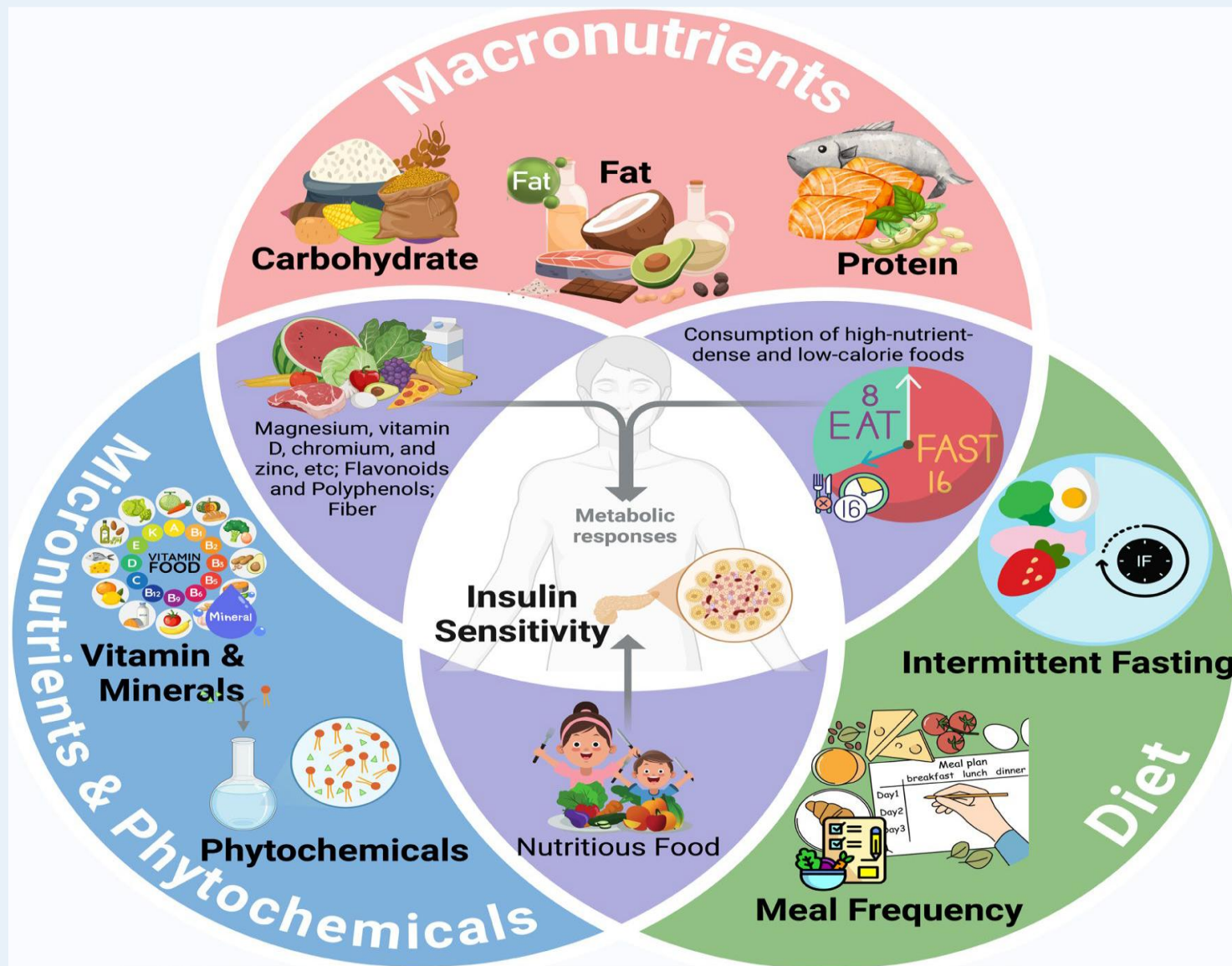


Fig-1: Interdependence Between metabolism, Diet & Insulin Sensitivity

<https://doi.org/10.1007/s44187-025-00422-6>

Dietary carbohydrate^{1,2,3}

Simple carbohydrates

- **Glucose:** Primary physiological stimulus to insulin.
- **Fructose:**
 - Added fructose in processed foods can inhibit GLP-1 & PYY and induce adverse metabolic effects.
 - Fructose in natural foods is a prebiotic.
 - **High sugar intake from sugary beverages and processed foods lead to IR¹**



Complex & fermentable carbohydrates²

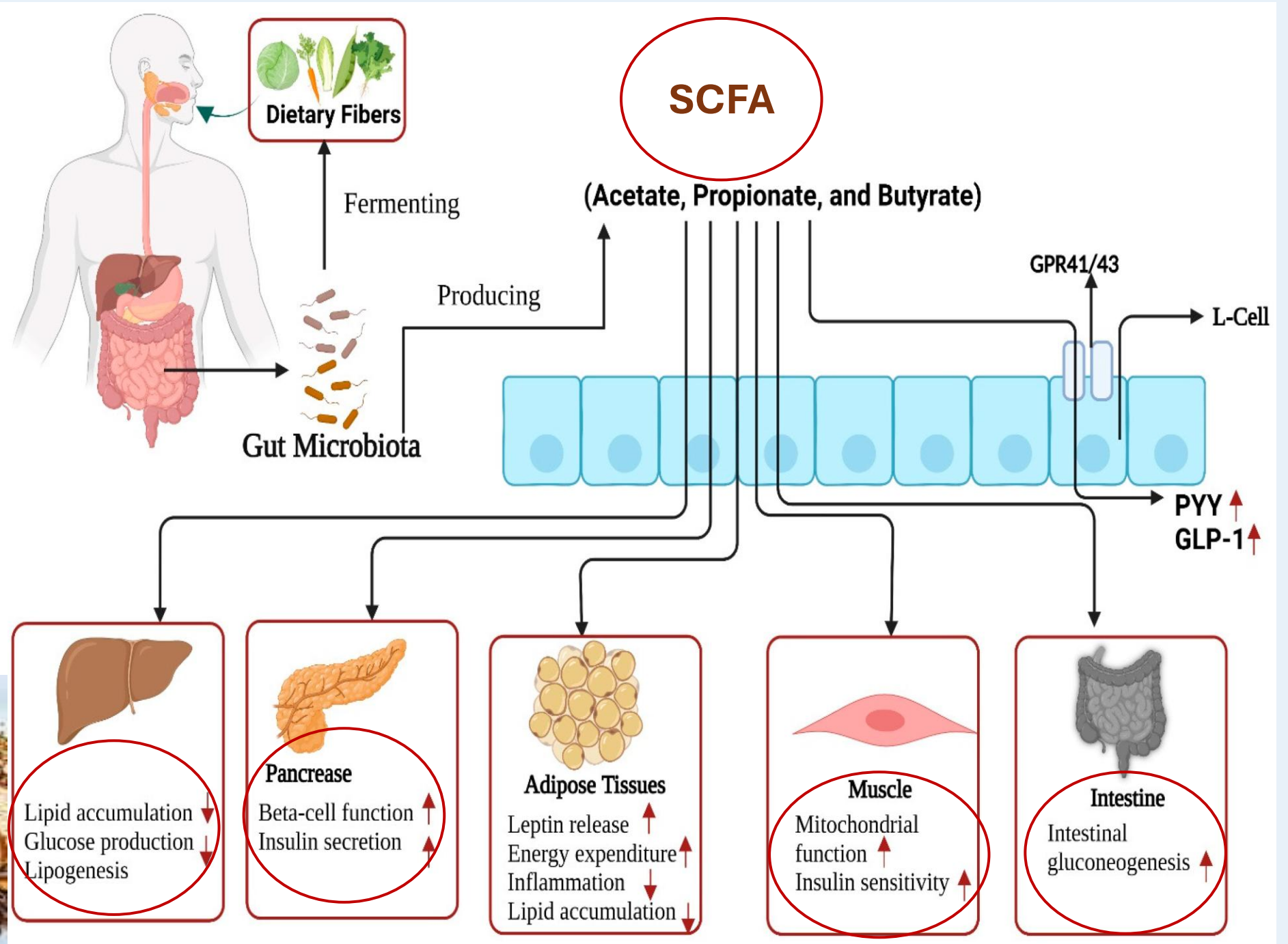
- Whole-grain, plant-based complex CHO are multi-beneficial
- **Fermentable CHOs stimulate gut-derived GLP-1 and PYY, supporting glucose homeostasis and appetite regulation.**

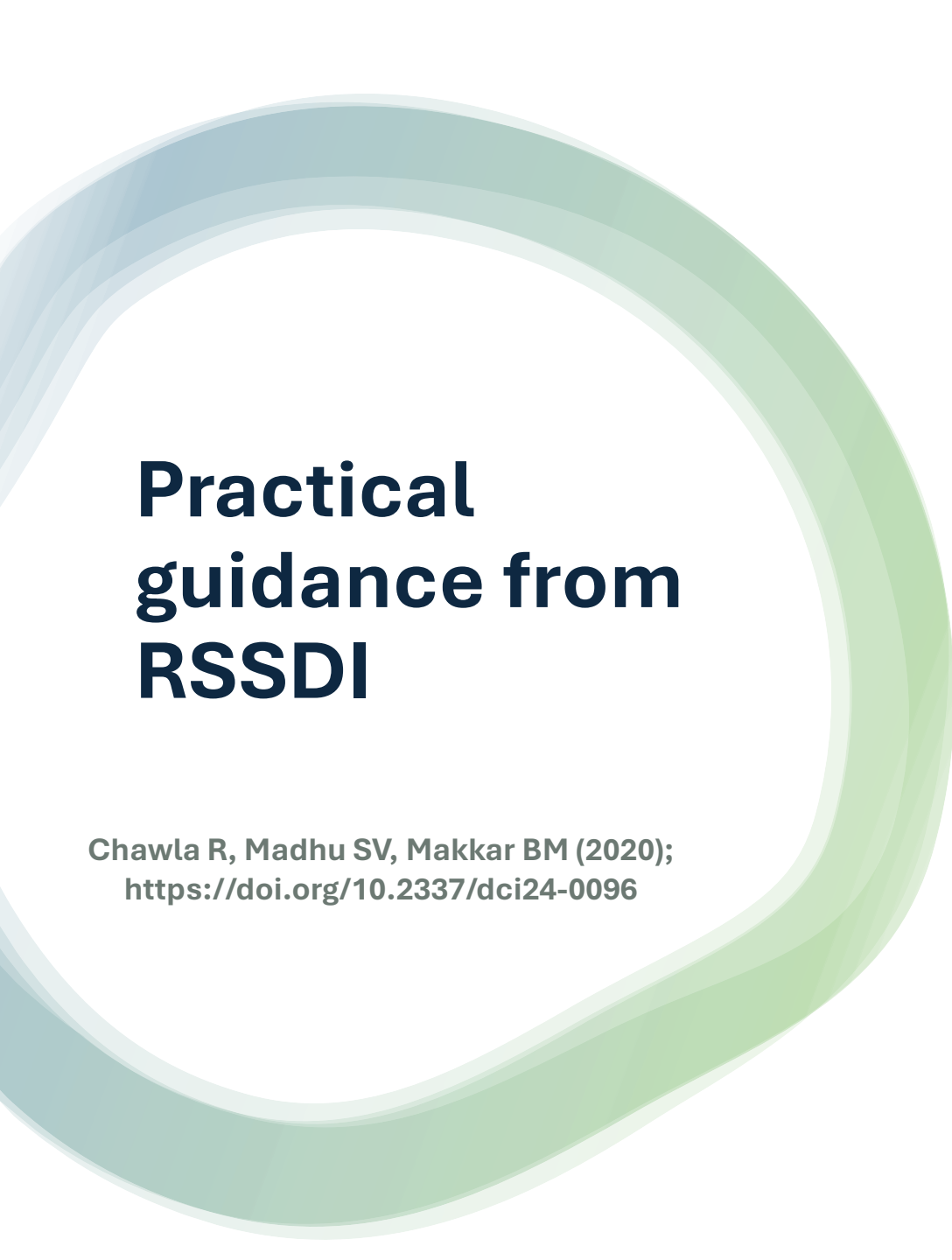


1. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3387883/>
2. <https://www.tandfonline.com/doi/full/10.1080/10911359.2020.1851843>)
3. <https://doi.org/10.1007/s44187-025-00422-6>

Dietary Fiber: A Multifaceted Role in Glycaemic Control¹

<https://www.mdpi.com/2304-8158/12/5/1023>





Practical guidance from RSSDI

Chawla R, Madhu SV, Makkar BM (2020);
<https://doi.org/10.2337/dci24-0096>

- Carbohydrates: 50–60% of total calorie intake
- Prefer complex carbohydrates over refined products
- Choose low-GI and low-GL foods
- MGI foods also influence glucose spikes
 - **Consider Portion size and frequency intake**
- Fibre: 25–40 g/day
 - **Both soluble & insoluble fibre can control glucose spikes, improve insulin sensitivity and help prevent inflammation**

Dietary protein & Postprandial blood glucose ^{1,2}

Requirements: 15% of total calorie intake & Quantity of protein intake depends on age, sarcopenia and renal dysfunction.

Benefits:

- **Slower digestion** than carbohydrates - prevents sharp post-meal blood sugar spikes.
- **Delayed stomach emptying** leading to a steady and gradual release of glucose into the bloodstream.
- **Improved insulin sensitivity and Stimulation of significant postprandial insulin response** (necessary for cellular amino acid uptake)
- **Increased satiety** reducing overeating and frequent snacking
- **Muscle maintenance** -supports muscle growth and maintenance which improves overall insulin sensitivity and glucose

Protein responses depend on Quality of Protein & Type of diabetes^{1,2}

T1DM

High protein intake (>28 g/meal) may be associated with sustained late postprandial hyperglycaemia (2–5+ h).

- **Mechanisms** - increased glucagon & cortisol production, and gluconeogenesis

T2DM

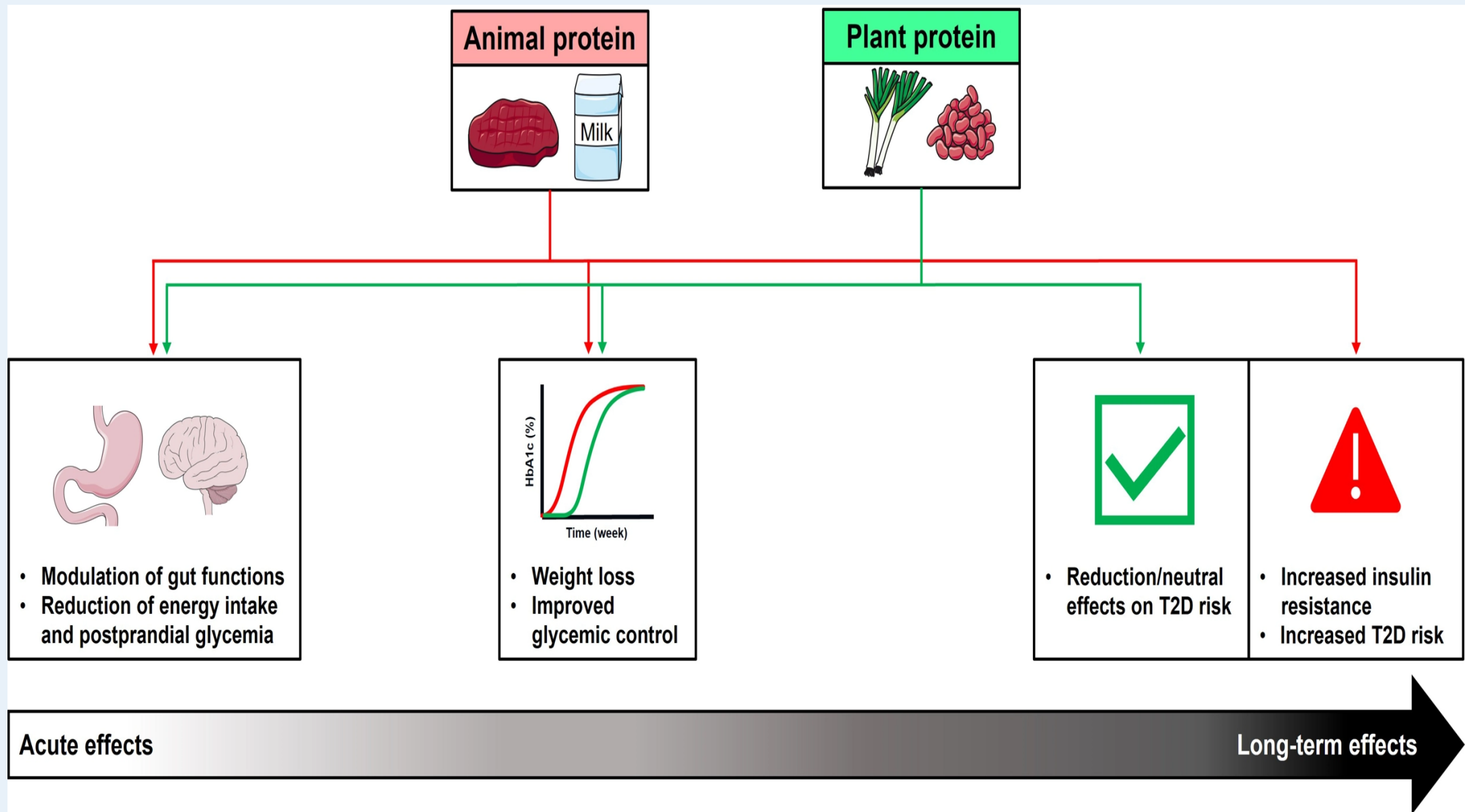
A mixture of wheat protein hydrolysate, free leucine, phenylalanine and carbohydrate can strongly elevate insulin concentrations.

Key points

- **18 of the 20 amino acids (90%) are gluconeogenic**
- **Beneficial AA: BCAA, Phe., Glu.,**
 - Leucine crosses BBB and control glucose metabolism in liver, kidney and muscle
- **Supplements with positive effect:**
 - Use diabetes-specific protein supplements
 - Whey protein,

1. [https://www.nmcd-journal.com/article/S0939-4753\(20\)30504-4/](https://www.nmcd-journal.com/article/S0939-4753(20)30504-4/),

2. <https://pubmed.ncbi.nlm.nih.gov/10871567/>,.



Protein strategies..

Eating order

- Eat Protein (such as chicken, fish, paneer, or lentils) first, before carbohydrates in a meal to minimize blood sugar surge.

Balanced meals

- Combine protein with fiber-rich complex carbohydrates to lower the overall glycemic impact of the meal.

Source selection

- Focus on healthy protein sources like fish, poultry, beans, lentils, nuts, seeds, and tofu while limiting high-fat animal products.
- Consider protein supplements if necessary
 - **Whey protein supplementation has a better effect than other animal or veg proteins²**

1. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4512569/>

2. <https://www.frontiersin.org/journals/endocrinology/articles/10.3389/fendo.2024.1412182/full>)

Dietary fat

Fat in a mixed diet provides sustained satiety and Delayed gastric emptying of CHO in the immediate & subsequent meals ^{1,2}

Regular high fat intake de-sensitises stomach for fat effect ^{3,4}

High fat diet leads to IR & increases insulin need ³

1. <https://pubmed.ncbi.nlm.nih.gov/24323910/>;
2. <https://pmc.ncbi.nlm.nih.gov/articles/>
3. <https://pubmed.ncbi.nlm.nih.gov/3545642/>;
4. <https://pubmed.ncbi.nlm.nih.gov/19126262/>



Dietary Fatty Acids & Glycemic control^{1,2}

Fatty acids & Cell membrane

- **Functions at cellular level:** maintain Fluidity & Permeability, activity of insulin receptors, glucose transporters, second messengers of glucose-stimulated insulin secretion (modulation of G protein-coupled receptor & peroxisome proliferator-activated receptors ¹

Elevated plasma FFA & high SFAs to PUFA ratio decrease Insulin sensitivity & induce pancreatic apoptosis

- MCFA, MUFA & PUFA are negatively associated with T2DM
- SCFA, SFA from processed foods-Positive association with T2DM

PUFA-facilitates Glycemic control

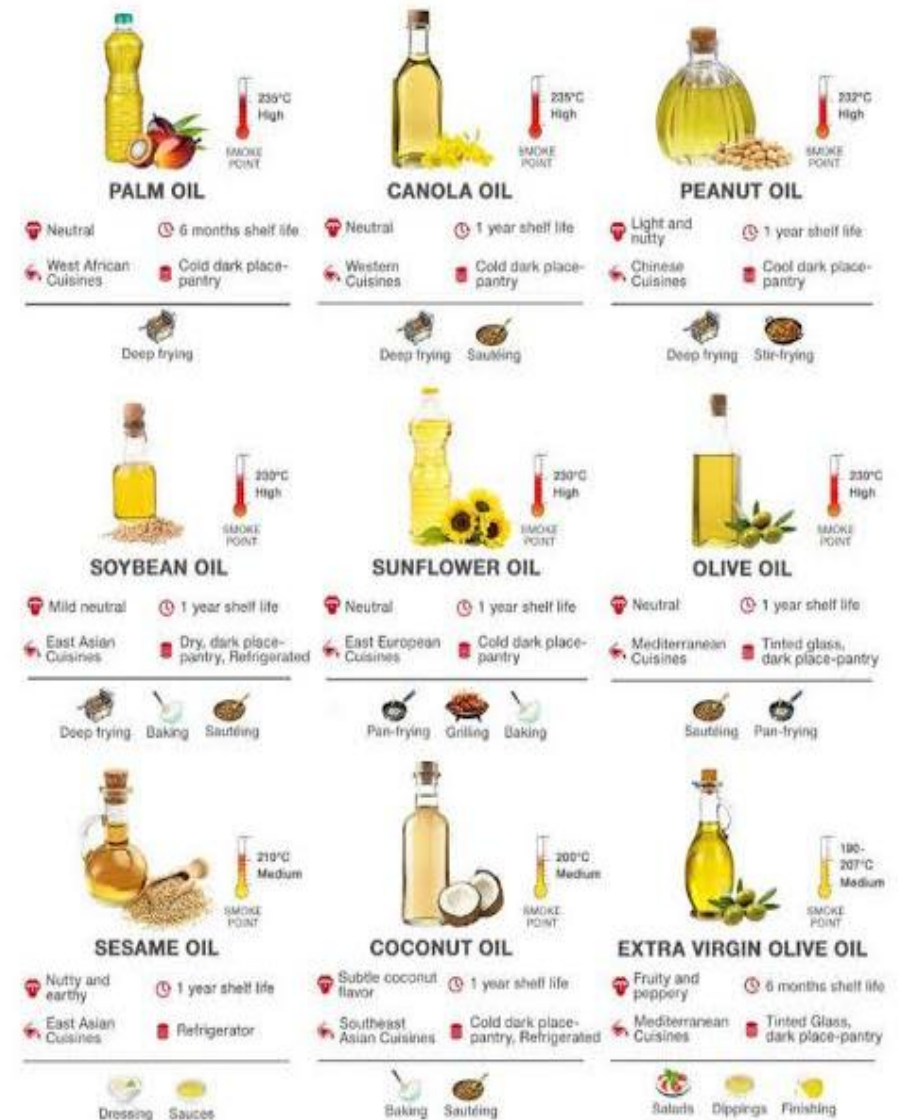
- improve cell membrane fluidity, GLUT4 translocation, insulin receptor binding and affinity, & insulin sensitivity

MUFA: enhances the function of β -cells, endothelial cells, and the hypothalamus & protect β cells from apoptosis

1. <https://pubmed.ncbi.nlm.nih.gov/27842617/>
2. <https://academic.oup.com/nutritionreviews/article/83/5/897/7895736>

The guidelines ¹..

- Fat intake should be limited to 25 to <30% of total calorie intake.
 - SFA-<10%TE
 - Omega-6 to Omega-3 Ratio =4:1 to 10:1
 - SFA:MUFA:PUFA Ratio: 1:1.5:2
 - Trans Fats: Zero to<1%
- Oils with high monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) should be used.
- Use of 2 or more vegetable oils is recommended in rotation.



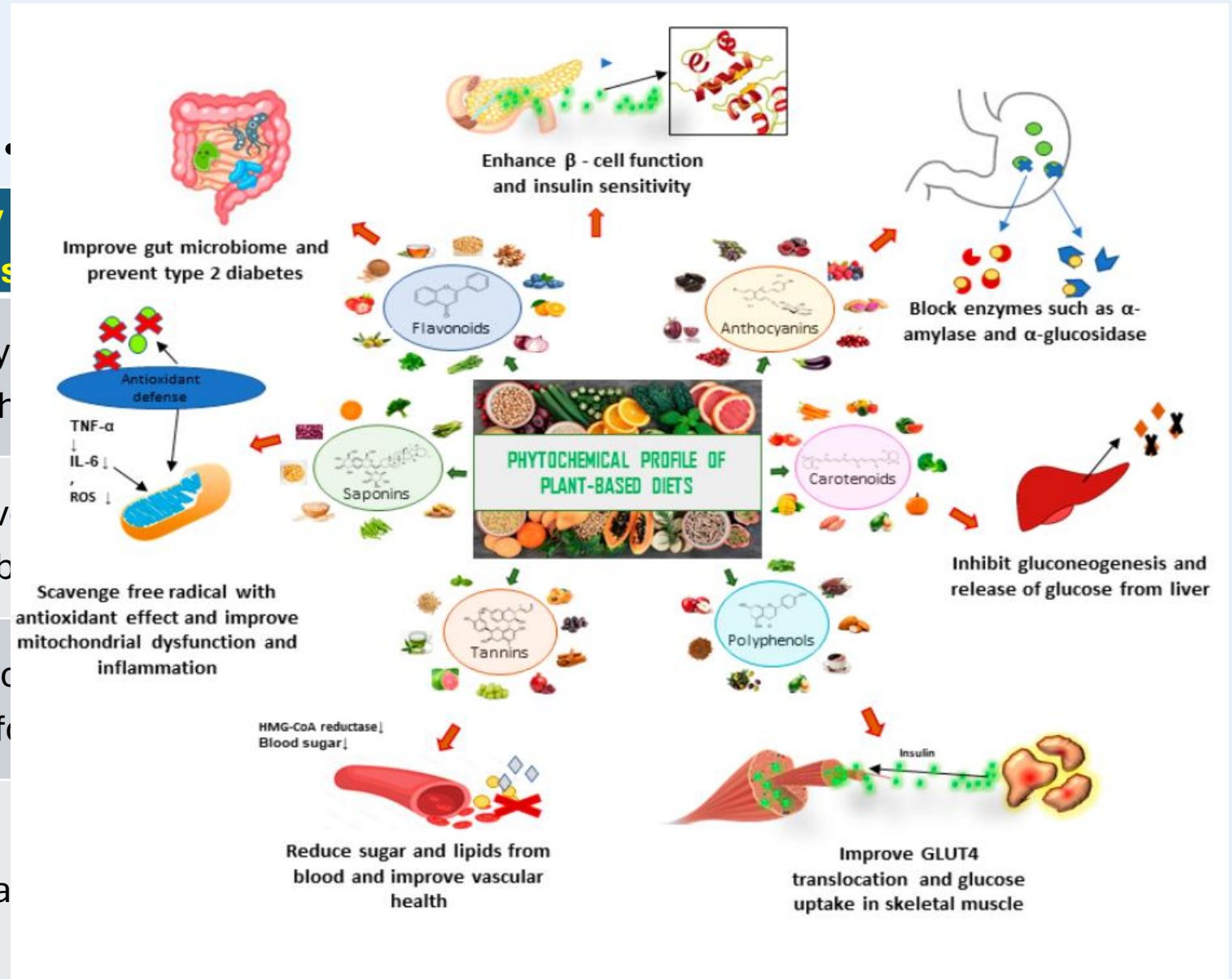
Micronutrients for glycemic control^{1,2,3}

Vitamins	Role	Minerals	Role
Vitamin D	• Anti-inflammatory • Pancreatic Beta cell development, maintenance & function. • Improve insulin sensitivity • Preventive role in Pre Diabetes	Zinc	• Improve insulin production • Control Insulin resistance • Improve glucose and lipid profiles
Vitamins E & C	• Antioxidants • Increase insulin sensitivity	Selenium	• Antioxidant Defense • Improve insulin sensitivity
Vitamin B6, Folate & B12	Prevent neurological problems	Chromium	• Promote Insulin Sensitization • Control IR

1. <https://www.sciencedirect.com/science/article/pii/S2666149723000555#sec5>
2. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7192664/>
3. <https://www.sciencedirect.com/science/article/pii/S104366182300244X>

Phytochemicals.

Mechanism	Key Class
Slowing Sugar Absorption	Polyphenols Anthocyanins
Enhancing Insulin Sensitivity	Flavonoids Stilbenes
Protecting Pancreatic β -cells	Carotenoids Sulfonamides
Reducing Hepatic Glucose Production	Alkaloids



Maintain Plant food diversity in the diet

Hypoglycemic foods



Garlic

↑ Lipid metabolism
↓ Oxidative stress



Bitter melon
(*Momordica charantia*)

↑ Insulin sensitivity
↓ Blood glucose level



Cinnamon
(*Cinnamomum verum*)
Supports glucose metabolism



Neem

Mitigating diabetes related complications

- Cardiovascular
- Renal damage



Gymnema sylvestre

↓ Sugar absorption in intestine.



Fenugreek seeds
Stimulates insulin secretion and improves glucose metabolism,

**DIABETES
MANAGEMENT**

PA/Exercise Guidelines

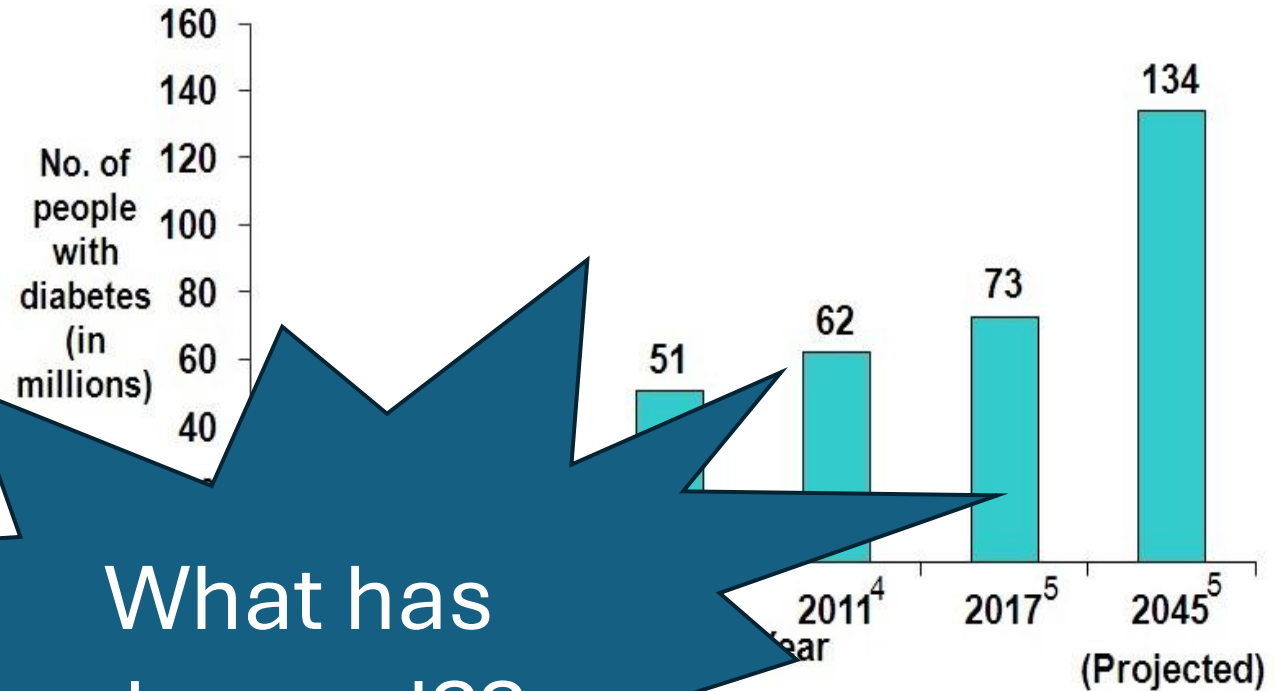
- Slow introduction of exercise based on the patient's willingness and ability
- Personalised exercise strategies
- A minimum of 150 min/week of physical activity for prevention of T2DM
 - ≥ 30 min of moderate-intensity aerobic activity each day
 - 15-30 min of work-related activity
 - 15 min of muscle-strengthening exercises (at least 3 times/week)
- yogic practices should not replace aerobic exercise.
- Monitor/measure the intensity and duration of physical activity using monitoring tools (accelerometers, GPS units, pedometers, mobile based apps).



Some interesting facts^{1,2} ..

- **Early 1970s ICMR Studies...**

- Urban diabetes prevalence was roughly **2% to 3%**,
- Rural prevalence was about **1% to 1.3%**



What has changed??

1. <https://idf.org/our-network/regions-and-members/south-east-asia/members/india/>

2. <https://www.indiascienceandtechnology.gov.in/featured-science/exploring-diabetes-epidemic-india>

The Deliciously Nutritious Traditional Indian Diets



South Indian diet



Maharashtrian diet



Indian Gujarati diet



**Leaf-Steamed
foods**



The Indian fermented foods

Our tradition of eating together!!



What are salient features of our traditional diets??

Home cooked gut friendly balanced meals

Dietary diversity

Low GI diets

Nutrient, fiber and phytochemical rich

High GI Foods

Natural prebiotics and probiotics

low salt, & Low fat

Functional beverages
(BM, Rasam, Fermented rice Kanji, Coconut water etc.,)

Home processing-techniques

Steaming, sprouting, malting, and fermentation enhanced nutrient content & Probiotic potential and reduced antinutrients.

No or Minimum mechanisation & Higher level of PA

Good interpersonal and social health

What was missing in our traditional diets??



Ultra Processed HFSS foods



Sugar rich & aerated beverages



Pesticides

Does our tradition offer healthy dietary & lifestyle practices for persons with DM?

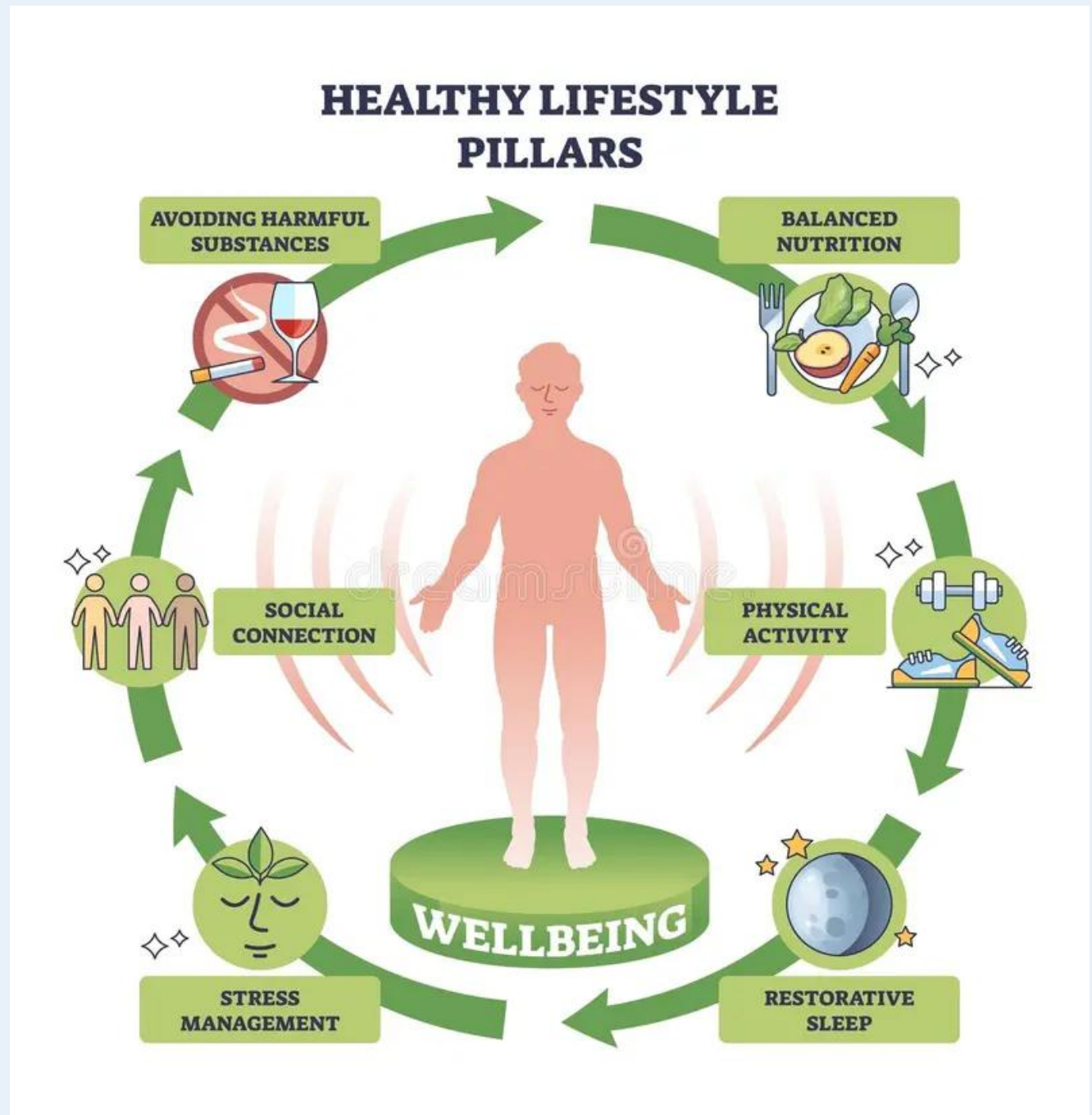


Indisciplined eating

Eating at irregular timings
Screen use while eating
Eating alone

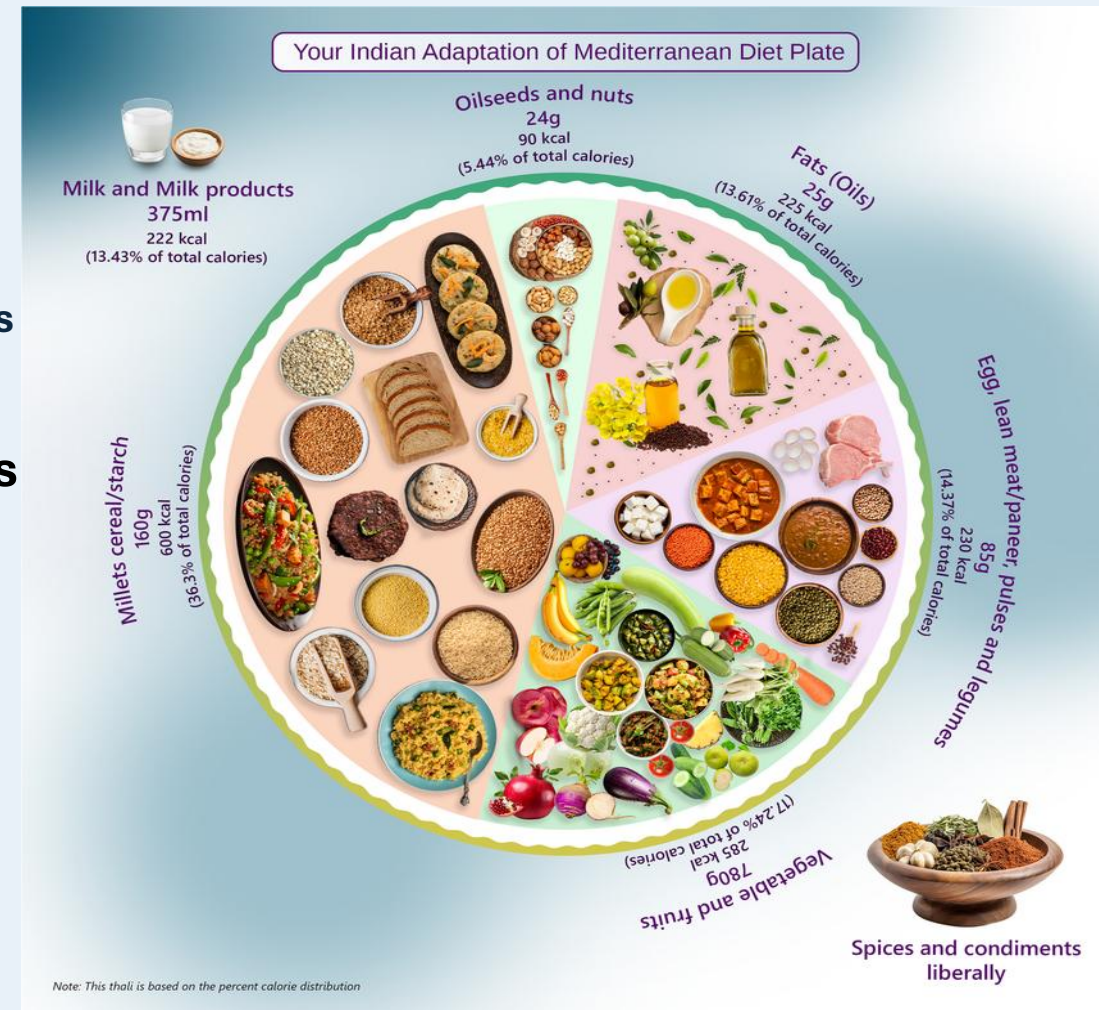
‘Healthy Lifestyle matters the most’

Consider all the pillars of lifestyle!!



Overall guidelines for better Glycemic Health!

- **Suggest a Mediterranean diet**
 - High fiber, Low carbohydrate, high protein, low fat, low sodium plant based diets
 - Whole grains (Brown rice, whole wheat, Rolled oats etc.), Nuts, legumes, unprocessed seasonal fruits and vegetables and low-fat dairy.
- **Be cautious while planning of special/Extreme diets for T2DM patients**
 - Restrict for a short period.
 - low-carbohydrate ketogenic diets
- **Consider Potential for personalized nutritional therapies.**
- **Integrate metabolic understanding with practical dietary strategies.**



Integrate the Best of Tradition and Modern Science for Better Glycaemic Control !!

Embrace traditional dietary and lifestyle wisdom, enriched by modern evidence-based approaches, to create personalised, practical and sustainable strategies for effective diabetes management.



**THANK
YOU**