

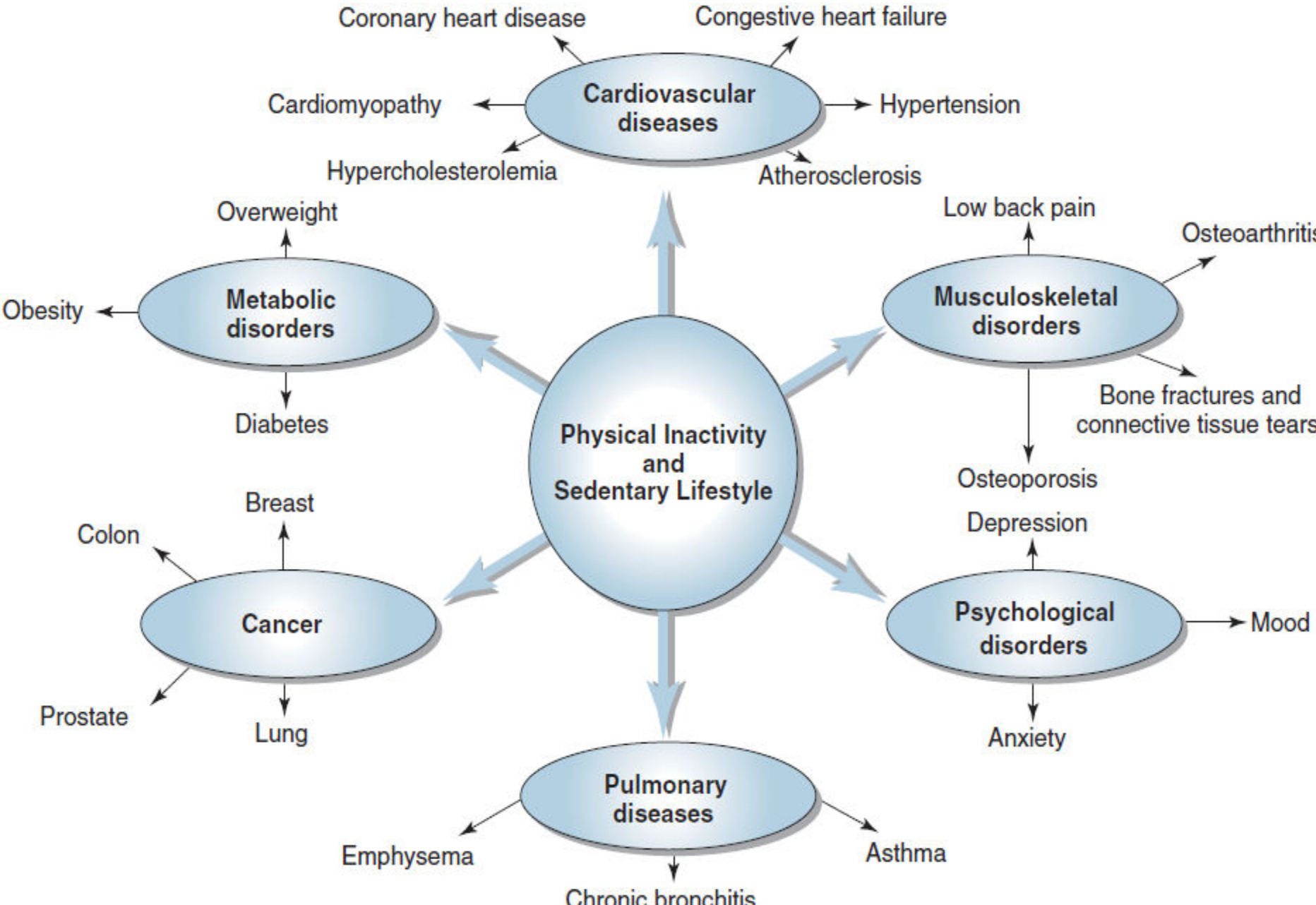
DIABETES MELLITUS

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Diabetes

- **Diabetes mellitus is a group of metabolic diseases characterized by an elevated fasting blood glucose level (i.e., hyperglycemia) as a result of either defects in insulin secretion or an inability to use insulin.**

Diabetes

The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.

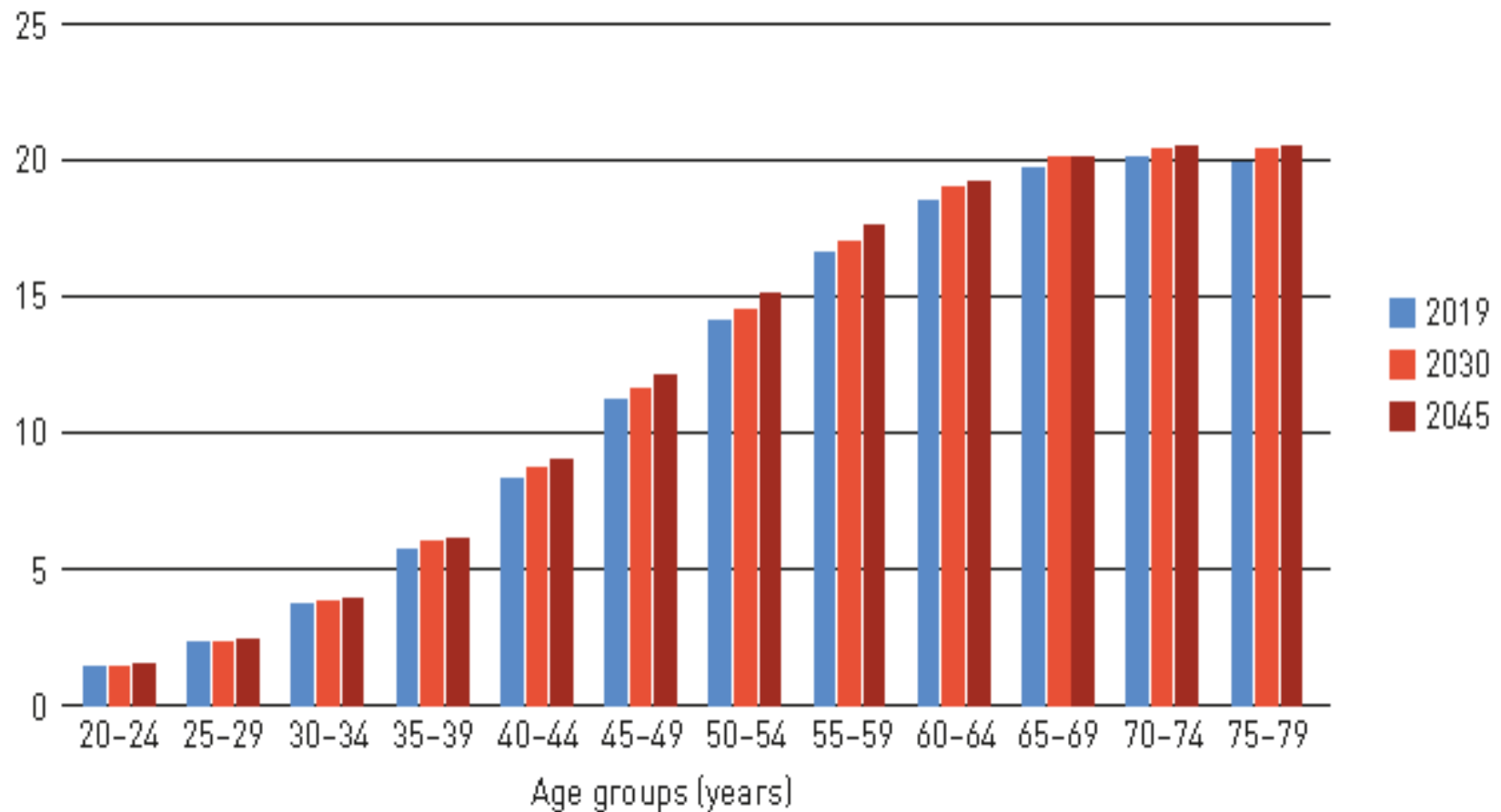
Prevalence

- ❖ **Diabetes mellitus (DM) is increasing globally and has reached epidemic proportions in many countries.**
- ❖ **International Diabetes Federation (IDF) showed that In 2019, it is estimated that 88 million people have diabetes and this number is projected to reach 115 million by 2030, and 154 million by 2045.**
- ❖ **Two-thirds of people with diabetes live in urban areas and three out of four are of working age. Over four million people aged 20–79 years is estimated to die from diabetes-related causes in 2019.**

Prevalence

- ❖ In 2019, over one million children and adolescents have type 1 diabetes.
- ❖ The incidence and prevalence estimates of type 1 diabetes in children and adolescents (0–14 and 0–19 years of age).
- ❖ The countries with the largest numbers of adults with diabetes aged 20–79 years in 2019 are China, India and the United States of America.

Prevalence of diabetes by age groups in adults (20–79 years)



Etiology of Diabetes

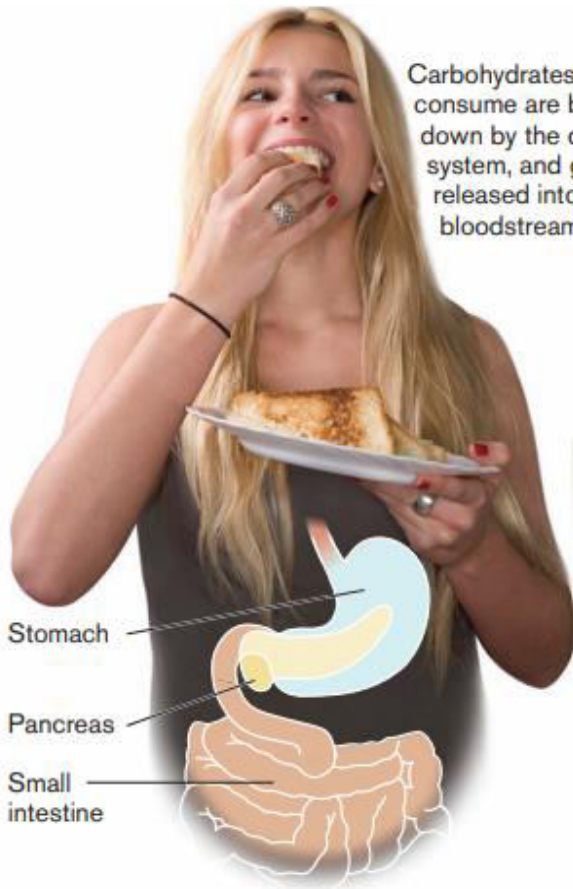
- ❖ Heredity appears to play a major role in both **Type I and Type II diabetes**.
- ❖ **Type I diabetes** generally has a sudden onset during childhood or young adulthood. This leads to almost total insulin deficiency, and daily injections of insulin are usually required to control the disease.
- ❖ **Type II diabetes** is often characterized by
 1. Delayed or impaired insulin secretion
 2. Impaired insulin action (insulin resistance) in the insulin-responsive tissues of the body, including muscle
 3. Excessive glucose output from the liver
- ❖ **Obesity** plays a major role in the development of **Type II diabetes**.

Causes

- ❖ Insulin is an essential hormone produced in the **pancreas**.
- ❖ It allows glucose from the bloodstream to enter the body's cells where that **glucose is converted into energy**.
- ❖ Insulin is also essential for the metabolism of **protein and fat**.
- ❖ A lack of insulin or the inability of cells to respond to it, leads to **high levels of blood glucose (hyperglycaemia)**, which is the clinical indicator of **diabetes**.

Converting Glucose to Energy

- ❖ In healthy people, after a meal, food is broken down into a sugar called **glucose** enters the bloodstream.
- ❖ Which is carried by the blood to cells throughout the body. Glucose is a source of fuel for the body.
- ❖ The role of insulin is to move **glucose** from the bloodstream into **muscle, fat, and liver cells**, where it can be used as fuel.
- ❖ People develop **type 2 diabetes** because the cells in the muscles, liver, and fat do not use insulin properly.



Carbohydrates you consume are broken down by the digestive system, and glucose is released into the bloodstream.

Normal Glucose Metabolism

1. The pancreas releases insulin into the bloodstream.
2. Insulin binds to receptors on cell walls, triggering the glucose transporters to open.
3. Glucose enters cells and provides energy.

Type 1 Diabetes

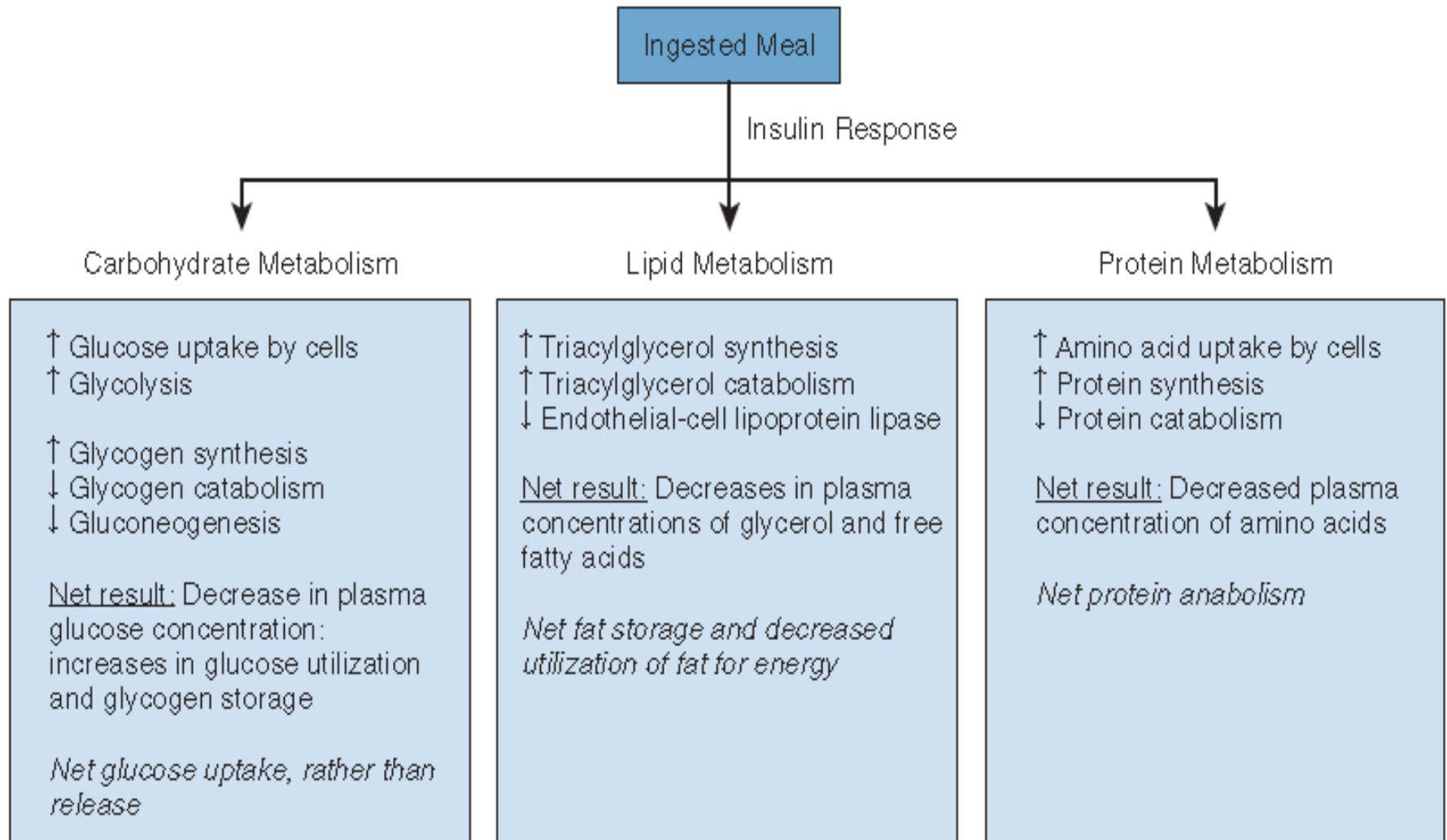
1. The pancreas cannot produce insulin.
2. Without insulin to trigger the glucose receptors to open, glucose builds up in the bloodstream to dangerous levels.
3. Without glucose, cells starve and die.

Type 2 Diabetes

1. The pancreas releases insulin into the bloodstream.
2. Cells are resistant to insulin, so both insulin and glucose build up in the bloodstream.
3. Some glucose enters the cell, but the amounts are insufficient for healthy cellular function.

Figure 11-10 Normal glucose metabolism, type 1 diabetes, and type 2 diabetes. In diabetes, glucose metabolism is disrupted, and blood glucose levels increase. Cells become starved for energy and may die.

Metabolic effects of insulin on Macronutrients



Types of Diabetes Mellitus

Four types of diabetes are recognized based on etiologic origin:

- ❖ **Type 1 diabetes-** body does not produce any insulin.
- ❖ **Type 2 diabetes-** body is not making enough or is losing sensitivity to insulin made.
- ❖ **Gestational diabetes-** diagnosed during pregnancy, and other
- ❖ **'other specific types' - Monogenic diabetes**

Type I Diabetes

- ❖ **Type 1** diabetes is caused by an autoimmune reaction in which the body's immune system attacks the insulin-producing beta cells of the pancreas.
- ❖ As a result, the body produces **very little or no insulin.**

Type I Diabetes Cell



Insulin



Insulin Receptor



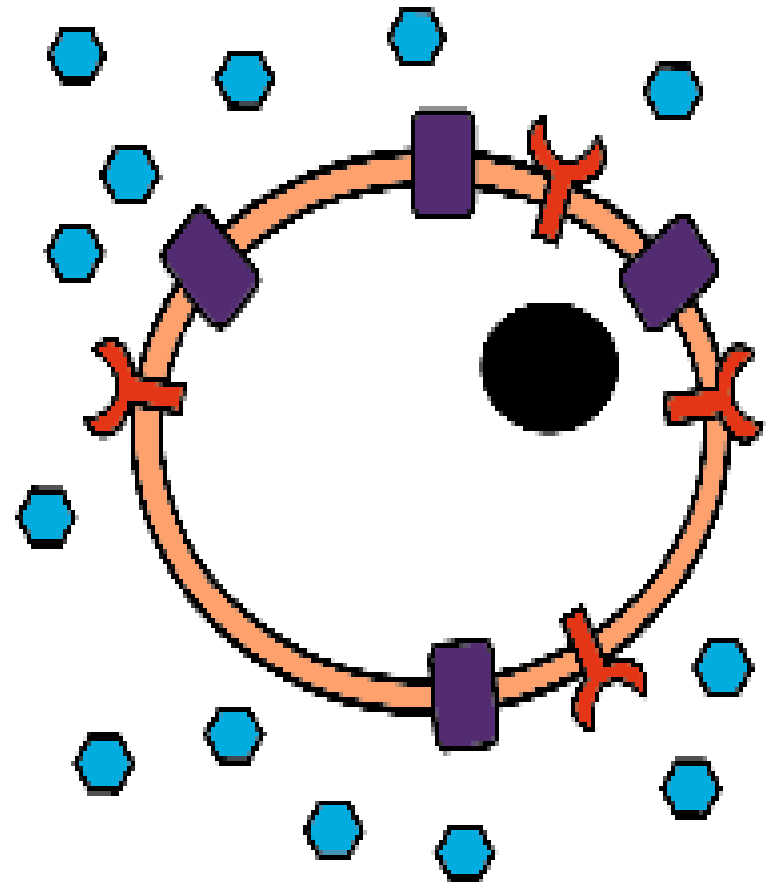
Glucose



Closed Glucose Transporter



Open Glucose Transporter



Type I Diabetes Cell

- ❖ People with type 1 diabetes need daily **insulin injections** to maintain a glucose level in the appropriate range.
- ❖ Without insulin, they would not survive.
- ❖ **Daily insulin treatment, regular blood glucose monitoring, education and support**, they can live healthy lives and delay or prevent many of the complications associated with diabetes.

Signs and Symptoms of type 1 diabetes

TYPE 1 DIABETES



Excessive thirst



Blurred vision



Bedwetting



Frequent
urination



Lack of energy,
fatigue



Constant
hunger






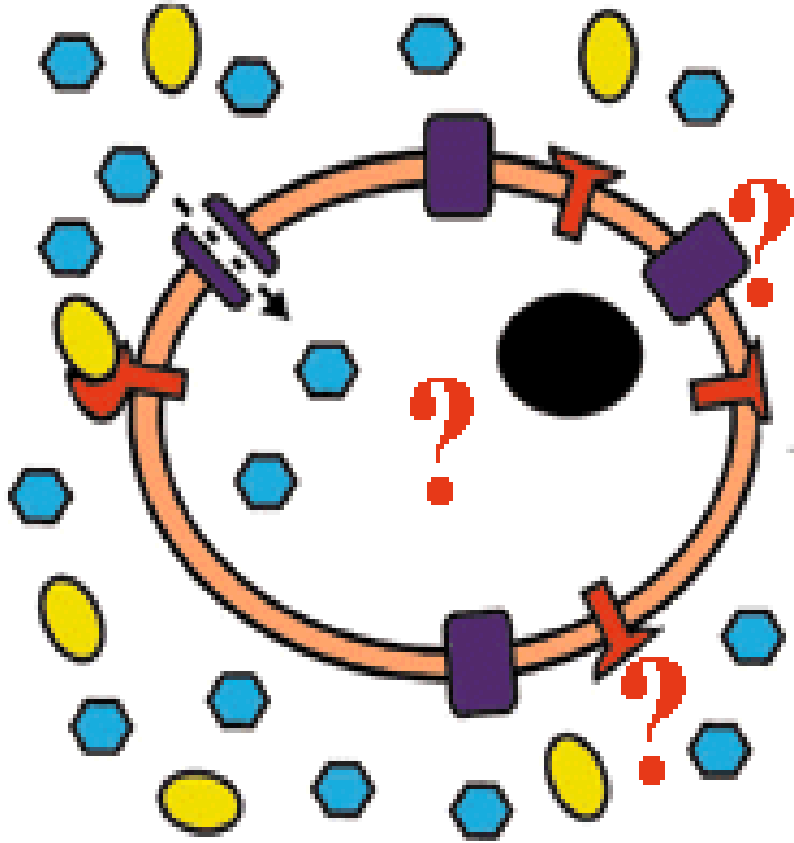
Sudden weight
loss

Type II Diabetes

- ❖ Type 2 diabetes occurs when body cells cannot properly use the insulin produced by the pancreas. This is called insulin resistance (i.e., **impaired insulin action in which body cells are resistant to the action of insulin**).
- ❖ Insulin normally allows glucose to enter cells in the body to provide energy; but with insulin resistance, the glucose cannot enter the cells and thus remains in the blood.
- ❖ Type 2 diabetes is most commonly seen in older adults, but is increasingly seen in children and younger adults owing to rising levels of obesity, physical inactivity and inappropriate diet.

Type II Diabetes

-  Insulin
-  Insulin Receptor
-  Glucose
-  Closed Glucose Transporter
-  Open Glucose Transporter



Type II Diabetes Cell

Signs and Symptoms of Type 2 Diabetes

Hyperglycemia ($>300 \text{ mg}\cdot\text{dL}^{-1}$)	Hypoglycemia ($<70 \text{ mg}\cdot\text{dL}^{-1}$ or rapid drop in glucose)
Dry skin	Dizziness and headache
Hunger	Weakness and fatigue
Nausea/vomiting	Shaking
Blurred vision	Tachycardia (fast heart rate)
Frequent urination	Irritable
Extreme thirst	Confusion
Drowsiness	Sweating
Acetone breath ("fruity breath")	Slurred speech
	Anxious
	Hunger

Gestational Diabetes Mellitus (GDM)

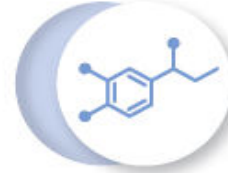
- ❖ **women with hyperglycaemia early in pregnancy, GDM arises in women with insufficient insulin secretory capacity to overcome the diminished action of insulin (insulin resistance) due to hormone production by the placenta.**
- ❖ **This can cause a high birth weight for baby.**
- ❖ **Women who have gestational diabetes are at high risk of type 2 diabetes and cardiovascular disease later in life.**

Other types of diabetes

- ❖ **Monogenic diabetes, as the name implies, results from a single gene rather than the contributions of multiple genes and environmental factors as seen in type 1 and type 2 diabetes.**
- ❖ **Monogenic diabetes is much less common and represents 1.5–2% of all cases, though this may well be an underestimate.**
- ❖ **It is often misdiagnosed as either type 1 or type 2 diabetes**

Other specific Types of Diabetes

Diabetes that is caused by diseases of the exocrine pancreas, such as pancreatitis, trauma, infection, pancreatic cancer and pancreatectomy.



Diabetes due to endocrine disorders that cause excess secretion of hormones that antagonize insulin.

Drug and chemical-induced diabetes from drugs that disrupt insulin secretion or insulin action.



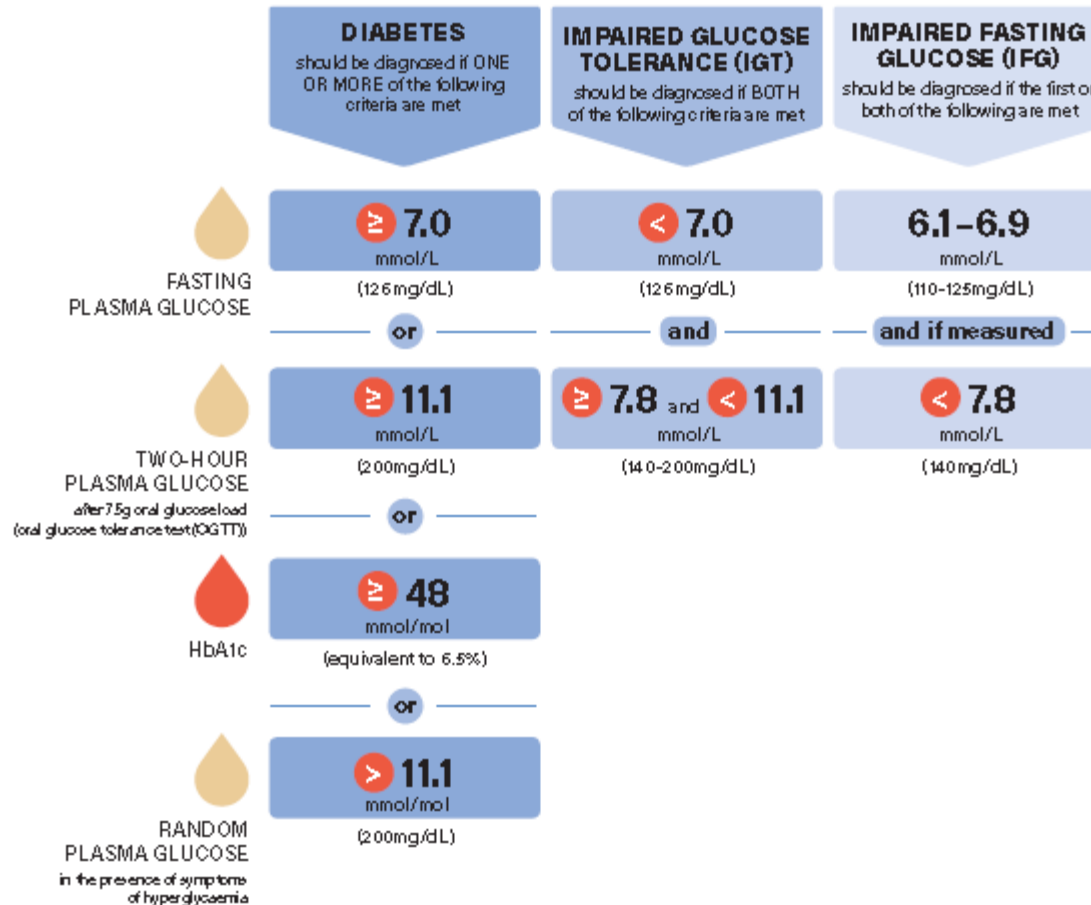
Infection-related diabetes that is caused by viral infection associated with beta cell destruction.

Uncommon specific forms of immune-mediated diabetes (e.g. immunological disorders other than those that cause type 1 diabetes).



Other genetic syndromes sometime associated with diabetes (i.e. Prader-Willi syndrome, Down's syndrome, Friedreich's ataxia).

Modified diagnostic criteria for diabetes



Fasting is defined as no caloric intake for at least 8 hours.

The HbA1c test should be performed in a laboratory using a method that is NGSP-certified and standardised to the Diabetes Control and Complications Trial assay.

The 2-hour postprandial glucose test should be performed using a glucose load containing the equivalent of 75g anhydrous glucose dissolved in water.

Complications of Diabetes

Insulin deficit, if left unchecked over the long term, can cause damage to many of the body's organs, leading to disabling and life-threatening health complications such as

- ❖ Cardiovascular diseases (CVD),
- ❖ Nerve damage (neuropathy),
- ❖ Kidney damage (nephropathy) and
- ❖ Eye disease (leading to retinopathy, visual loss and even blindness).

Diabetes and cardiovascular diseases

- ❖ Diabetes and elevated blood glucose are associated with an approximate doubling of cardiovascular diseases risk.
- ❖ CVD associated with diabetes are coronary heart disease, cerebrovascular disease, peripheral artery disease, and congestive heart failure, ischaemic and haemorrhagic stroke, as well as sudden death.
- ❖ The risk of cardiovascular diseases in people with diabetes can be reduced by **lowering high blood pressure and high glucose levels**, and using **lipid lowering medications**.

Diabetic eye disease

- ❖ Early diagnosis and timely treatment of diabetic retinopathy can prevent sight impairment and blindness.
- ❖ Optimised **blood glucose and blood pressure management** complemented by screening for diabetic retinopathy can reduce the impact of diabetic eye disease.

Diabetic kidney disease

- ❖ Diabetes, hypertension, or a combination of both, cause 80% of end-stage renal disease globally.
- ❖ Both diabetes and chronic kidney disease are strongly associated with cardiovascular diseases.
- ❖ Controlling blood glucose and blood pressure can reduce associated risks.
- ❖ Hyperglycaemia induces hyperfiltration and morphological changes in the kidneys that ultimately lead to an increased urinary albumin excretion (albuminuria), podocyte damage and loss of filtration surface.

Nerve and diabetic foot complications

- **Diabetic foot and lower limb complications, which affect 40 to 60 million people with diabetes globally.**
- **Chronic ulcers and amputations result in a significant reduction in the quality of life and increase the risk of early death.**

Lifestyle Changes for Diabetes Prevention and Control

❖ **lifestyle modification (LSM) or administration of pharmacological agents.**

- Maintain a healthy body fat level. For many, achieving a healthy body fat level is effective in preventing or reducing Type II diabetes symptoms.

- Maintain healthy blood sugar levels. For diabetics, regular testing is necessary.

- Eat well. Limit fats and simple carbohydrates in the diet. Increase complex carbohydrates. Keep total calorie consumption at a level that keeps the body weight at a healthy level.

- Exercise regularly. Physical activity expends calories and helps regulate blood sugar levels.

- Learn to recognize symptoms of diabetes and seek screening.

- If you are diabetic, are pre-diabetic, or have symptoms, seek and adhere to medical advice. Many pre-diabetics do not know that they have a problem. Diabetics need to adhere to a plan for blood sugar regulation.

- Learn stress-management skills to reduce stress and maintain a healthy sleep schedule.

Preparticipation Screening

- Health History,
- Current Medical Conditions,
- Risk Factors,
- Signs/Symptoms, Current
- Physical Activity/Exercise Habits,
- Medications and
- Literacy Level

Exercise Testing

The special considerations for exercise testing people with diabetes mellitus are:

- ❖ Patients with diabetes mellitus should undergo an extensive medical evaluation, particularly of the **cardiovascular, nervous, renal, and visual systems** to identify related diabetic complications.

Exercise Prescription

- ❖ The benefits of regular exercise in patients with type 2 diabetes mellitus include improved glucose tolerance, increased insulin sensitivity, decreased HbA1C, and decreased insulin requirements.
- ❖ Additional exercise benefits for people with type 1 and type 2 diabetes mellitus include improvement in CVD risk factors (i.e., lipid profiles, BP, body weight, and functional capacity) and well being.

Intensity: ACSM recommends a range of **50%–80% of VO2R or HRR** for clients with diabetes.

The following formula of Gellish (2007) represents the most accurate.

HRmax = 207 – (0.7 X age) Men and women participants in an adult fitness program with broad range of age and fitness levels.

(OR)

An RPE range of 11 to 13 (on the 6–20 scale).

Resistance Training:

- ❖ **Volume:** 1–3 sets per exercise
- ❖ **Intensity:** 60% to 80% 1-RM
- ❖ **Rest period:**
 - ❖ 2–3 min between sets for core lifts
 - ❖ 1–2 min for assistance exercises

Exercise for people with Type 1 Diabetes

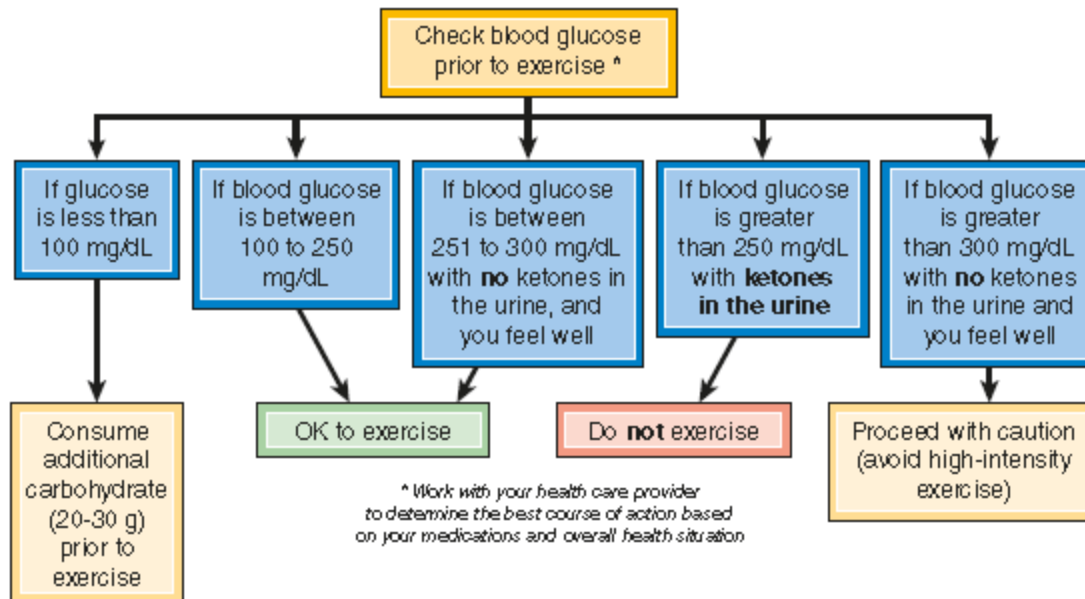


Table 4.5**General Exercise Guidelines for Clients With Type 2 Diabetes**

Parameter	Guideline
Aerobic exercise frequency	Sedentary clients should start with two or three 10-min bouts of aerobic activity per day and progress to 30 min of continuous aerobic activity on 5 to 7 days per week
Aerobic exercise intensity	50-85% heart rate reserve; 12-16 rating of perceived exertion (RPE); talk test ^a is applicable for most clients
Aerobic exercise duration	Minimum of 10 min per session (even lower with peripheral neuropathy or peripheral vascular disease) with a minimum goal of 30 min per session; if weight loss needed, gradually progress to 60 min per session or per day; minimum goal is 150 min per week, up to 300 min or more if weight loss and prevention of weight regain needed
Aerobic exercise modes	Rhythmic, continuous; emphasize large muscle groups as with walking, biking, and swimming
Aerobic exercise caloric expenditure	Goal of 300+ per session and >2,000 per week
Resistance training frequency	2-3 days per week or, ideally, every other day or 48 h apart
Resistance training duration	30-60 min per session using 8-12 repetitions, 2-3 sets, 10-12 large-muscle multijoint exercises
Resistance training intensity	If just beginning a program, use 50-70% 1RM and gradually progress such that by 3-6 months the program consists of a nonlinear plan of 50-65% 1RM with high reps for one session, 65-80% 1RM with moderate reps for one session, and 80-95% 1RM for one session each week (occasionally may test the 1RM)
Resistance training exercise types	Large variety of possibilities depending upon the goals, interests, capabilities, and clinical status of the client (e.g., resistance bands; pneumatic, hydraulic, plate-loaded, or selectorized machines; free weights); goal is to primarily use free weights
Flexibility training ^b	Stretch all major muscle groups every other day, 1-2 static stretches per major muscle groups, hold stretches for 10-30 s each, 20-25 min total duration

^aThe talk test is a test of how comfortably a person can talk during exercise. The intensity at which a person can “just barely respond in conversation” is considered to be safe and appropriate for aerobic endurance improvement (165).

^bFlexibility exercise is very important in persons with type 2 diabetes due to the association of poor range of motion with this disease.

TABLE 13.1 Aerobic Training Recommendations for People With Diabetes

	Type 1	Type 2
Frequency	Three to seven days per week	Three to seven days per week
Intensity	Moderate to vigorous	Moderate to vigorous (but may be low intensity to start)
Time	At least 150 min per week of moderate-intensity activity, 75 min of vigorous-intensity activity, or a combination of both intensities	At least 150 min per week of moderate- to vigorous-intensity activity
Type	Large-muscle group activities such as walking, biking, jogging, and water aerobics	Large-muscle group activities such as walking, biking, dancing, and water aerobics

Adapted by permission from American College of Sports Medicine, 2018.

TABLE 13.2 **Resistance Training Recommendations for People With Diabetes**

	Type 1	Type 2
Frequency	Two to three nonconsecutive days per week	Two to three nonconsecutive days per week
Intensity	Moderate to vigorous	Low to moderate to start, working up to moderate to vigorous
Time	8 to 15 repetitions per exercise 8 to 10 different exercises One to three sets per exercise	8 to 15 repetitions per exercise 8 to 10 different exercises One to three sets per exercise
Type	Resistance machines and free weights	Resistance machines and free weights

Adapted by permission from American College of Sports Medicine, 2018.

TABLE 13.3 **Flexibility Recommendations for People With Diabetes**

	Type 1 and type 2
Frequency	Two to three days per week
Intensity	Stretch to the point of tightness (not pain)
Time	10 to 30 sec per stretch (or dynamic stretching for that amount of time) Two to four repetitions per stretch
Type	Four or five exercises for both the upper and lower body (can be static or dynamic)

Adapted by permission from American College of Sports Medicine, 2018.

TABLE 2-4. Recommended Macronutrient Proportions by Age

	Carbohydrate	Protein	Fat
Young children (1-3 years)	45-65%	5-20%	30-40%
Older children and adolescents (4-18 years)	45-65%	10-30%	25-35%
Adults (19 years and older)	45-65%	10-35%	20-35%

Source: Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.

YOUR HEALTHY EATING PLATE*

Vegetables:

Increase use of vegetables of all colors and varieties. Include as snacks and in drinks such as smoothies and blended fruit juices.

Daily Physical Activity:

Do not avoid physical activity and exercise. Welcome every chance you have to be physically active every day.

Fruit:

Use fruits of all colors as and appetizer, desserts, snacks, and blended fruit drinks.

Beverages:

Drink mainly water with meals and use tea and coffee but with limited or no sugar. Use only low-fat or skim milk in moderation.



Protein:

Choose healthy proteins including fish, white poultry meat, beans, nuts, nonfat milk products and Greek yogurt, tofu, and quinoa. Use red meat and cheese sparingly and avoid processed meats (hot dogs, sausage, bacon, and cold cuts).

Healthy Oils:

Use primarily healthy oils such as olive and canola oil for cooking, salad dressings, and at the table. Minimize the use of butter and do not use trans fat or hydrogenated oils.

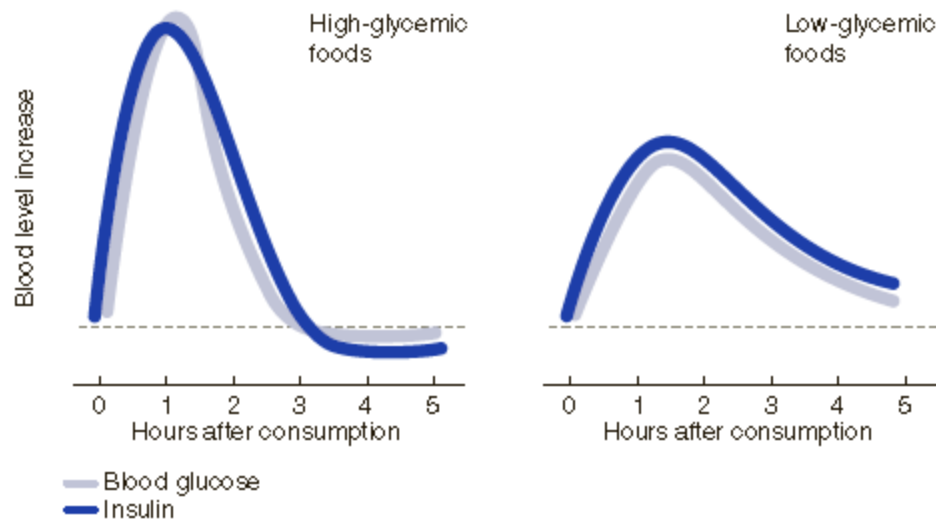
Whole Grains:

Increase the consumption of whole grains, including 100% whole wheat bread, brown rice, whole grain pasta, and quinoa. Limit refined grains such as white bread and rice.

*For most meals, three quarters of the plate should be taken up by fruits, vegetables, and grains.

Table 5.1 Glycemic index of selected foods

Item	Index	Item	Index	Item	Index	Item	Index
All-Bran cereal	38	Carrots, raw	47	Honey	58	Peas	50
Apples	40	Cherries	20	Milk, chocolate, low fat	34	Pizza, cheese	60
Bagel, white	72	Colas	65	Milk, skim	32	Potato, baked	56–100
Banana	56	Corn, sweet	60	Milk, whole	40	Potato, French fries	75
Bread, French	95	Corn Flakes	92	Jelly beans	80	Potato, sweet	51
Bread, wheat	73	Doughnut	76	Oatmeal	75	Rice, white	56
Bread, white	70	Frosted Flakes	55	Oranges	48	Sugar, table	65
Carrots, boiled (Australia)	41	Fruit cocktail	55	Pasta, white	50	Watermelon	72
Carrots, boiled (Canada)	92	Gatorade	78	Pasta, wheat	32	Yogurt, low-fat	32
		Glucose	100	Peanuts	20		



Approximate Calorific Value of Some Cooked Preparations

Preparation	Quantity for one serving	Calories (Kcal)	Preparation	Quantity for one serving	Calories (Kcal)
1. Cereal			5. Savoury snacks		
Rice	1 cup	170	Bajji or pakora	8 Nos.	280
Phulka	1 No.	80	Besan ka pura	1 No.	220
Paratha	1 No.	150	Chat (Dahi-pakori)	5 pieces	220
Puri	1 No.	80	Cheese balls	2 Nos.	250
Bread	2 slices	170	Dahi vada	2 Nos.	180
Poha	1 cup	270	Vada	2 Nos.	140
Upma	1 cup	270	Masala vada	2 Nos.	150
Idli	2 Nos.	150	Masala dosa	1 No.	200
Dosa	1 No.	125	Pea-kachori	2 Nos.	380
Kichidi	1 cup	200	Potato bonda	2 Nos.	200
Wheat porridge	1 cup	220	Sago vada	2 Nos.	210
Semolina porridge	1 cup	220	Samosa	1 No.	200
Cereal flakes with milk (corn/wheat/rice)	1 cup	220	Sandwiches (butter- 2tbsp)	2 Nos.	200
			Vegetable puff	1 No.	200
2. Pulse			Pizza (Cheese and tomato)	1 slice	200
Plain dhal	½ cup	100	6. Chutneys		
Sambar	1 cup	110	Coconut/groundnuts/til	2 tbsp	120
			Tomato	1 tbsp	10
3. Vegetable			Tamarind (with jaggery)	1 tbsp	60
With gravy	1 cup	170			
Dry	1 cup	150	7. Sweets and Desserts		
4. Non-Vegetarian			Besan barfi	2 small pieces	400
Boiled egg	1 No.	90	Chikki	2 pieces	290
Ommelette	1 No.	160	Fruit cake	1 piece	270
Fried egg	1 No.	160	Rice puttu	½ cup	280
Mutton curry	¾ cup	260	Sandesh	2 Nos.	140
Chicken curry	¾ cup	240	Double ka meetha	½ cup	280
Fish fried	2 big pieces	190	Halwa (kesari)	½ cup	320
Fish cutlet	2 Nos.	190	Jelly/Jam	1 tbsp	20
Prawn curry	¾ cup	220	Custard (caramel)	½ cup	160
Keema kofta curry	¾ cup (6 small koftas)	240	Srikhand	½ cup	380
			Milk chocolate	25 g	140
			Ice-cream	½ cup	200

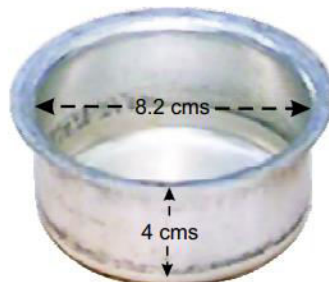
Preparation	Quantity for one serving	Calories (Kcal)
8. Beverages		
Tea (2 tsp sugar + 50 ml toned milk)	1 cup	75
Coffee (2 tsp sugar + 100 ml)	1 cup	110
Cow's milk (2 tsp sugar)	1 cup	180
Buffalo's milk (2 tsp sugar)	1 cup	320
Lassi (2 tsp sugar)	1 cup/glass (200 ml)	110
Squash	1 cup/glass	75
Syrups (Sharabats)	1 cup/glass	200
Cold drinks	1 bottle (200 ml)	150
Fresh lime juice	1 glass	60



Teaspoon - 5 ml



Tablespoon - 15 ml



Cup 200 ml

Meal Pattern For The Traditional South Indian Client With Diabetes Type 2

Breakfast	Typical	Modified
7.30 A.M.	1cup coffee with whole milk 3 idlis or 1plate upuma coconut chutney	1cup coffee with 1% fat milk 2 slices of whole wheat toast with 2 tsp. Margarine or 2 small idlis or 1Cup Uppuma 2 table spoon of chutney (tomato or dhal chutney preferable to coconut)
Snack 10:30 A.M.		1 fresh fruit 8 oz. Diluted buttermilk
Lunch 12:30 P.M	3 cups of white rice 1 cup Sambhar 1 cup Rasam 1 cup green plantain curry 1 cup mixed veg.koottu 1 cup curds 1 or 2 fried papadums or potato chips ghee,pickles	1½ cups of brown rice ½ cup Sambhar 1 cup rasam 1 cup string beans curry shredded carrot salad w/lemon ½ cup non-fat yogurt 1 roasted small papadum 2 tsp oil in cooking water to drink
Afternoon coffee 3:30 P.M.	2 murukkus (pretzel like fried) cup coffee	½ cup dry real mix 1 cup coffee w/low fat milk
Dinner 8 P.M	3 cups of cooked rice 1 serving of fish, chicken (for non-vegetarains) 1 cup of sambhar 1 cup fried vegetables 1 cup whole milk curds pickles, papadum etc	1½ cup of cooked rice (brown) or 3 small rotis 3 oz of chicken or fish cury or 1 cup sambhar or whole gram sundal 1 cup stir- fried vegetables with 2 oz. tofu ½ cup low fat yogurt (High in salt) use occasionally 2 tsp oil in cooking
Snack 9:00 P.M.	1 fresh fruit 1 cup ice cream	1 kiwi or a small orange 10 peanuts roasted