

The background is a light blue gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance. The text is centered on the page.

INSULIN AND CARB COUNTING

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WHAT IS INSULIN?

INSULIN IS A HORMONE THAT IS NECESSARY:

- *MOVES GLUCOSE FROM BLOOD INTO CELLS FOR ENERGY*

WITHOUT ENOUGH INSULIN, HIGH BLOOD GLUCOSE RESULTS:

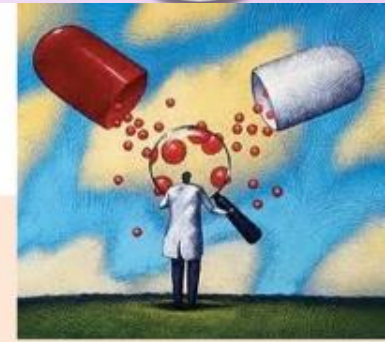
- *ENERGY LEVELS ARE LOW*
- *DEHYDRATION*
- *COMPLICATIONS*

HISTORY

- Canadian scientist (1921)
 - Fredrick G. Banting
 - Charles H. Best
- extracted insulin
 - from dog's pancreas



ANALOGUES.....



1921 : Insulin extracted by Banting & Best.

Conventional insulin preparations from beef/pork pancreas (antigenic)

1970s : Highly purified porcine insulins : Single peak insulins & Monocompetent insulins (greater efficacy & lesser side effects)

1980s : Human insulins by recombinant DNA technology (still better)

1990 : Insulin analogues with novel pharmacokinetics (*Eli Lilly & Co.*)



STRUCTURE OF INSULIN

- **Insulin**
 - Polypeptide hormone
 - 51 amino acids
 - Two chains
 - A chain 21 a.a.
 - B chain 30 a.a.
- **Held by interchange disulfide bridges**

SO.....WHAT ARE INSULIN ANALOGUES??

Molecules produced by genetic engineering wherein the amino acid sequence in human insulin is changed to alter its pharmacokinetics.
However, they bind to insulin receptors in the same way as human insulin and produce similar effects

Also termed as:



Designer Insulins

Insulin receptor ligands

Democratic insulins

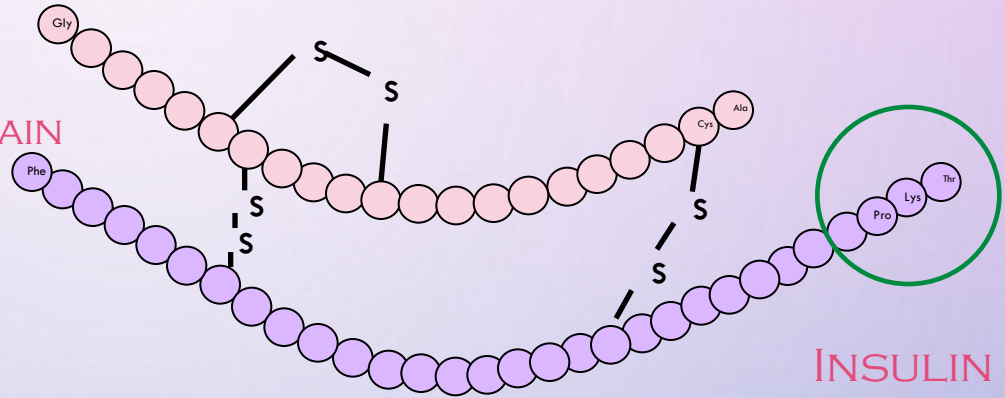
WHAT ARE ANALOGUE INSULINS?

- ANALOGUE (OR MODERN) INSULINS ARE FORMED BY MODIFYING HUMAN INSULIN MOLECULES

- LIKE SOLUBLE HUMAN INSULIN, ANALOGUE INSULINS ARE PRODUCED BY RECOMBINANT DNA TECHNOLOGY

α -CHAIN

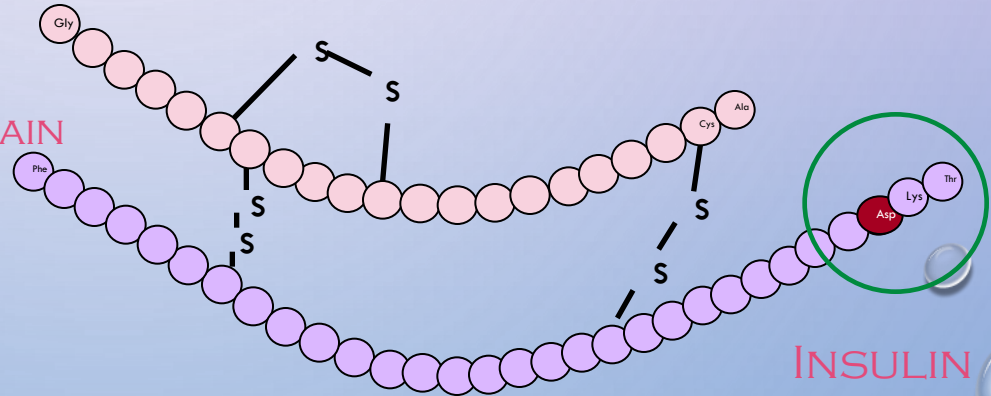
β -CHAIN



INSULIN LISPRO

α -CHAIN

β -CHAIN



INSULIN ASPART

CLASSIFICATION

INSULINS

Short acting

- Regular

Intermediate acting

- NPH / Isophane

Pre-mix insulins of
NPH/Regular insulins

INSULIN ANALOGUES

Ultra-short acting/Rapid acting

- Lispro
- Aspart
- Glulisine

Long acting

- Glargine
- Detemir
- Degludec

** Protaminated lispro – NPL
Protaminated Aspart – NPA

Pre mix analogues of NPL with Lispro (50/50
& 75/25)

Pre mix analogues of NPA with Aspart
(70/30)



TYPES OF INSULIN

- **RAPID-ACTING INSULIN**– WORKS VERY RAPIDLY TO LOWER THE BLOOD SUGAR
- NAMES: INSULIN LISPRO (HUMALOG ®)
- INSULIN ASPART (NOVOLOG ®)
- INSULIN GLULISINE (APIDRA®)
- BEGINS WORKING: 10-15 MINUTES
- STRONGEST EFFECT (PEAK): 1-2 HOURS
- ALL GONE 3-4 HOURS
- THIS INSULIN WORKS VERY FAST AND SHOULD BE GIVEN NO EARLIER THAN 20 MINUTES BEFORE A MEAL. IT MAY BE GIVEN IN A SYRINGE OR BY PEN, AND MAY BE GIVEN BY ITSELF OR IN COMBINATION WITH AN INTERMEDIATE OR LONG

- ***INTERMEDIATE – ACTING INSULIN*** - WORKS MORE SLOWLY AND LAST LONGER
- NAME: NOVOLIN NPH
- HUMULIN NPH
- BEGINS WORKING: 1 - 1 ½ HOURS
- STRONGEST EFFECT (PEAK) 6-8 HOURS
- ALL GONE 8-16 HOURS
- MAY BE GIVEN BY PEN OR SYRINGE, AND MAY BE COMBINED WITH A RAPID-ACTING INSULIN
- THIS INSULIN IS CLOUDY AND MUST BE ROLLED SEVERAL TIMES BEFORE USING IT

- **LONG-ACTING INSULIN** – WORKS UP TO 24HOURS AS A BACKGROUND OR “BASAL” INSULIN
- NAME: INSULIN GLARGINE (LANTUS®)
- INSULIN DETEMIR (LEVEMIR®)
- BEGINS WORKING: 2-4 HOURS
- STRONGEST EFFECT (PEAK): NO PEAK
- ALL GONE 14-24 HOURS
- MUST BE GIVEN BY ITSELF BY PEN OR IN A SYRINGE, NOT MIXED WITH ANY OTHER INSULINS
- SOME PEOPLE NEED ONLY ONE DOSE PER DAY, OTHERS NEED TO HAVE TWO INJECTIONS PER DAY

CLASSIFICATION

Insulin and analogue preparations

Short acting

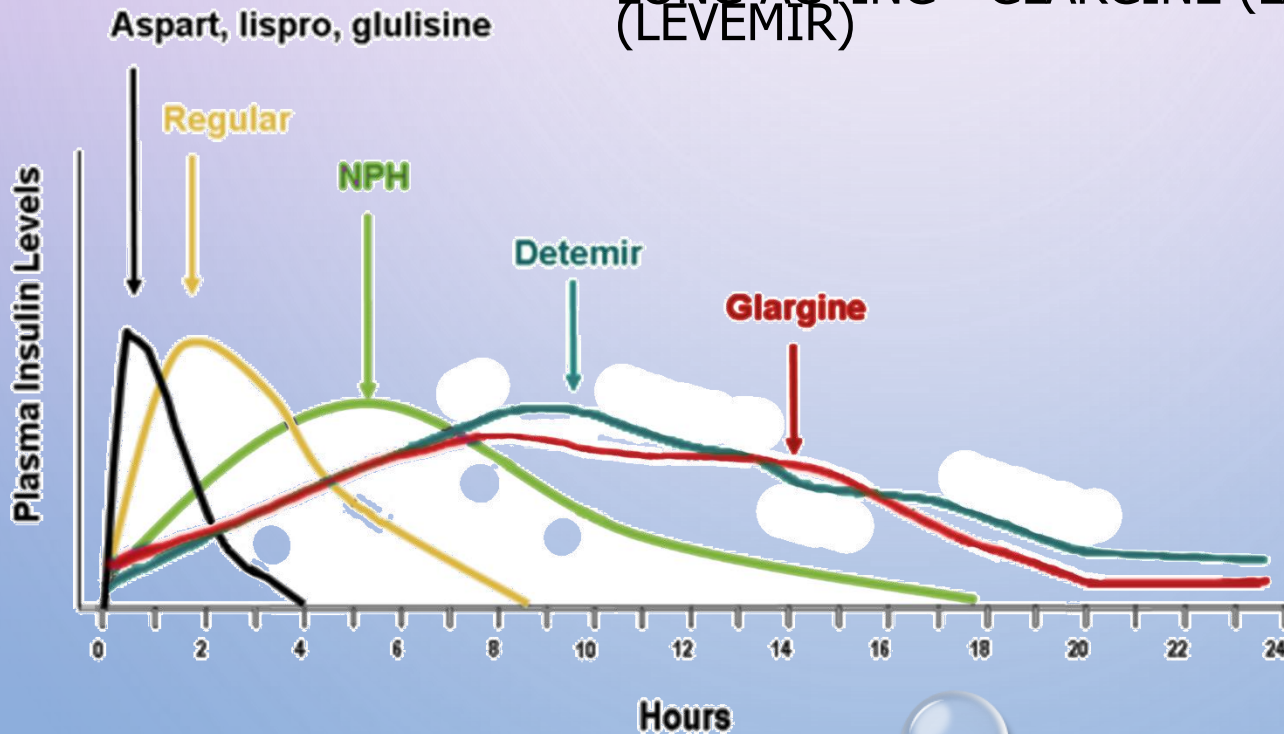
- Regular
- Lispro
- Aspart
- Glulisine

Long acting

- NPH
- Glargine
- Detemir
- Degludec

INSULIN TYPES

- RAPID-ACTING - HUMALOG ®, NOVOLOG ®, APIDRA
- SHORT-ACTING - REGULAR
- INTERMEDIATE - NPH
- LONG-ACTING - GLARGINE (LANTUS), DETEMIR (LEVEMIR)



LIMITATIONS OF REGULAR INSULINS

- Regular insulins form hexamers which dissociate slowly into monomers thus delaying absorption.



Delayed onset of action (1/2 to 1 hr)

Post prandial hyperglycemia

Prolonged time of peak action (2 to 3 hrs)

Duration of action (5 to 8 hrs)

Late post prandial hypoglycemia

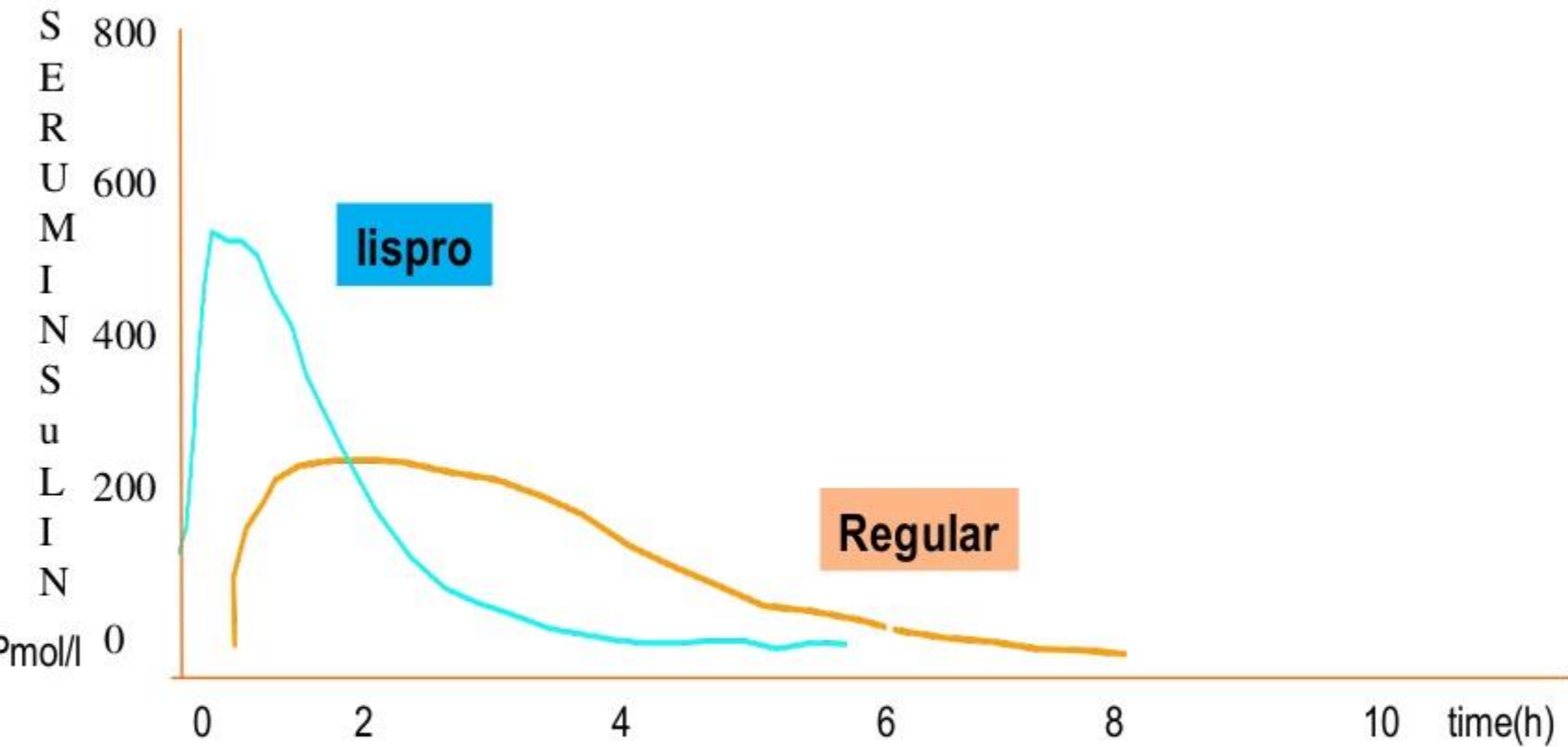
Hence regular insulins cause a mismatch between need & availability of bolus insulin and do not ideally mimic physiological bolus secretion of insulin.

OTHER LIMITATIONS OF REGULAR INSULINS

- Regular insulin has to be administered **30-45mins before meal** - **dose of insulin cannot be adjusted according to size of meals.**
- Time of onset, peak action & duration of action is **dose dependent** (**increases with dose**)
- Absorption **varies with injection site & exercise** (variability of absorption as much as 25%)



LISPRO VS REGULAR



LONG ACTING INSULIN ANALOGUES


Glargine

Detemir

Degludec



LIMITATIONS OF NPH INSULINS

- Doesn't mimic physiological basal insulin secretion
 - Peak action 5 to 7hrs after administration (risk of **nocturnal hypoglycemia** (if administered at bedtime)
 - Duration of action not long(\approx 20hours) enough to cover insulin requirements of the whole day with a single injection .
 - Action profile depends on dose.
 - Variability of absorption with site/exercise/variation in mixing of suspension (50%variability). Highly unpredictable action profile.
- 

GLARGINE

- Action prolonged by changing isoelectric point in glargine.

Glargine available as a clear solution at pH 4 but precipitates at neutral pH in subcutaneous tissue.



Precipitate slowly dissociates to release monomers which are absorbed slowly providing prolonged, uniform action.

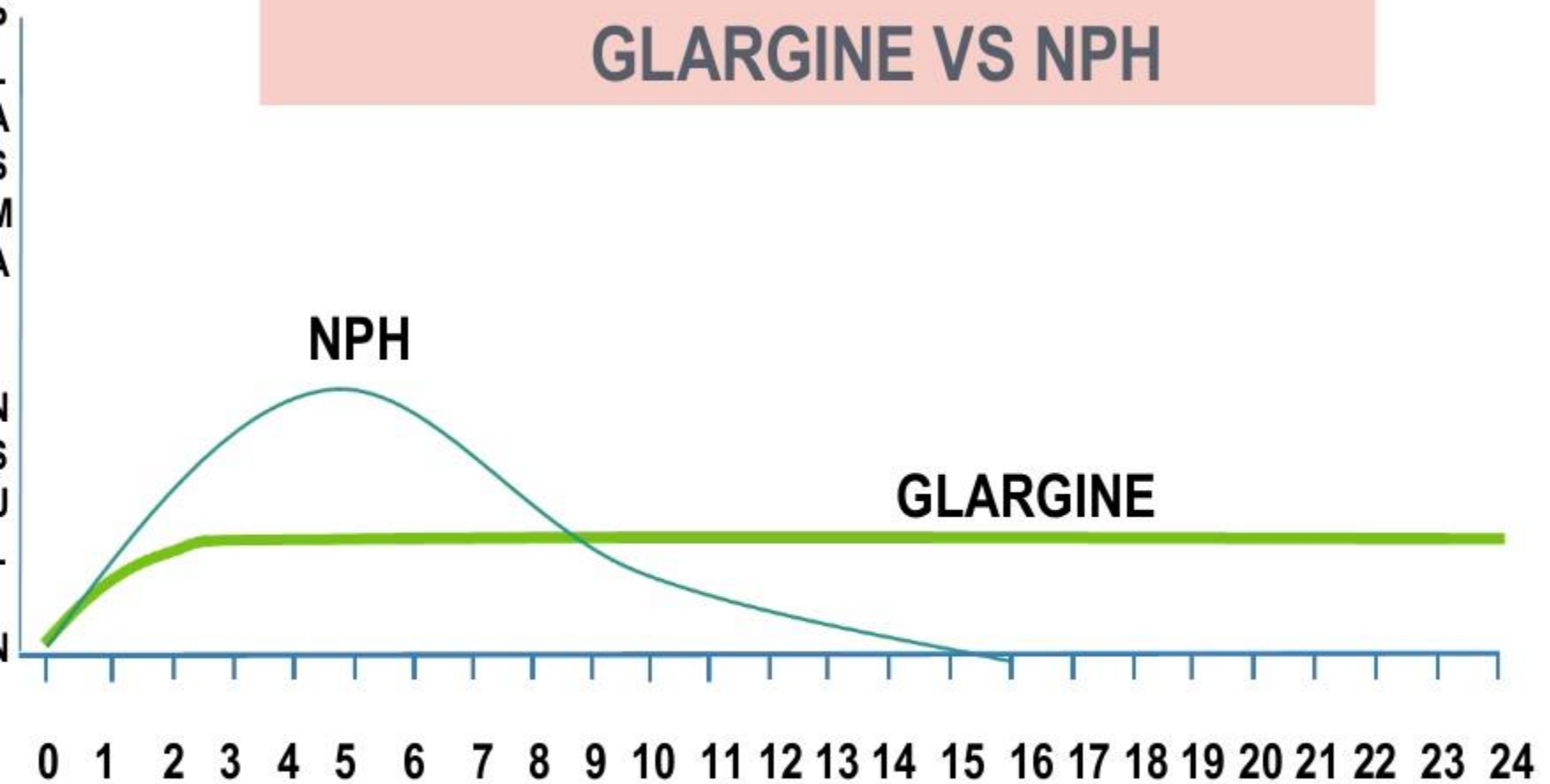


ADVANTAGES OF GLARGINE OVER NPH

- Low insulin levels maintained uniformly for 24hrs with no peak (mimics physiological basal insulin secretion)
 - Decreased risk of nocturnal hypoglycemia
 - Fasting & interdigestive blood glucose levels effectively controlled throughout the day irrespective of the time of injection
 - Suitable for once daily dosing.
 - Predictable absorption independent of dose/site of inj/exercise/mixing
- Wt gain reported less with glargine.

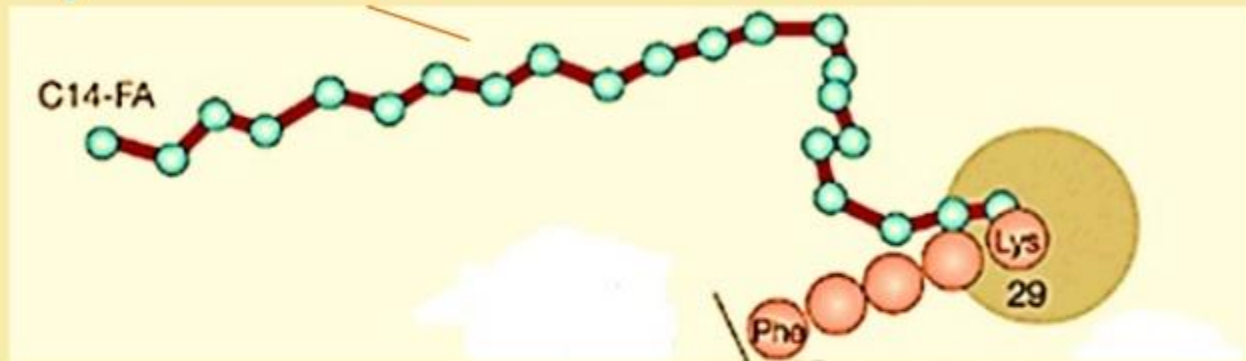


GLARGINE VS NPH



DETEMIR

Myristic acid



Smooth time action profile with no peak.

Glycemic control similar to NPH but produces less hypoglycemia than NPH

Onset of action is dose dependent

Duration of action slightly less than 24 hrs & may require twice daily dosing.

DEGLUDEC

- Ultralong acting insulin analogue in the process of development.
- Suitable for thrice weekly administration



INSULIN DELIVERY METHODS

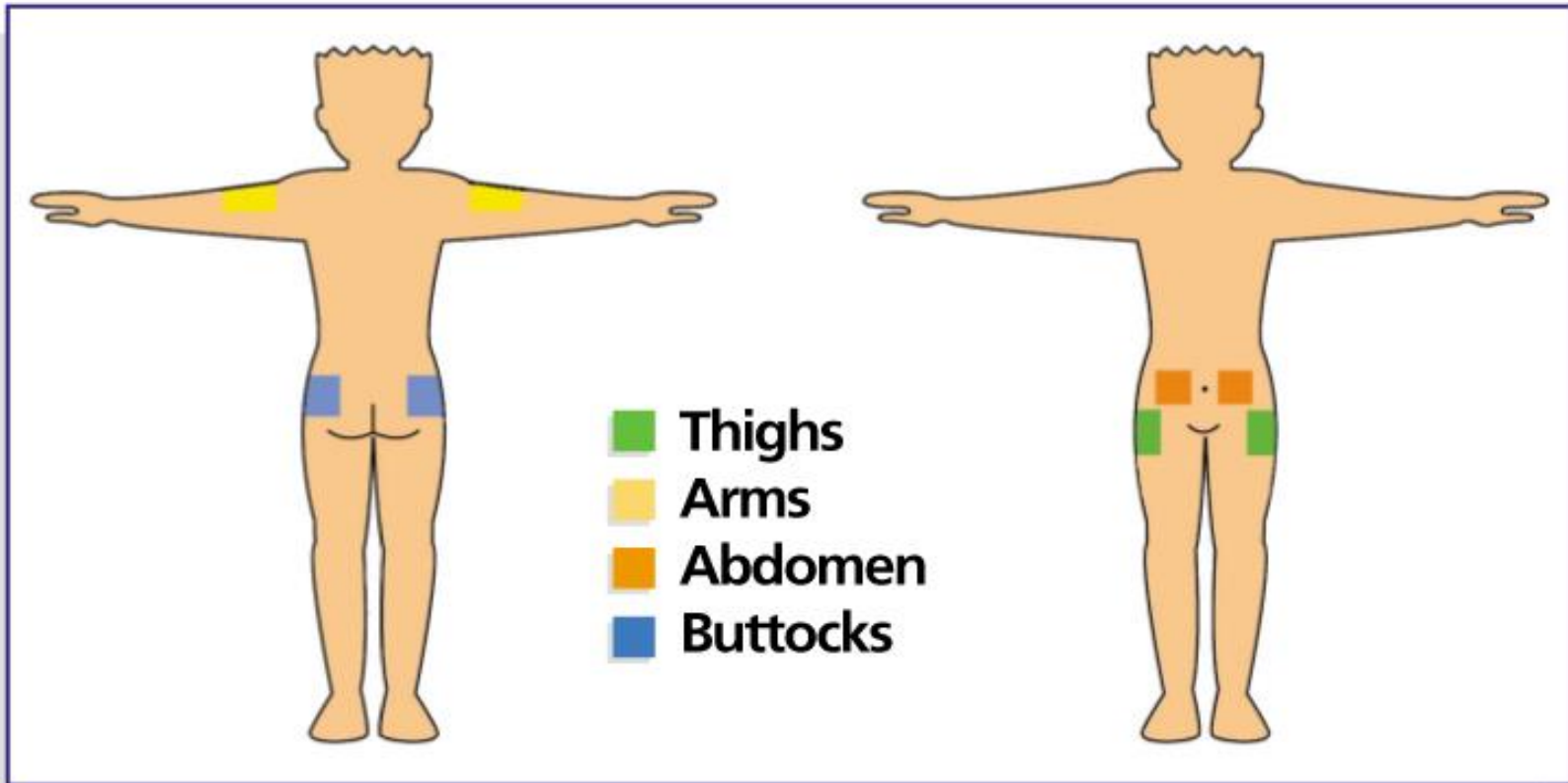
- INSULIN SYRINGE
- INSULIN PEN
- INSULIN PUMP OR POD
- JET INJECTOR

STORING INSULIN

- REVIEW THE PRODUCT STORAGE INSTRUCTIONS AND CHECK THE EXPIRATION DATE
- GENERALLY STORE AT ROOM TEMPERATURE LESS THAN 86 DEGREES
- REFRIGERATE UNOPENED VIALS AND INSULIN PENS
- BE CAREFUL NOT TO FREEZE

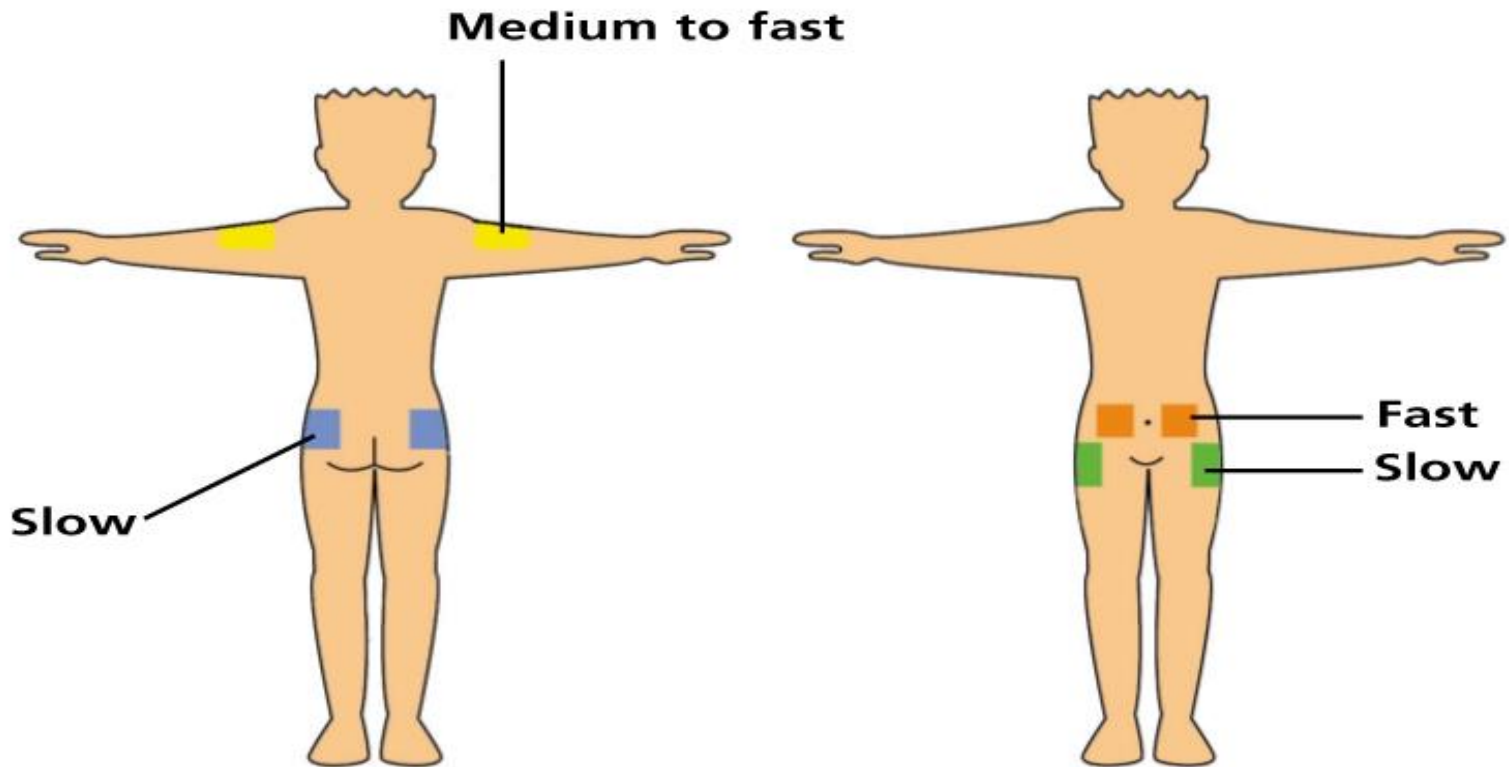
INJECTION TECHNIQUE

INJECTION SITES



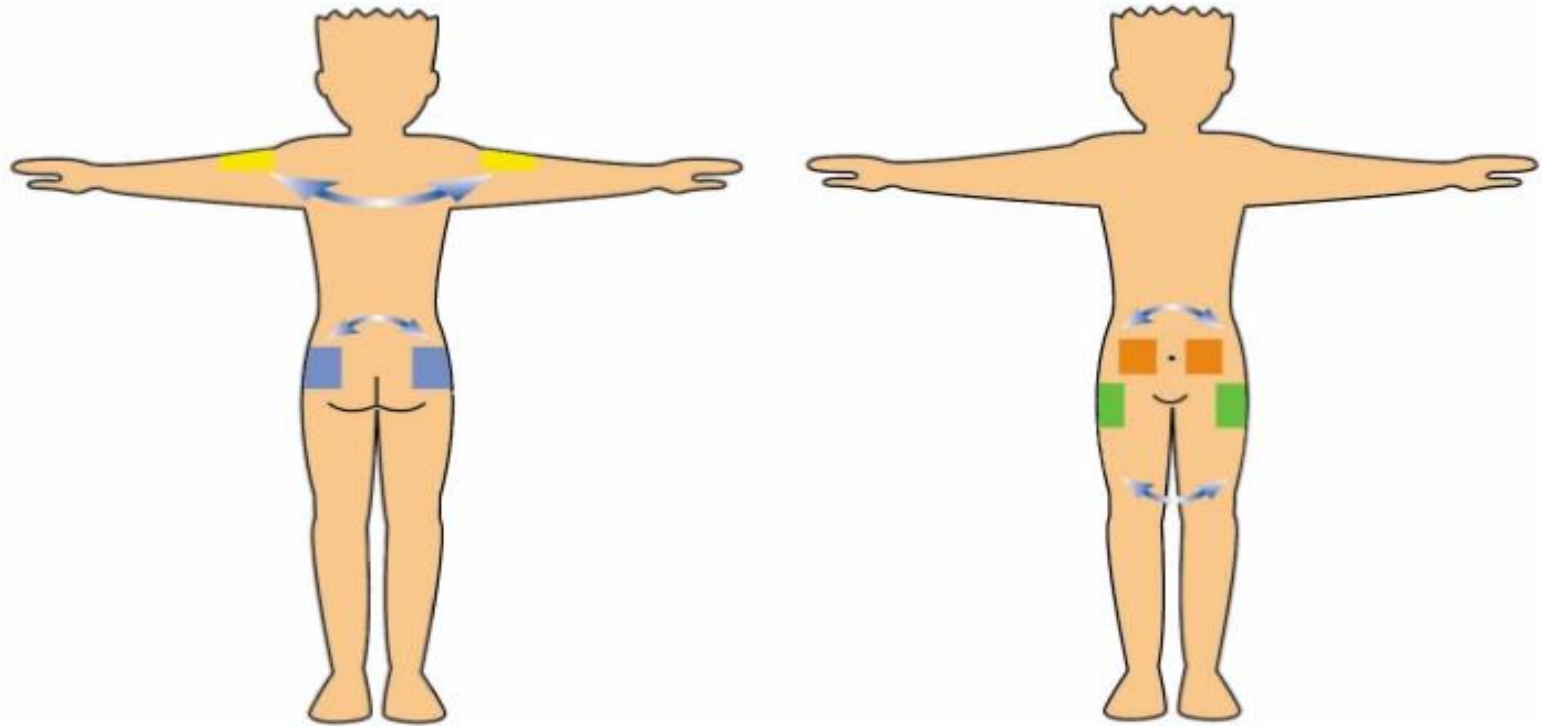
INJECTION TECHNIQUE

SPEED OF ABSORPTION IN INJECTION SITES



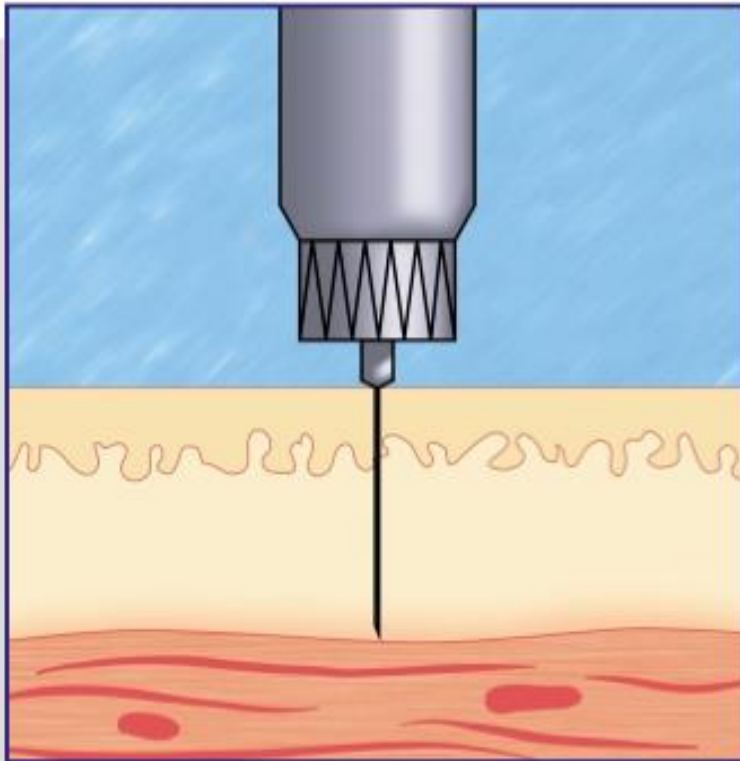
INJECTION TECHNIQUE

INJECTION SITE ROTATION

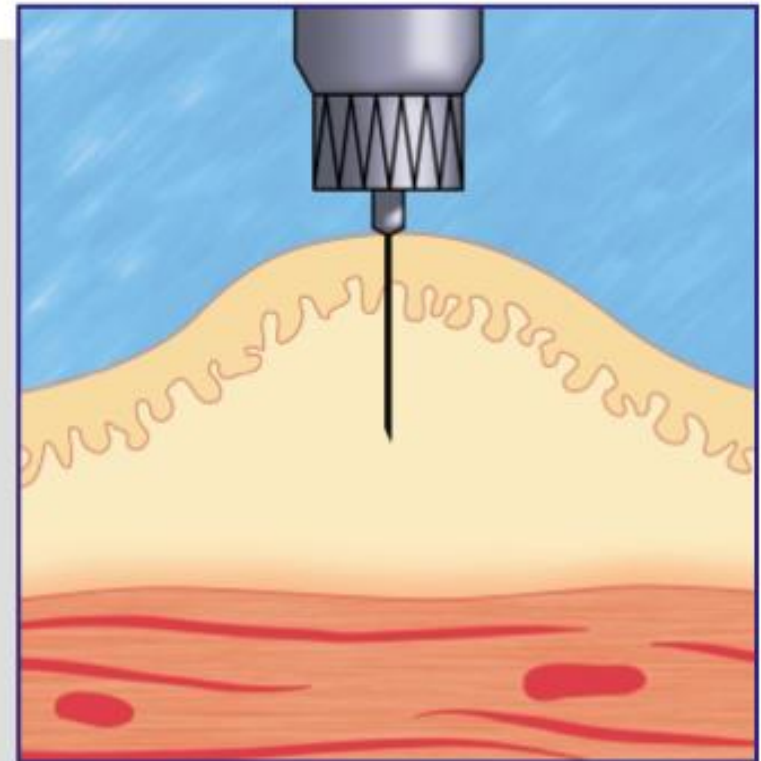


INJECTION TECHNIQUE

No lifted skin fold

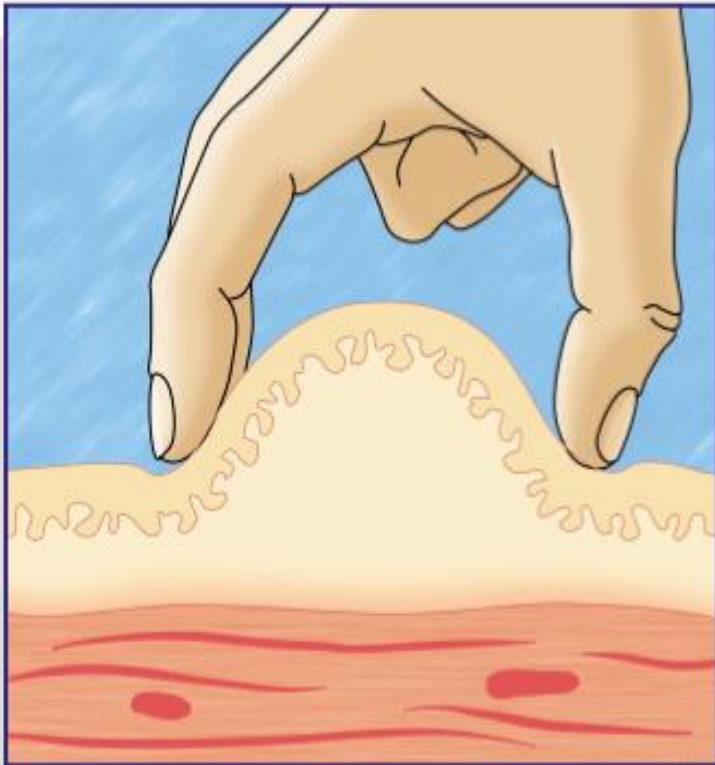


Lifted skin fold

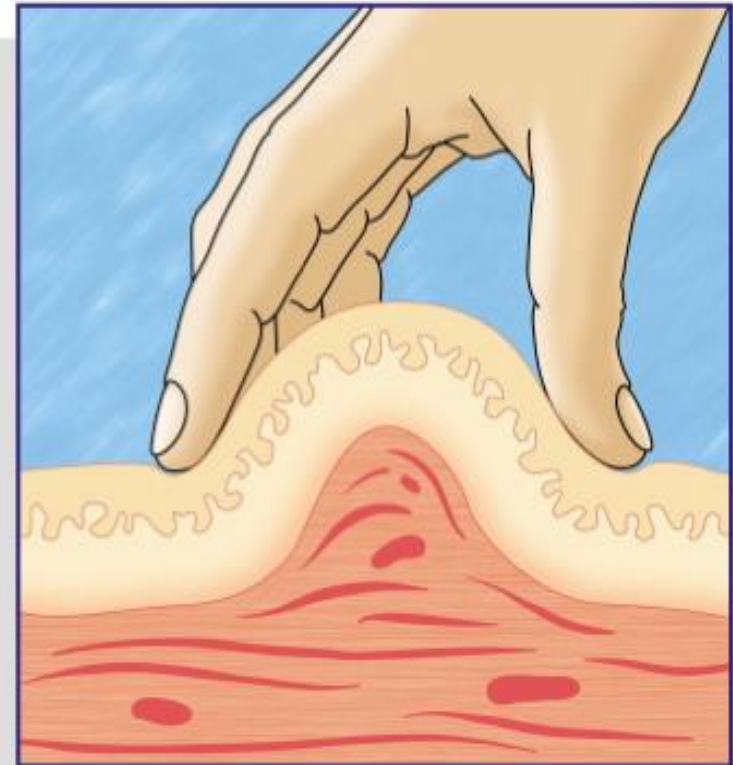


INJECTION TECHNIQUE

Correctly lifted skin fold

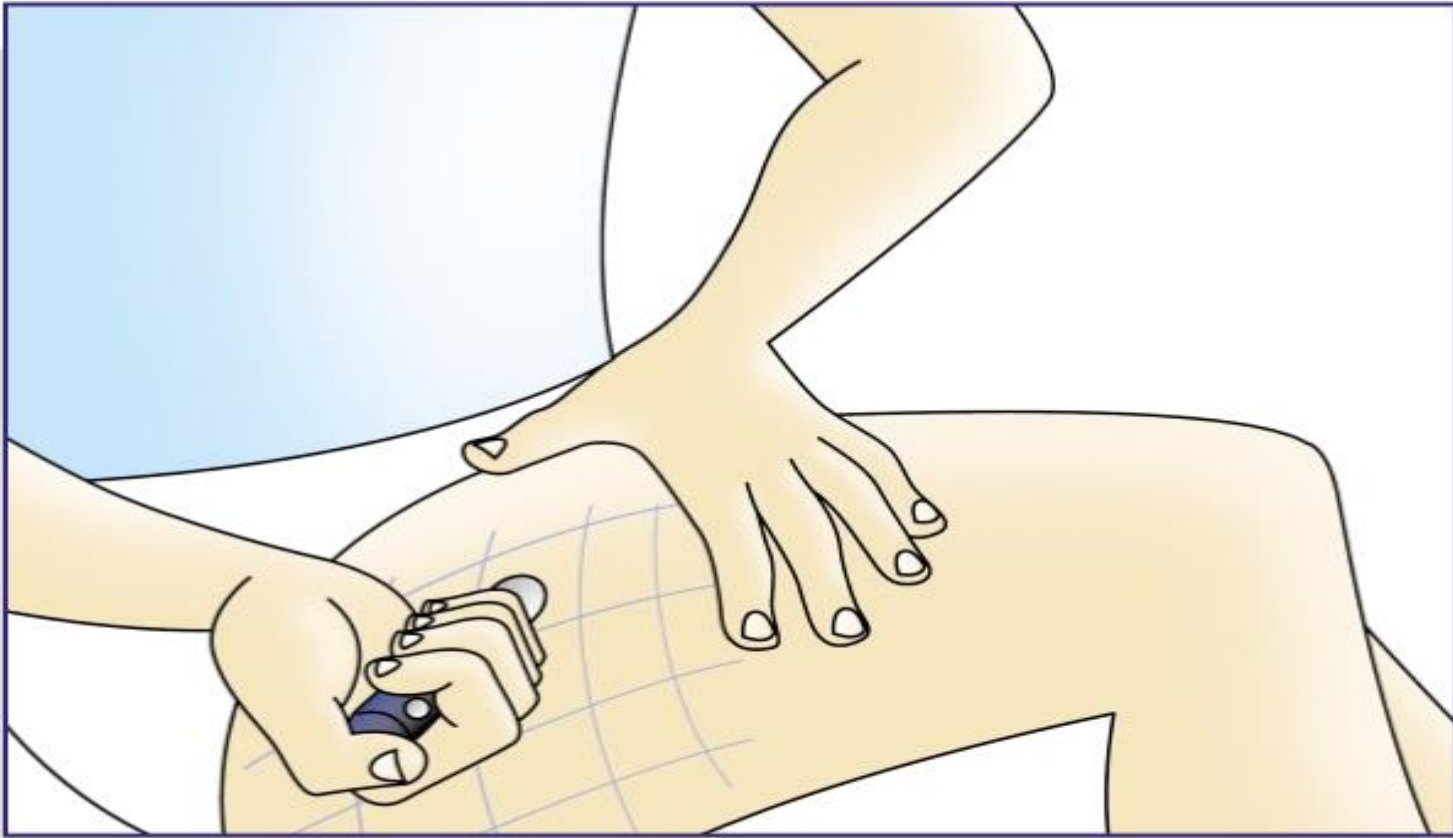


Incorrectly lifted skin fold

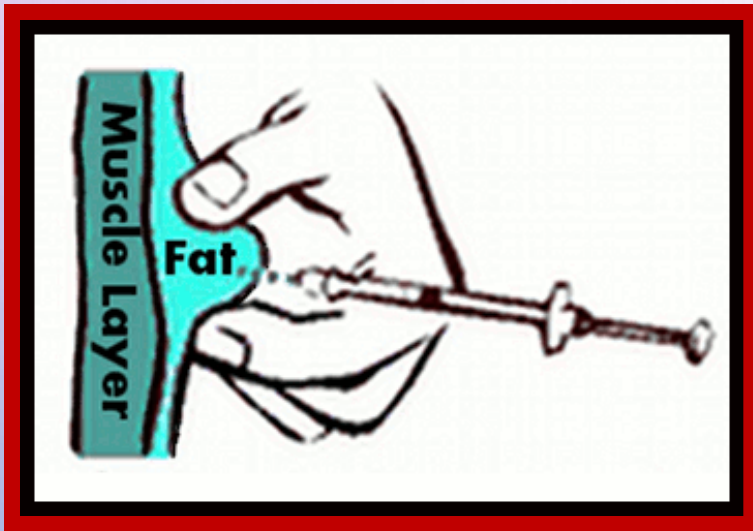


INJECTION TECHNIQUE

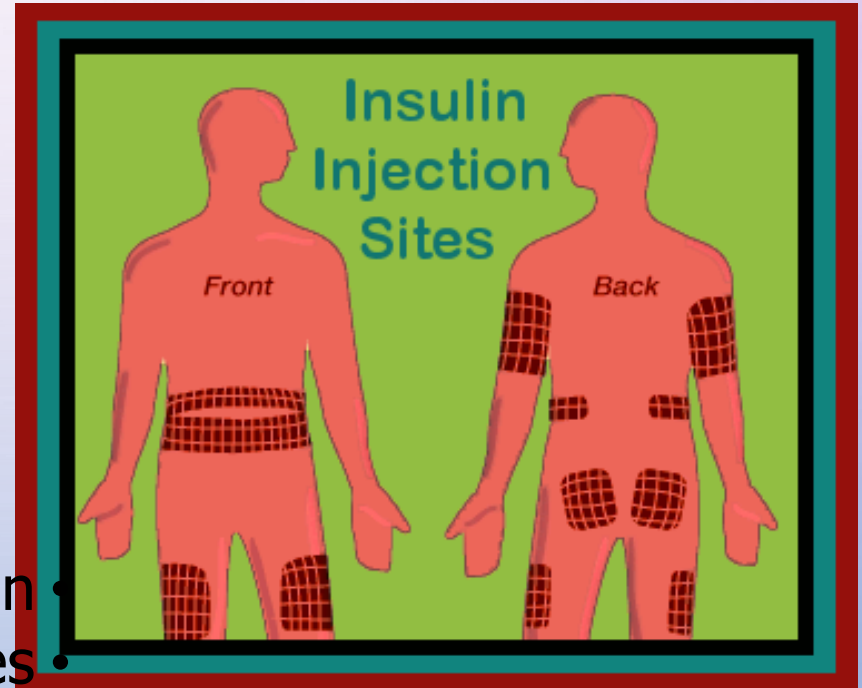
INJECTION SITE ROTATION



WHERE TO GIVE INSULIN: ON TARGET!



Inject into fat layer under skin •
Rotate sites •



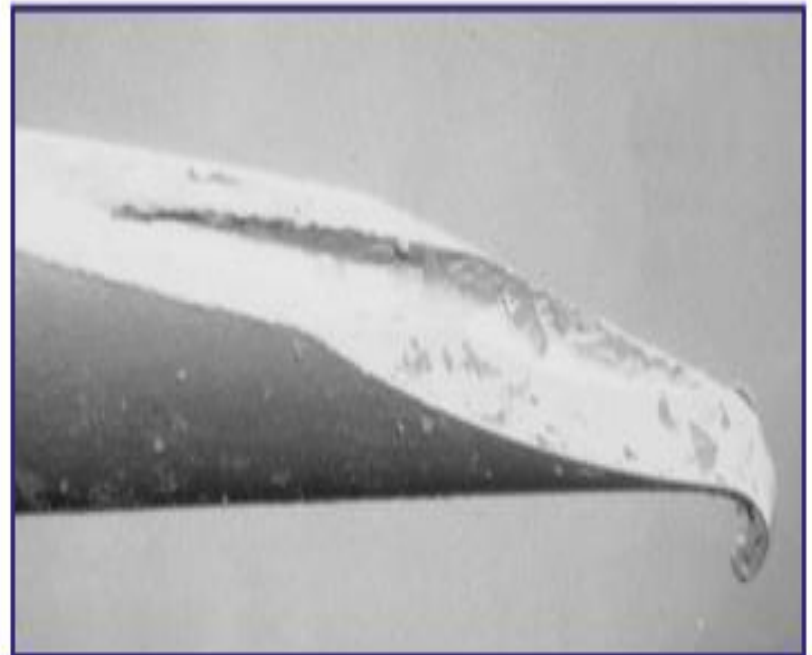
Common sites: abdomen, •
thigh buttocks, upper arms •

INJECTION TECHNIQUE

New needle



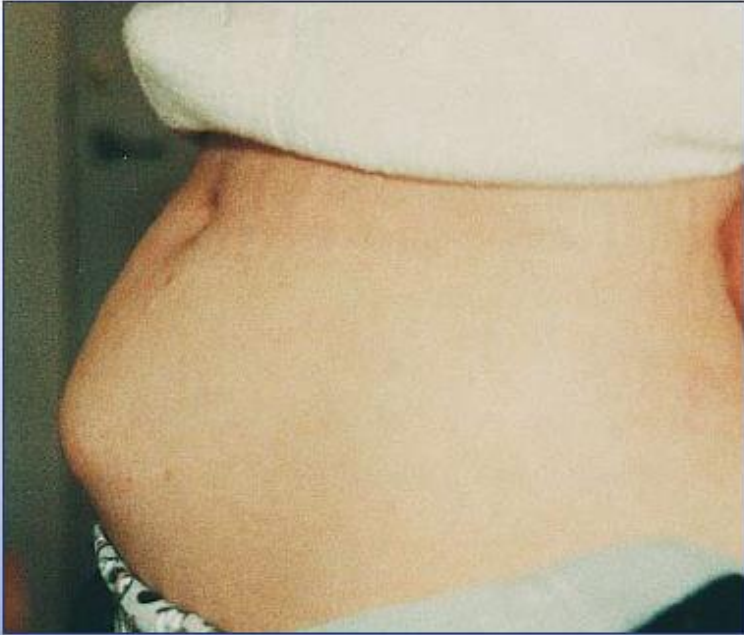
Reused needle



Lipoatrophy



Lipohypertrophy



INSULIN REGIMES WITH INSULIN ANALOGUES

- **Basal regime**: Glargine once daily at bedtime or Detemir twice daily .
 - *May be used when starting insulin in type 2 DM (along with OHA)*
 - *Used when there is dependence on others for injection.*
- **Conventional split dose regimes**: Pre-mix analogues injected twice a day (pre-breakfast & pre-evening meal).
 - *Type 1 & 2 diabetes*
 - *Simplify dosing & decreases no. of injections.*
- **Basal bolus regimen (intensive regimes)**: Glargine at bedtime to cover basal insulin secretion + short acting analogue to cover mealtime
 - *Type 1 usually (Type 2 at times)*
 - *Analogues preferred in intensive regimes due to decreased risk of hypoglycemia with their use.*

Continuous subcutaneous insulin infusion (CSII) through pumps

- Most physiological method of insulin delivery
 - Preferred in patients uncontrolled on multiple injections & those needing excellent control (pregnancy)
 - Specially suitable for patients with risk of hypoglycemia, uncertain lifestyles, meal times.
- Consists of insulin reservoir, program chip, keypad & screen. Insulin infused through plastic tubings connected to s/c inserted infusion set .



INSULIN DELIVERY – short acting insulin analogues like Aspart(lispro) used.

- Provides constant basal infusion of insulin & patient can activate pre-meal boluses.
- Pumps can be discontinued for short periods for activities like exercise
- Pump can be pre-programmed to compensate for nocturnal & early morning glucose fluctuation.

Advantages

- Rate of insulin absorption more predictable than multiple injections
- Risk of hypoglycemia less

Drawbacks

Pump failure -→ ketoacidosis

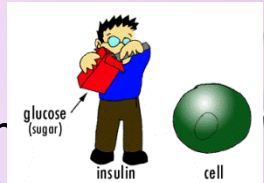
Injection site abscess

Only motivated & committed patients can use it.



Insulin Use

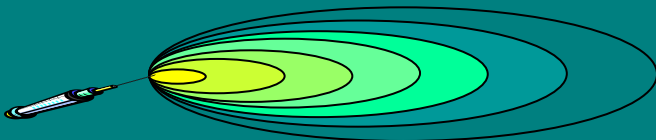
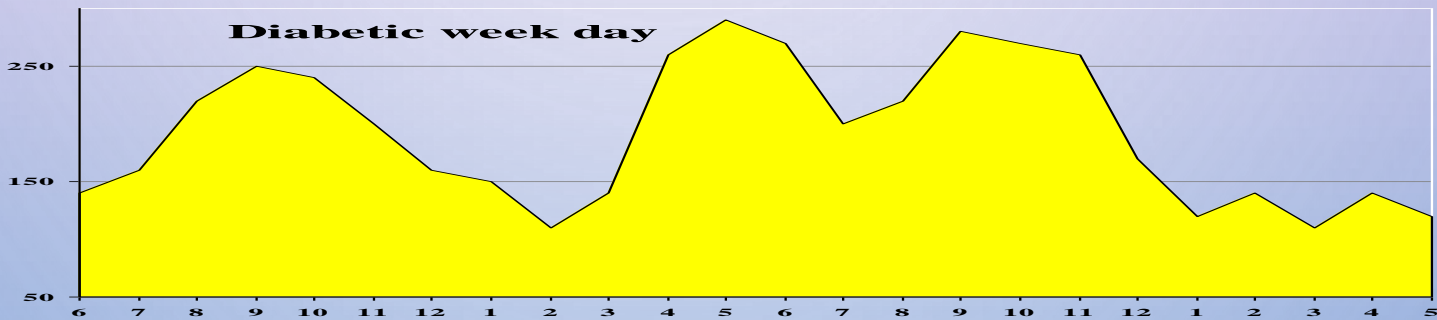
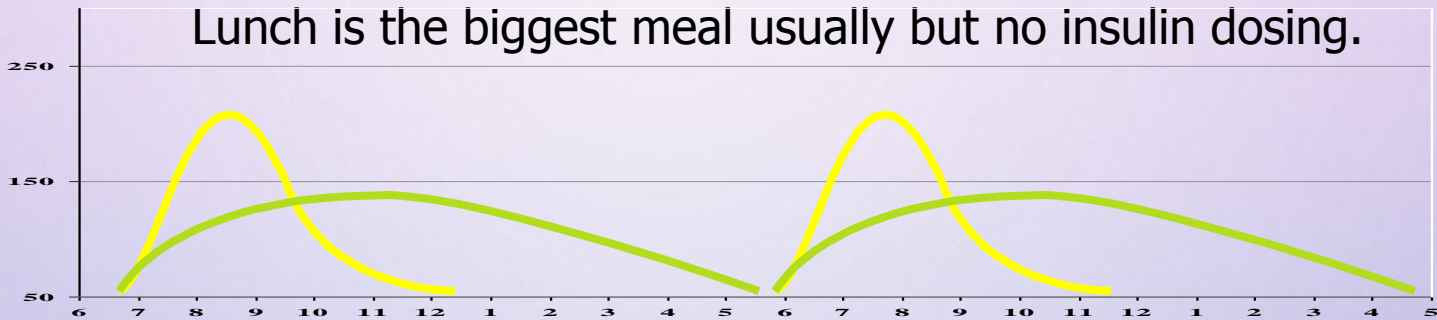
Regular and NPH use twice daily the commonest regimen



used.

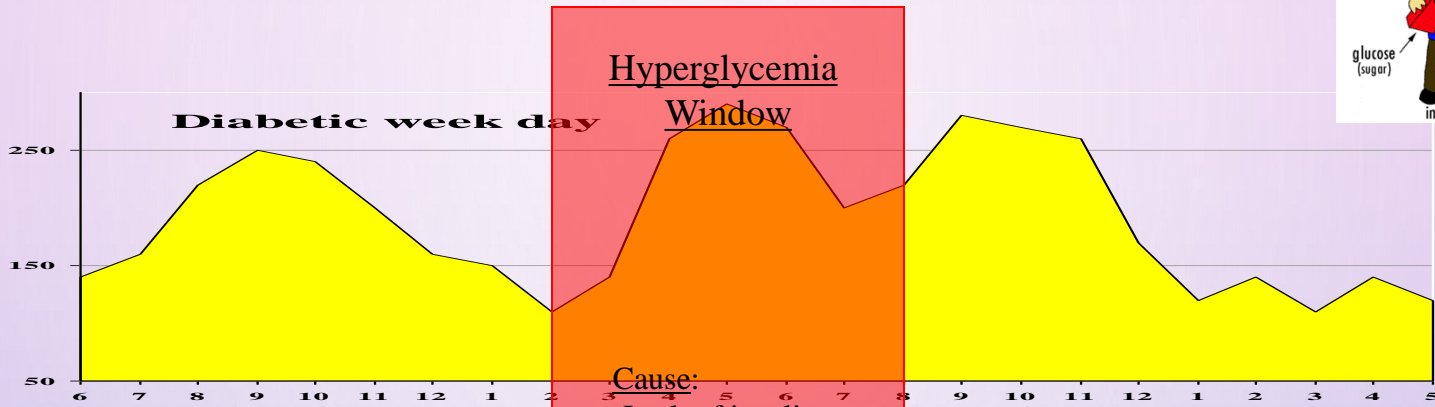
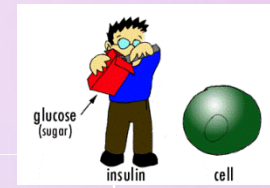
Premixed with different concentration (30/70, 40/60, 50/50).

Lunch is the biggest meal usually but no insulin dosing.



Injection Therapy

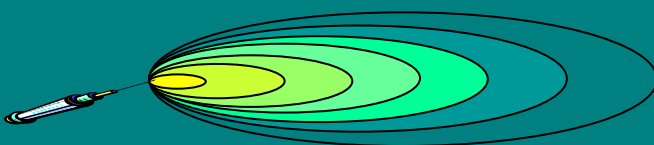
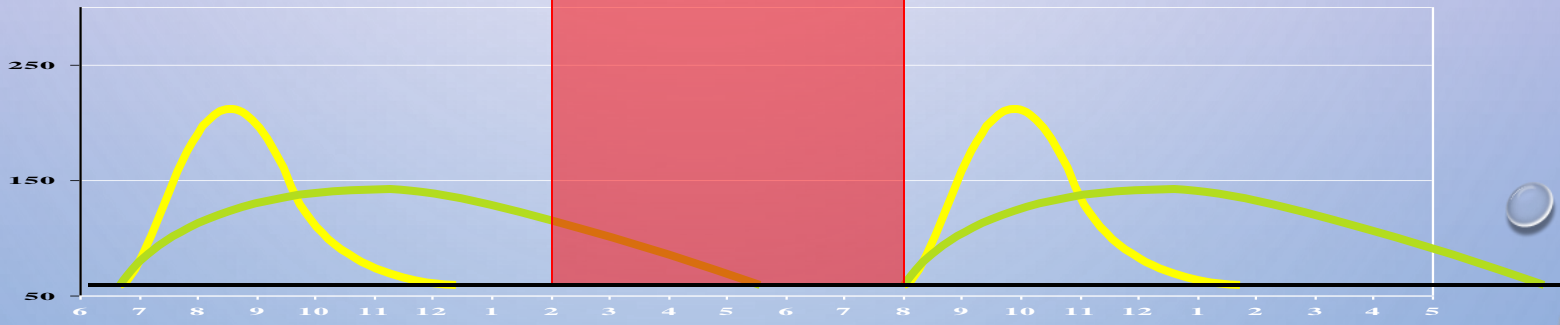
Hyper-glycemia window



Hyperglycemia Window

Cause:
Lack of insulin
Lunch effect
afternoon snacks

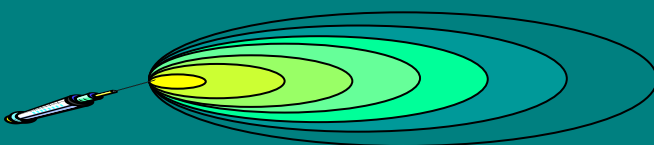
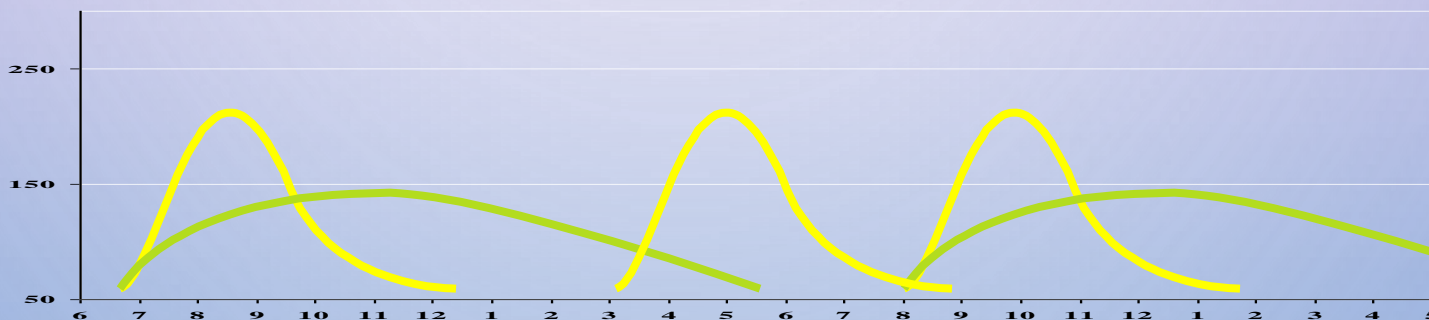
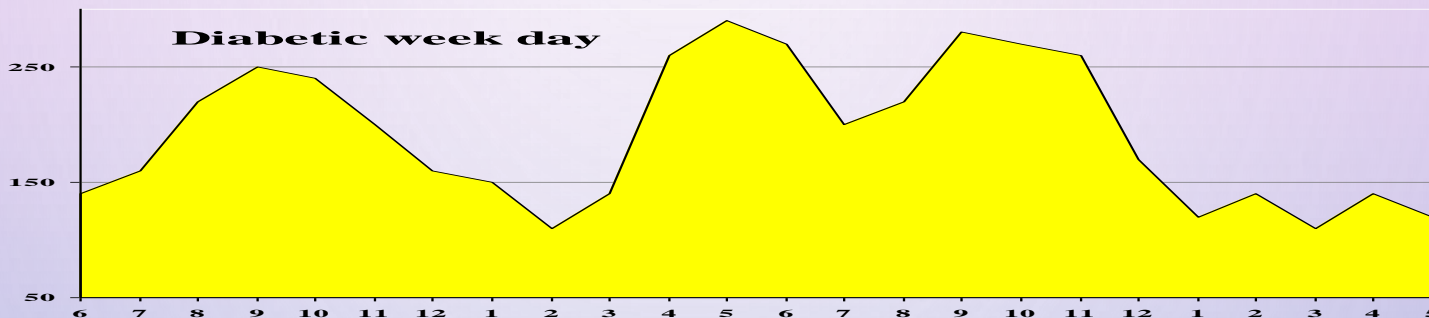
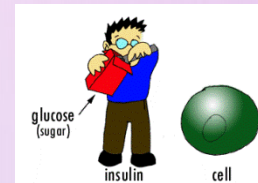
Effect:
Pre-meal hyperglycemia
↑ HbA1c by 1.7%



Injection Therapy

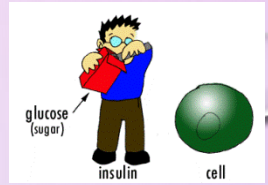
Hyper-glycemia window

Treat by adding regular dose pre-lunch

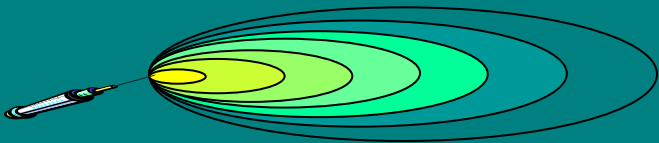
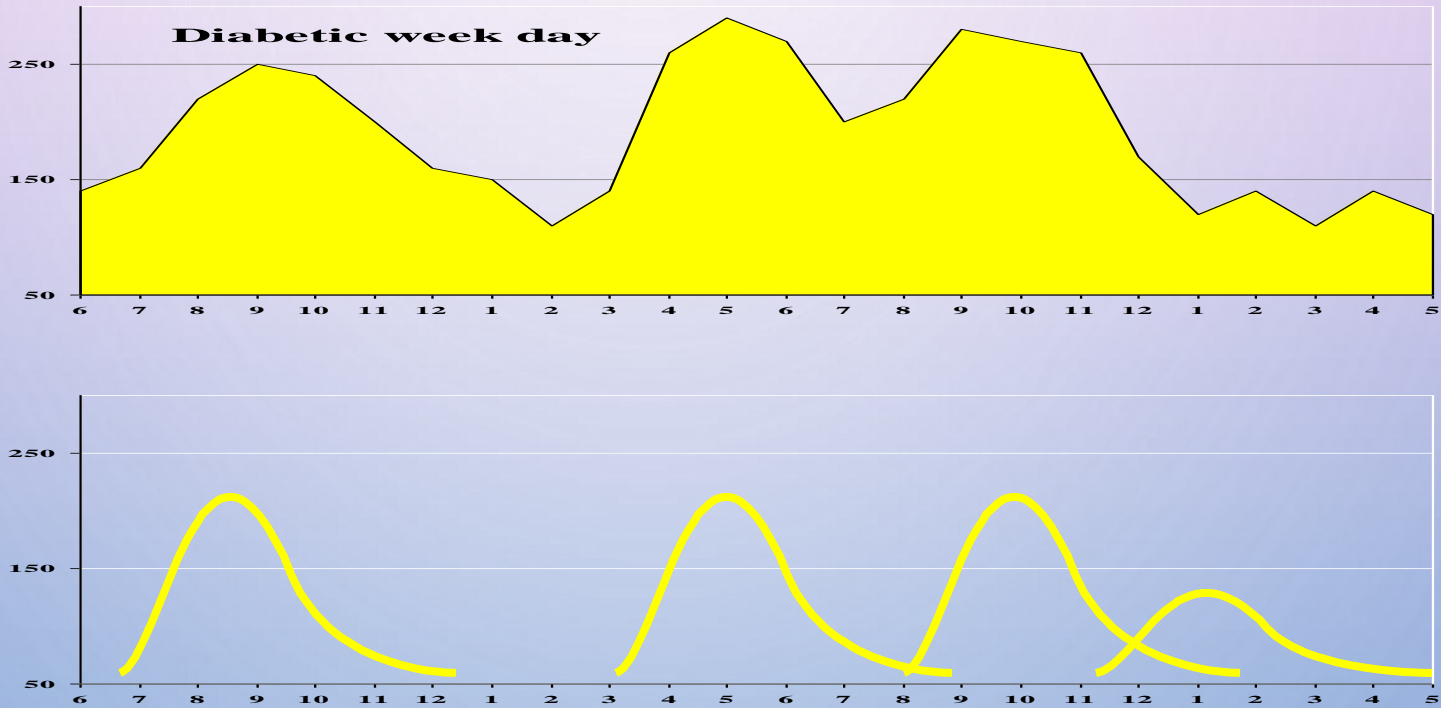


Injection Therapy

Hyper-glycemia window

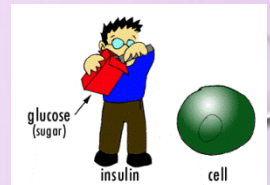


Treat by adding regular dose pre-meals and small one before sleep

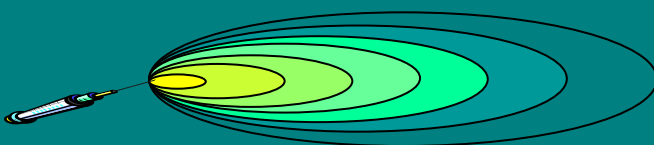
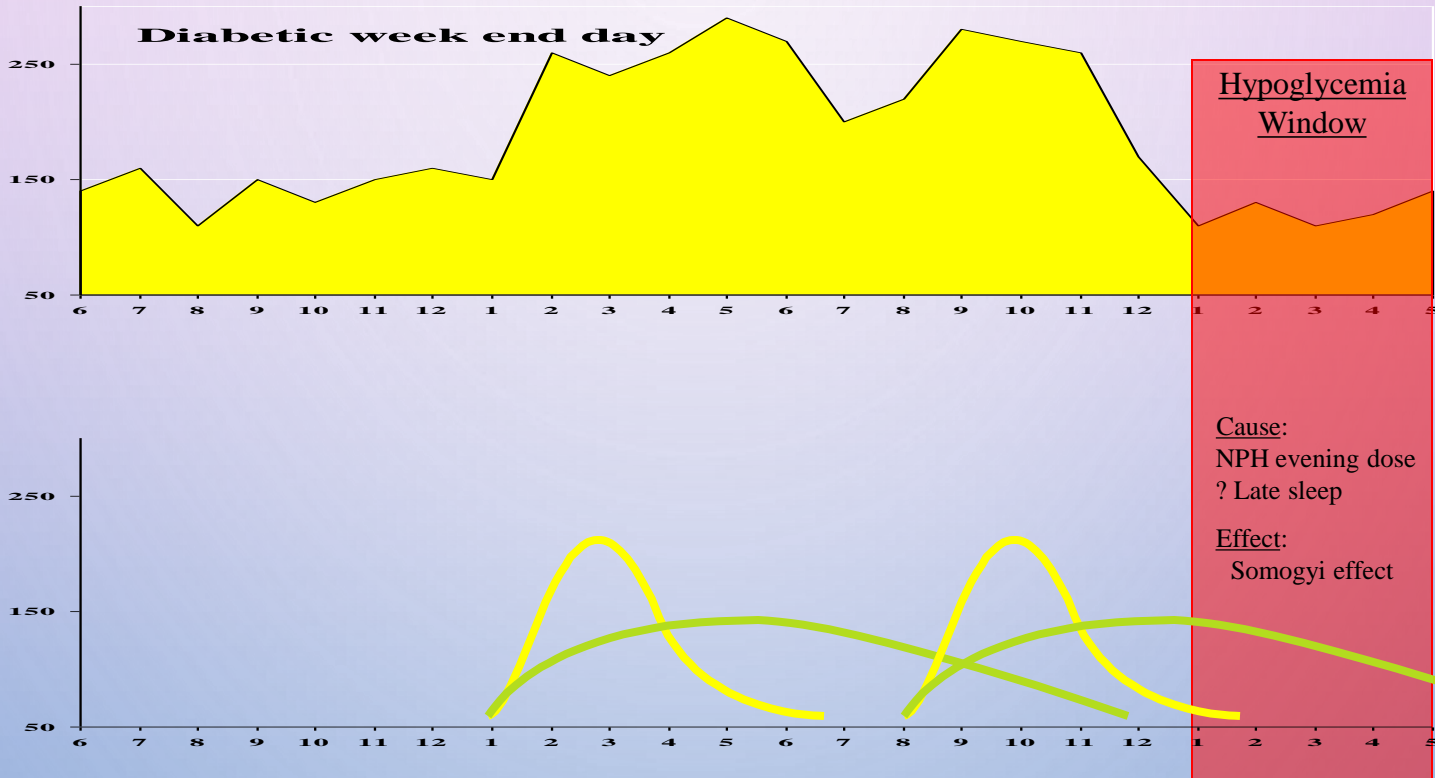


Injection Therapy

Hypo-glycemia window

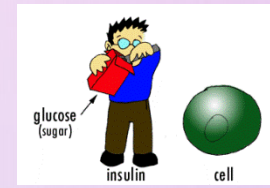


Week end Problem

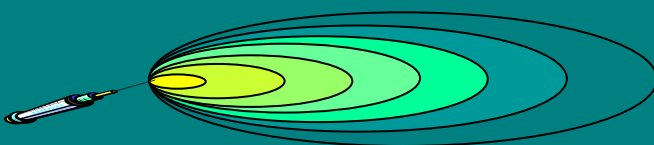
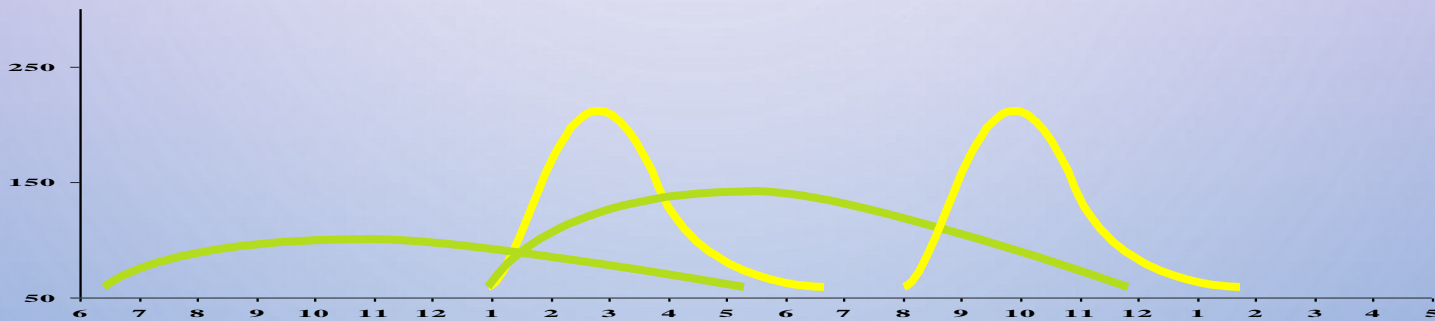
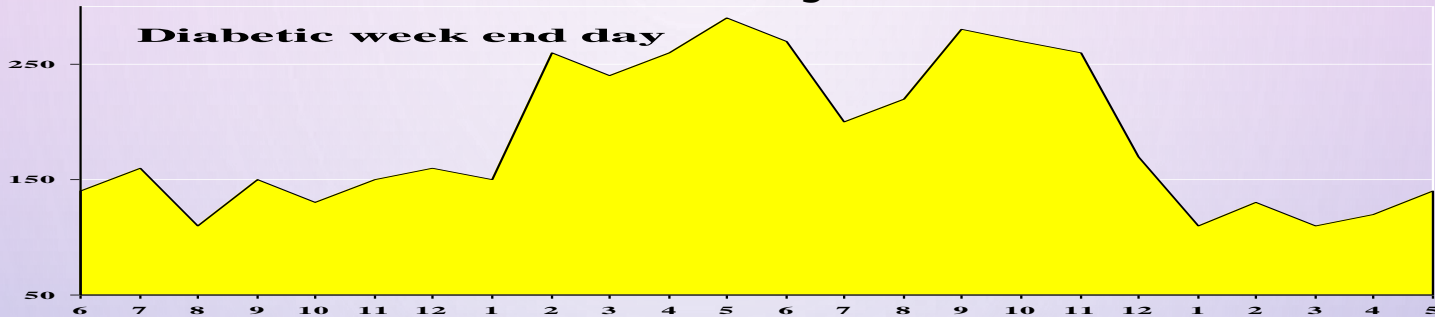


Injection Therapy

Hypo-glycemia window



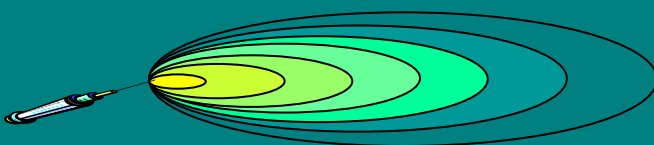
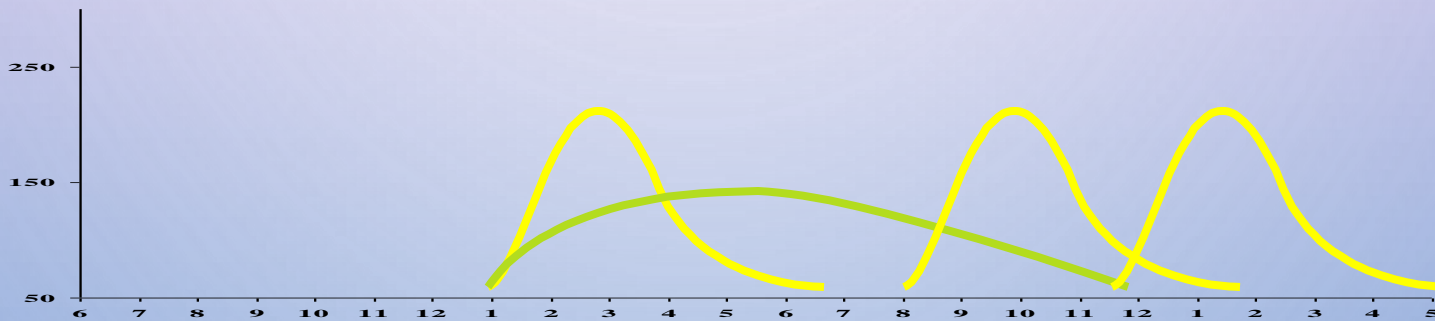
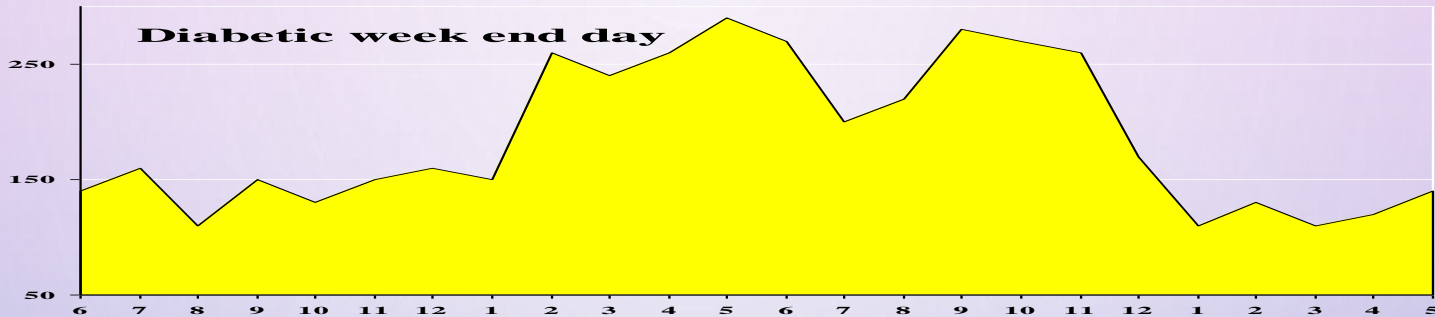
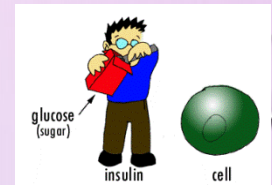
Treat by moving am dose late and regular dose pre-supper and NPH at night



Injection Therapy

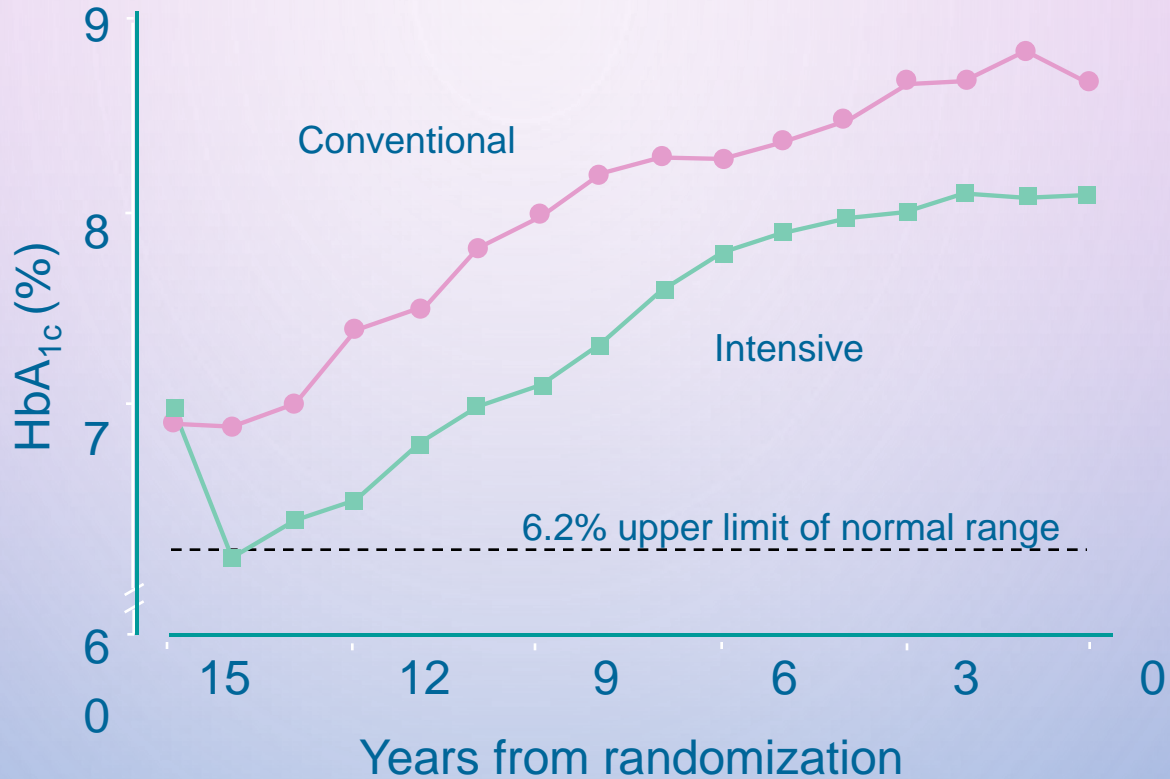
Hypo-glycemia window

Treat by moving am dose late and regular dose pre-supper and another dose pre bed

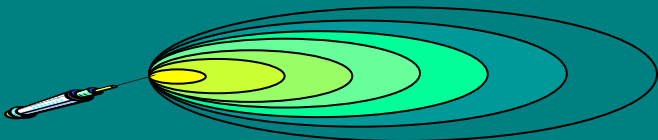


Injection Therapy

Glycemic control

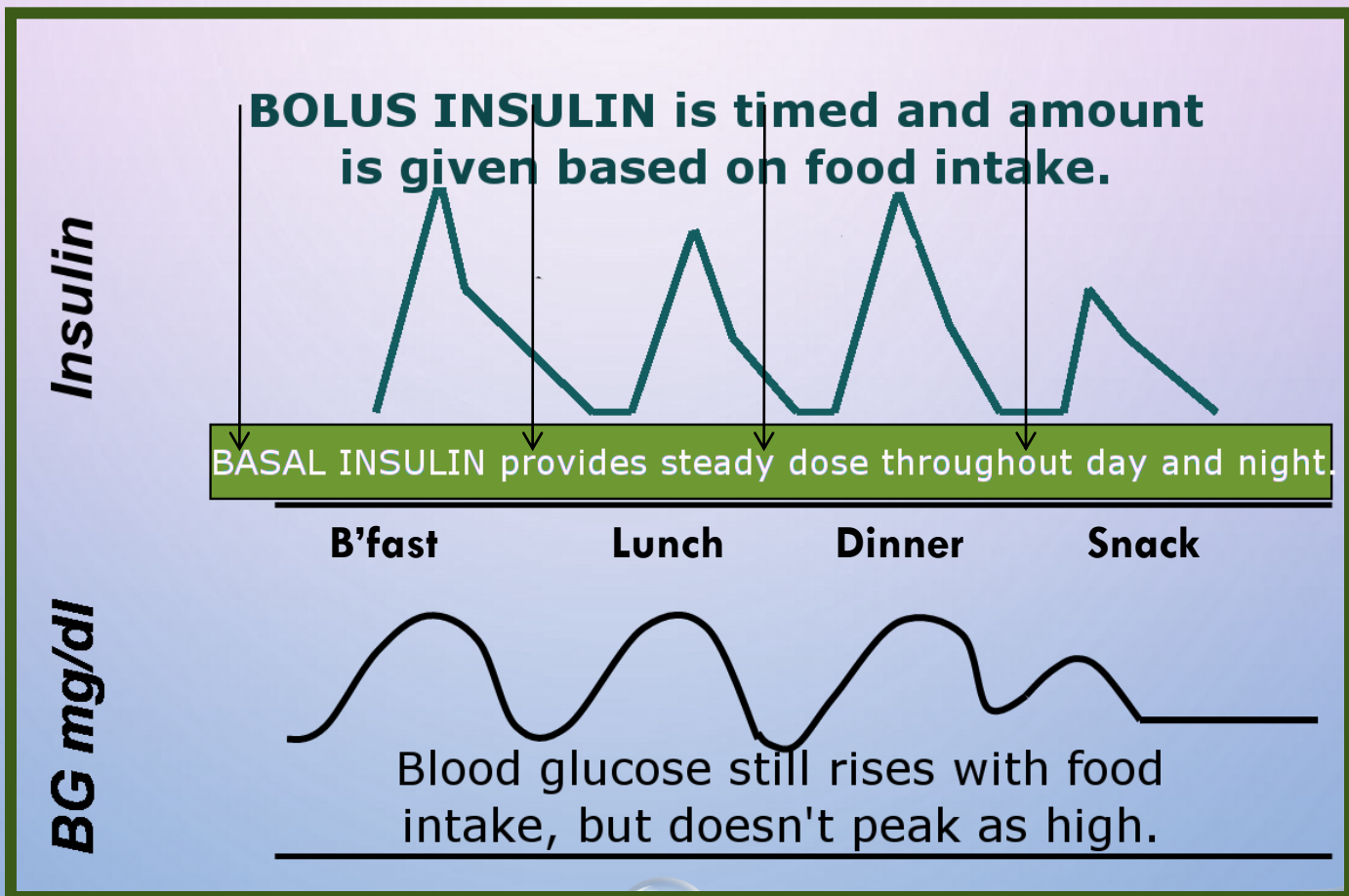


UK Prospective Diabetes Study (UKPDS) Group. *Lancet* 1998; 352:837-853.

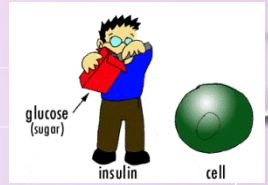


Injection Therapy

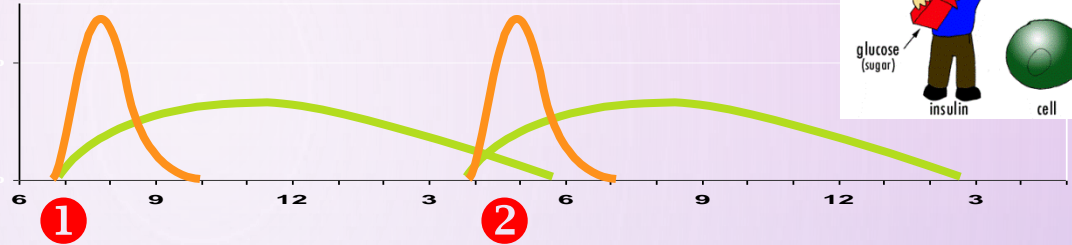
Basal and Bolus Insulin



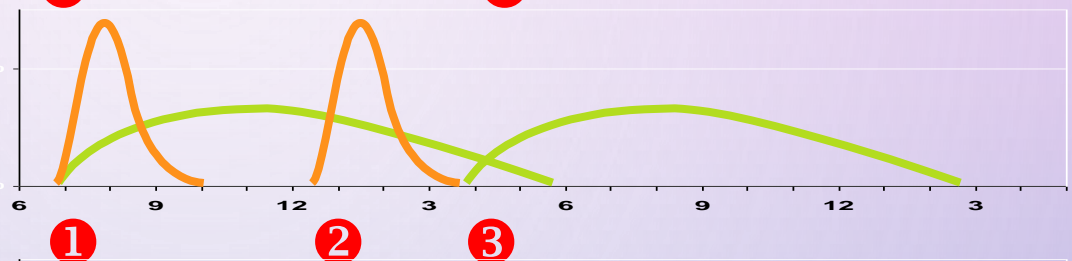
Western regimen



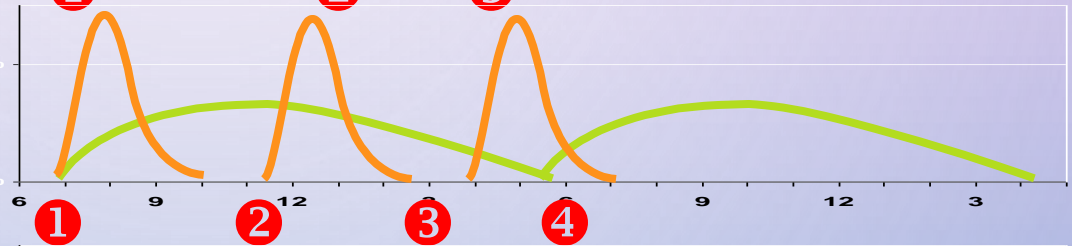
Two doses:
The usual dosing commonly used.
Initial insulin therapy



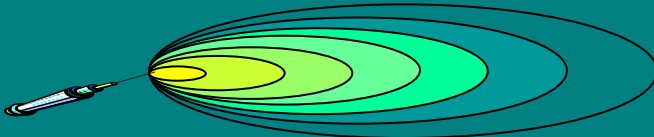
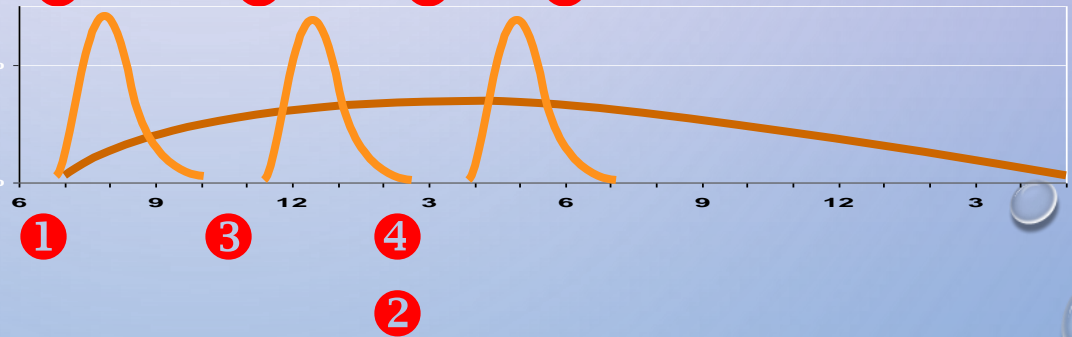
Three doses:
Used for active patients.
Patients taking two main meals.



Four doses:
Brittle diabetic patient.
Pregnant mothers specially type 1.



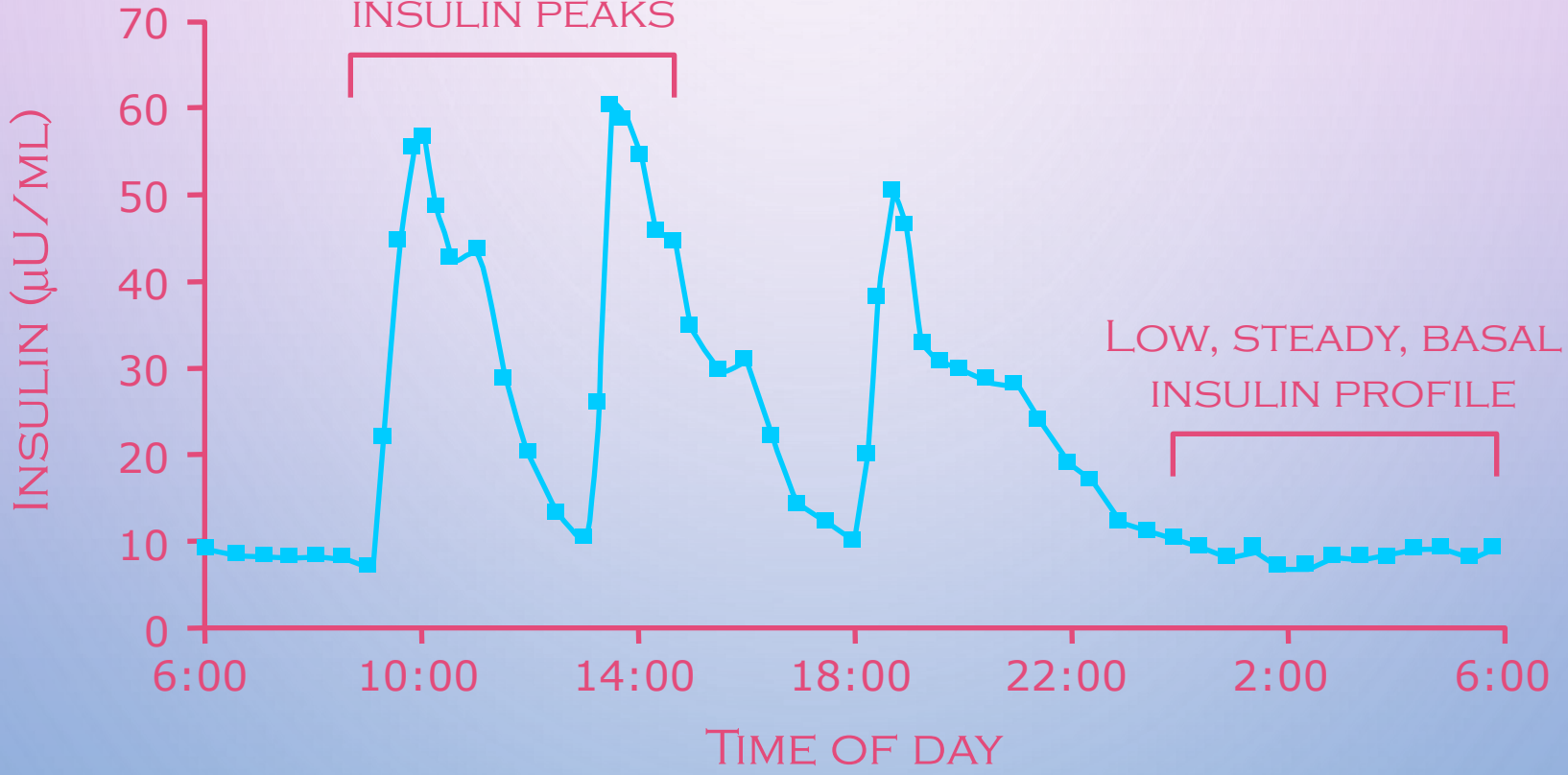
Four doses:
Brittle diabetic patient.
Pregnant mothers specially type 1.
Motivated patients.



INSULIN TREATMENT ATTEMPTS TO MIMIC THE PATTERN OF NORMAL INSULIN SECRETION

SHORT-LIVED, RAPIDLY
GENERATED MEAL-RELATED

INSULIN PEAKS



BENEFITS OF A BASAL–BOLUS INSULIN REGIMEN

- THIS REGIMEN PRODUCES AN INSULIN PROFILE THAT IS CLOSEST TO NATURAL INSULIN PRODUCTION BY THE BODY
- OFFERS GREATER FLEXIBILITY OVER TYPE OF FOOD AND WHEN IT CAN BE EATEN
- SUITED TO THOSE WHO ARE HIGHLY MOTIVATED

INSULIN PRACTICALITIES

TIMING

- SOLUBLE INSULIN: 30-45 MINUTES PRE-MEAL
- SHORT-ACTING INSULIN ANALOGUES: NO MORE THAN 15 MINUTES PRE-MEAL AND CAN BE GIVEN POST-MEAL
- INTERMEDIATE- OR LONG-ACTING INSULINS DO NOT HAVE TO BE GIVEN IN RELATION TO A MEAL

INSULIN PRACTICALITIES

STORAGE

- ONE MONTH IN FRIDGE OR AT ROOM TEMPERATURE ONCE THE VIAL HAS BEEN OPENED
- MUST NEVER BE FROZEN
- STORE AWAY FROM SOURCE OF HEAT
- IF REFRIGERATION NOT AVAILABLE – FRIO BAGS AVAILABLE
- MAY BE DAMAGED BY DIRECT SUNLIGHT OR VIGOROUS SHAKING

VOCABULARY

TARGET RANGE: A RANGE OF NUMBERS THAT REPRESENTS AN INDIVIDUAL'S IDEAL BLOOD GLUCOSE LEVEL; DETERMINED BY HEALTH CARE TEAM WITH THE INDIVIDUAL (CHILD WITH DIABETES AND PARENT/GUARDIAN)

BASAL INSULIN: SOMETIMES CALLED "BACKGROUND" INSULIN, THE INSULIN WORKING STEADILY THROUGHOUT THE DAY

BOLUS INSULIN: A SINGLE DOSE OF INSULIN, GIVEN FOR ONE OF TWO REASONS:

- **CARB OR MEAL/SNACK BOLUS:** INSULIN DOSED WHEN FOOD IS EATEN
- **CORRECTION BOLUS:** INSULIN DOSED WHEN BLOOD GLUCOSE LEVEL IS TOO HIGH AND NEEDS TO BE CORRECTED (MADE LOWER)

WHEN TO GIVE INSULIN

DMMP SHOULD SPECIFY DOSING CLEARLY

GENERALLY:

- *BEFORE MEALS OR SNACKS*
- *FOR BLOOD GLUCOSE LEVELS SIGNIFICANTLY ABOVE TARGET RANGE*
- *FOR MODERATE OR LARGE KETONES*

Many people believe that a diabetes meal plan means that you just have to cut back on sugar.

This is not true!

Carbohydrates (carbs) have the greatest effect on your blood sugar.

90 to 100 percent of the carbs you eat appear in your bloodstream as blood glucose within minutes to hours after you have eaten.

You may be asked to count the carbs that you eat.

The carbs you will need to count are both:

- starches that break down slowly into sugar
- simple sugars that break down into blood glucose almost right away



Previous
slide



Next
slide



Starches include certain vegetables, all grains, and products made from grains

All of these foods contain starches:

Starchy Vegetables

Regular and sweet potatoes, corn, fresh peas and lima beans



Legumes

Dried beans and peas



Grains

Grains like wheat, oats, barley, and rice



Products made from grains, such as pasta, bread, rolls, bagels, crackers, cereals and baked goods



Sugars include the natural sugars in fruit and milk, plus certain sweeteners added to prepared foods and drinks

All of these foods contain sugars:

Fruit and fruit juices
Foods that contain fruit or fruit juices such as jams, jellies, and fruit smoothies



Sweet bakery products
such as cake with icing, pie, donuts, candy, and cookies



Sugary drinks
such as regular soda and fruit drinks



Sweet condiments
such as barbeque sauce, relish and ketchup



Milk and yogurt



Sugar goes by many names...

Some of the names for sugar that you may find in the ingredients include:

table sugar
brown sugar
molasses
honey
beet sugar
cane sugar
confectioner's sugar
powdered sugar
raw sugar
turbinado
maple syrup
high-fructose corn syrup
agave nectar
sugar cane syrup
fructose
lactose
sorbitol
xylitol
glycol
glycerol
mannitol
isomalt and other sugar alcohols



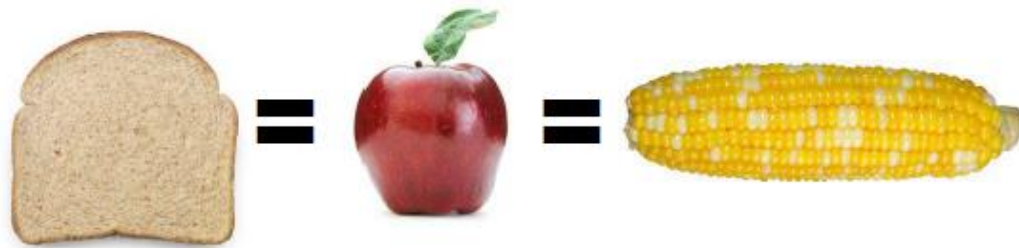
Carb Counting

Being more aware of the carbohydrates you eat, or counting the carbs in your meals, can help you match your medication or activity levels to the food you eat. This can help you to better control your blood glucose.

One serving of carbohydrate is measured as 15 grams.

A food that contains 15 grams of carbohydrate is called "one carb serving".

For example, one slice of bread, a small piece of fruit, or a ear of corn each have around 15 grams of carb. Each of these equals one carb serving.



Carb Counting

Here are examples of the carb amounts in specific foods:

1 cup cooked pasta or 1 cup cooked rice	45g carbohydrate
Whole English muffin	30g carbohydrate
3 cups popped popcorn	15g carbohydrate
Medium potato	30g carbohydrate
1 cup corn or peas	30g carbohydrate
1½ cups veggies (green beans, broccoli, or carrots, cooked)	15g carbohydrate
Small fruit (apple, orange, nectarine)	15g carbohydrate
17 grapes, 12 cherries, ½ cup applesauce	15g carbohydrate
1 cup milk	12g carbohydrate
1 container (6oz.) yogurt, flavored, artificially sweetened	12g carbohydrate
½ cup vanilla ice cream	15g carbohydrate
½ cup sherbet	30g carbohydrate
2 small cookies	15g carbohydrate



“Sugar-free” and “no sugar added” foods may still contain a large amount of carbs.



Sugar-free apple pie has carbohydrates from the apples and the pie crust.

This sugar-free pudding contains 8 grams of carb per ½ cup serving:



Sugar-free pudding has carbohydrates from the milk.

Nutrition Facts

Serving Size: 1/2 cup • 11g	
Amount Per Serving	
Calories 80	Calories from Fat 0
	% DV
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 300mg	12%
Total Carbohydrate 8g	3%
Dietary Fiber <1g	0%
Sugars 0g	
Protein <1g	0%
Vitamin A 4%	Vitamin C 0%
Calcium 15%	Iron 4%
Unofficial Pts: 2	
@DietFacts.com	

Percent of Calories from:
Fat-0% Carb-40% Protein-0%
 (Total may not equate 100% due to rounding.)

*Percent Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Nutrient	2,000		2,500	
	Calories	Calories	Calories	Calories
Total Fat	less than 65 g	80 g	80 g	80 g
Saturated Fat	less than 20 g	25 g	25 g	25 g
Cholesterol	less than 300 mg	300 mg	300 mg	300 mg
Sodium	less than 2400 mg	2400 mg	2400 mg	2400 mg
Total Carbohydrates	300 g	375 g	375 g	375 g
Fiber	25 g	30 g	30 g	30 g

1g Fat = 8 calories 1g Carbohydrate = 4 calories
 1g Protein = 4 calories 1g Alcohol = 7 calories



All carbohydrates affect blood sugar in the same way.

It is the amount of carb you eat that is important, not the type of carb.

A serving of ice cream does not raise blood sugar higher than one equal carb serving of potatoes, rice, or pasta. This is true whether you have type 1 or type 2 diabetes.

For example: These three foods will all raise your blood sugar by the same amount:

- 1 cup of vanilla ice cream that has 30 grams of carbs
- A 2 oz. roll that has 30 grams of carbs
- 2/3 cup of spaghetti that has 30 grams of carbs

Same impact on blood sugar:



30 grams of carb
1 cup serving



30 grams of carb
2 oz. roll



30 grams of carb
2/3 cup



Basic Carb Counting Using Grams


Your meal plan may call for you to eat a specified amount of carbohydrate at each meal or snack.

You do not have to eat the same foods everyday. Your food choices can change from day to day as long as the total carbs specified for each meal and snack stay about the same.


Being consistent is the key to successful carb counting.

For example, if you need to eat around 45 grams of carb for breakfast, here are two different breakfasts that each total around 45 grams of carb:

Breakfast #1	
2 slices of whole wheat toast	30 grams
1 tablespoon jam	15
Egg substitute or egg whites	0
Black coffee with sugar substitute	0
Total grams of carbohydrate:	45 grams



Breakfast #2	
$\frac{3}{4}$ cup of bran cereal	23 grams
$\frac{1}{2}$ cup of milk	6
$\frac{1}{2}$ banana	15
Black coffee with sugar substitute	0
Total grams of carbohydrate:	44 grams

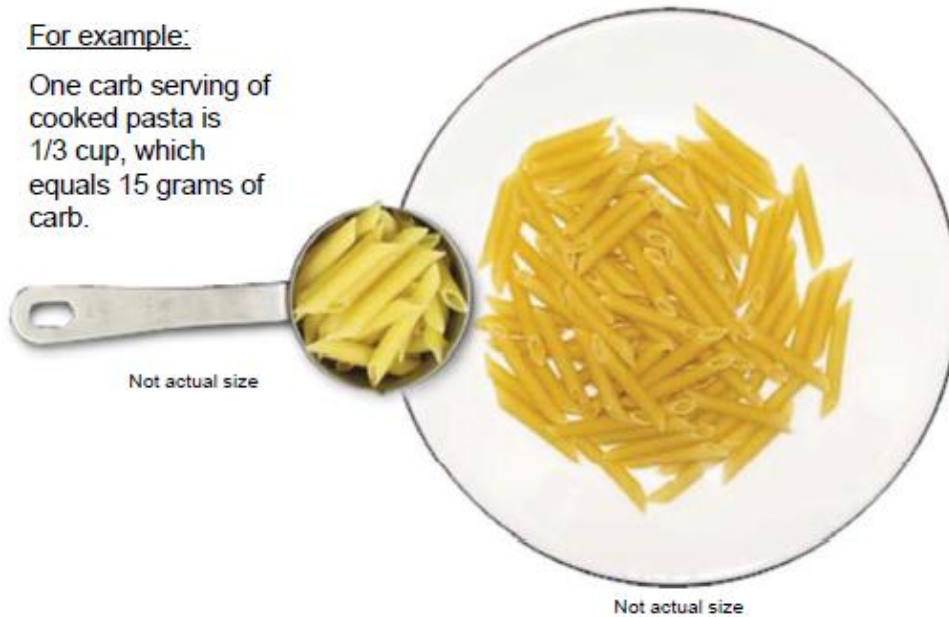


Portion Sizes Matter, so Read Food Labels!

What you think of as a portion may actually count as several carb servings.

For example:

One carb serving of cooked pasta is 1/3 cup, which equals 15 grams of carb.



If you eat 1 cup of cooked pasta, your portion is actually 3 carb servings, totaling 45 grams of carb.



Reading the Food Label

You will find the serving size and the grams of carbohydrate per serving on food labels:

Serving size is here →

Total carbohydrates per serving are here →

Nutrition Facts		
Serving Size: 1/2 cup • 11g		
Amount Per Serving		
Calories 80	Calories from Fat 0	
% DV*		
Total Fat 0g	0%	
Saturated Fat 0g	0%	
Trans Fat 0g		
Cholesterol 0mg	0%	
Sodium 300mg	12%	
Total Carbohydrate 8g	3%	
Dietary Fiber <1g	0%	
Sugars 0g		
Protein <1g	0%	
Vitamin A 4%	Vitamin C 0%	
Calcium 15%	Iron 4%	
Unofficial Pts: 2 @DietFacts.com		
Percent of calories from:		
Fat-0%	Carb-40%	Protein-0%
(Total may not equate 100% due to rounding.)		
*Percent Daily Values (DV) are based on a diet of 2000 calories a day. Your daily values may be higher or lower depending on your calorie needs:		
	2000	2500
Total Fat	less than 65g	80g
Saturated Fat	less than 20g	25g
Cholesterol	less than 300mg	300mg
Sodium	less than 2400mg	2400mg
Total Carbohydrate	300g	375g
Fiber	25g	30g
1g Fat = 9 calories	1g Carbohydrate = 4 calories	
1g Protein = 4 calories	1g Alcohol = 7 calories	



