Diabetes Education Services Presents:

Exploring the GI System or "Gut to the Butt"

2025

Beverly Thomassian, RN, MPH, BC-ADM, CDCES
www.DiabetesEd.net

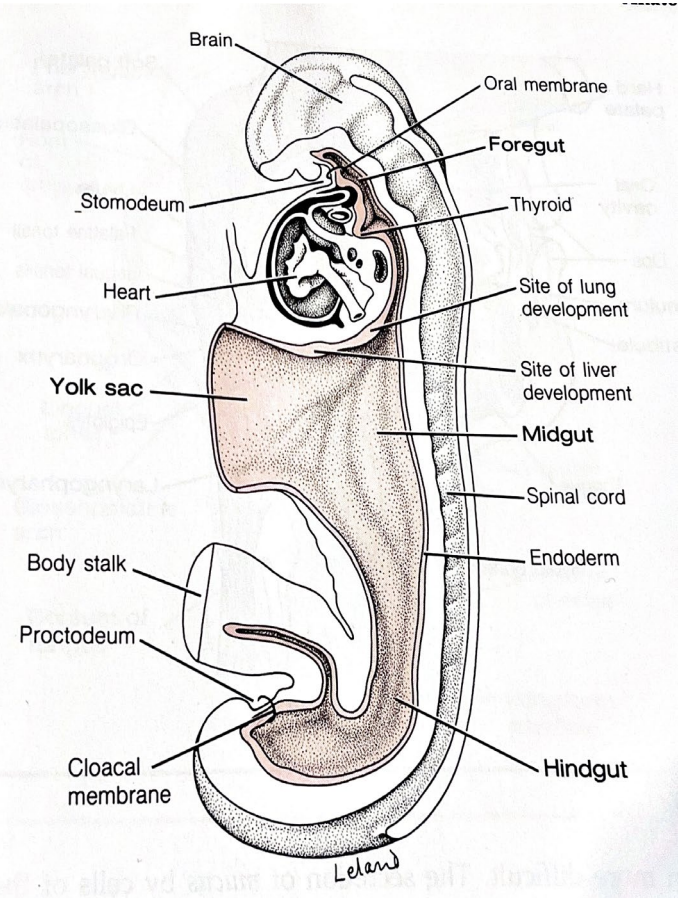
Learning Objectives Exploring the GI Tract

1. Identify complications of the GI System from the mouth to intestines including periodontal disease, gastroparesis, steatosis, pancreatic endocrine and exocrine disorders and infections.
2. Examine the relationship between gut health, microbiome, diabetes and inflammation.
3. Apply effective strategies to improve gut microbiota and intestinal health.

- Enjoy a state of WONDER.

Gut Tube -Embryonic Starting Point

- Embryonic endoderm develops into the interior linings of two tubes in the body, respiratory *and*
- **Digestive Tube**
  - Salivary glands
  - Esophagus
  - Stomach
  - Small and Large Intestine
  - Liver
  - Gallbladder
  - Pancreas
- Thyroid gland
- Parathyroid glands
  - Lose connection with gut before birth to become endocrine organs



Basic Human Anatomy, A. Pense, 1982

Eating Starts with the Eyes

JR thinks that their ability to taste food has diminished recently. They ask you, what are the five confirmed basic tastes of the tongue? Which of the following lists describes the best answer?

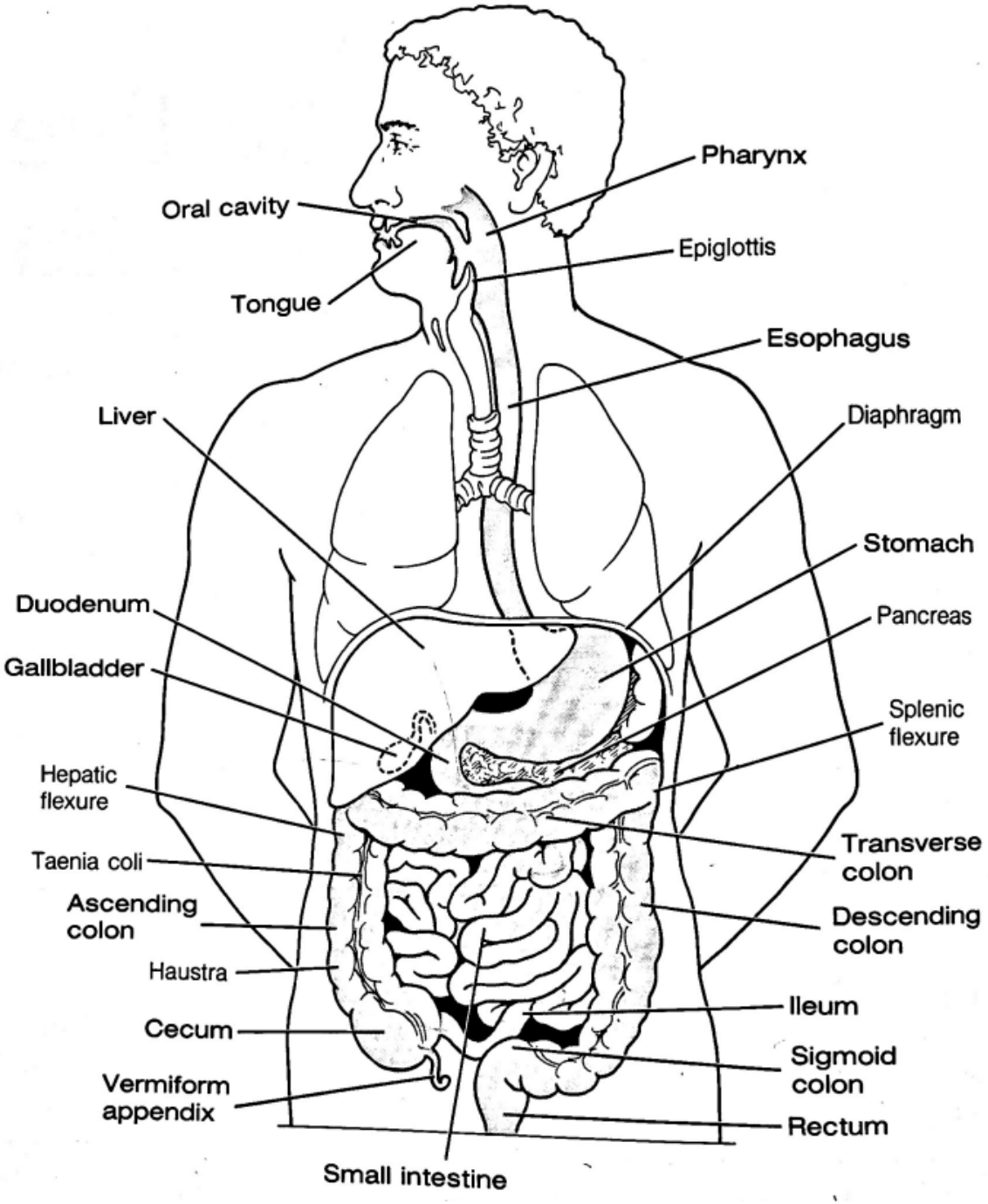
What are the 5 flavors?

Digestion Gets Started

- Eyes see food and make an appraisal of how to best prepare for incoming load.
- Glands secrete saliva to prepare for chewing.
- Salivary enzymes (amylase) help with initial digestion
- Creates bolus.
- Upper pharynx and esophagus under conscious control, the rest involuntary.
- Esophagus smooth muscle, controlled by brain.
- Lower esophageal sphincter gateway from esophagus to stomach.
  - Prevents reflux of gastric contents

Alimentary Canal

Buckle up!



Quick Question 1

- Diabetes is associated with an increased risk of oral disease. Which of the following statements is true?

a. People with diabetes benefit from vinegar gargles to decrease bacterial load
b. People with diabetes are at greater risk for tongue cancer.
c. 1 in 5 cases of tooth loss is linked to diabetes
d. Diabetes is associated with increased tonsillitis.

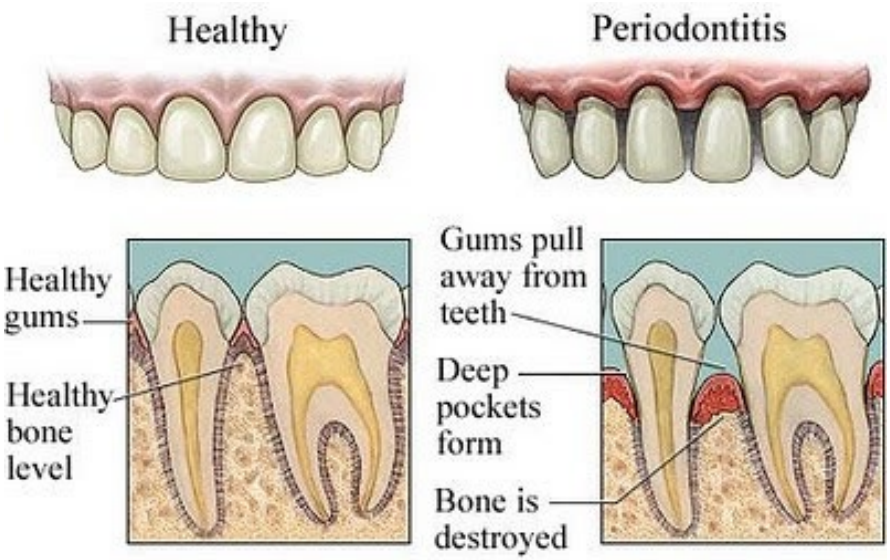
Salivary Dysfunction and Xerostomia (dry mouth) in DM

- Less saliva uptake and excretion = less protection against bacteria
- Hyperglycemia increases glucose levels in saliva, providing medium for bacterial growth- also promotes dry mouth
- Dry mouth increases risk o infection and can alter nutritional intake (due to chewing, swallowing difficulties)

Periodontal Disease

- More severe and prevalent with diabetes and elevated A1c levels.
  - periodontal treatment associated with better glycemic control

    (A1C 8.3% vs. 7.8%)
  - Benefits lasted for 12 mo's

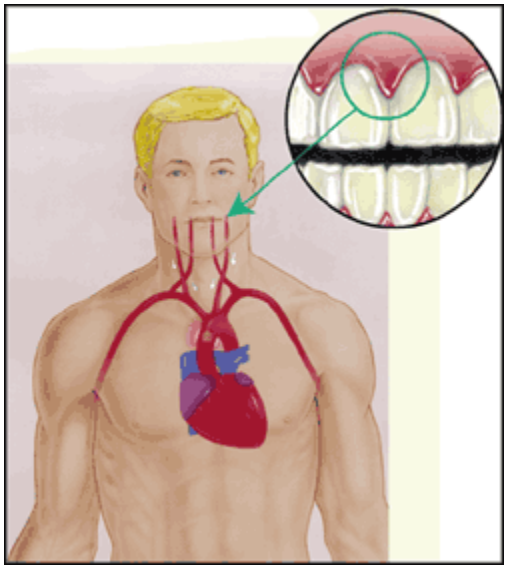


- People with periodontal disease have higher rates of diabetes.
- Bidirectional

Oral Care Matters

- See dentist at least yearly
- Dental hygienist twice yearly
- Brush twice daily
- Floss daily

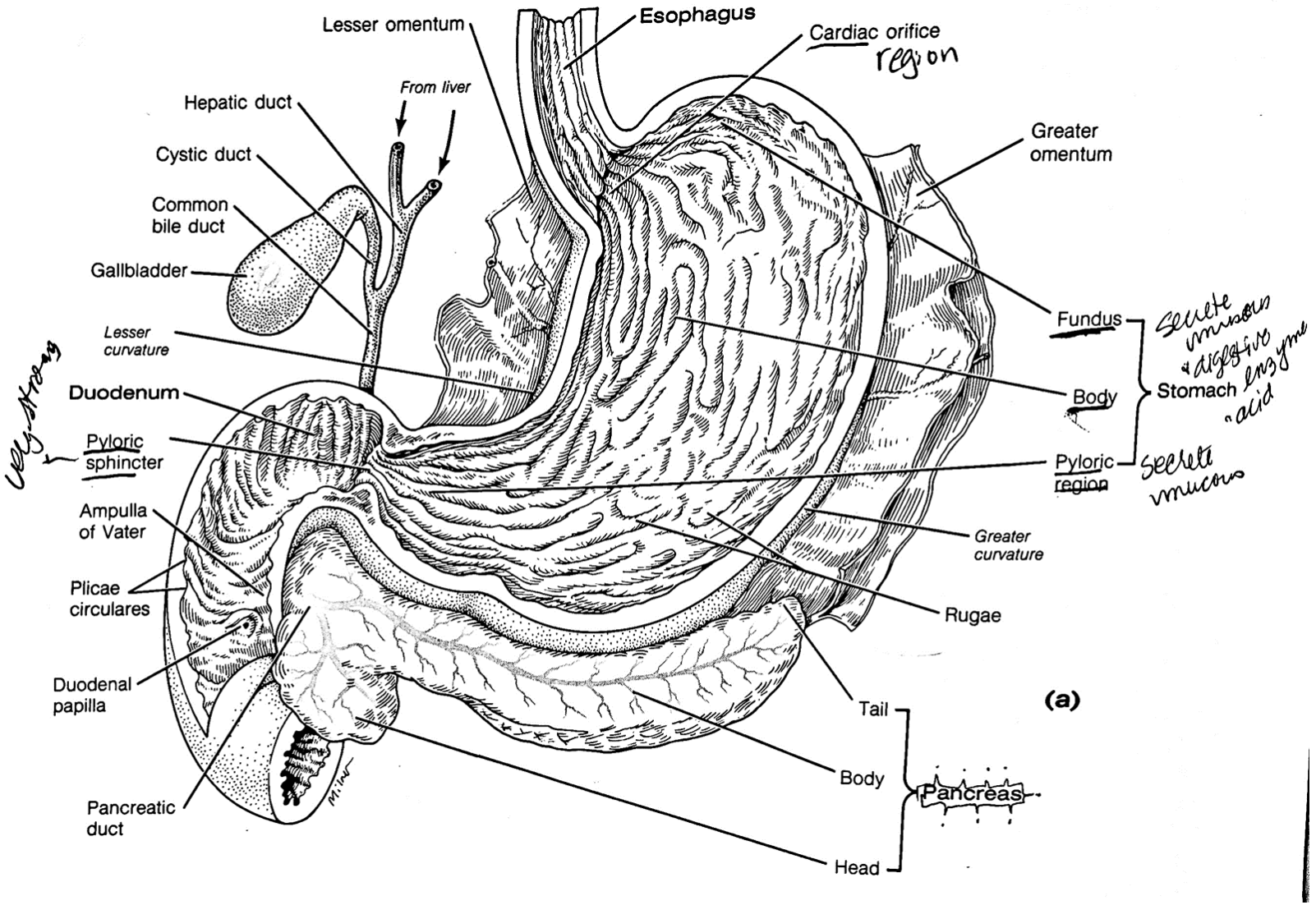
Periodontal disease and Heart Disease



- Heart disease link:
  - oral bacteria enter the blood stream, attach to fatty plaques in coronary arteries increasing clot formation
  - inflammation increases plaque build up, which may contribute to arterial inflammation
- Hyperglycemia = Gingivitis = Heart Disease

Best $10 You Will Ever Spend

Stomach


Lesser omentum
Esophagus
Cardiac orifice
region
From liver
Hepatic duct
Cystic duct
Common bile duct
Gallbladder
Greater omentum
Lesser curvature
Fundus
Body
Stomach
Pyloric region
secrete mucus
Duodenum
Pyloric sphincter
Ampulla of Vater
Plicae circulares
Duodenal papilla
Pancreatic duct
Greater curvature
Rugae
Tail
Body
Head
Pancreas
(a)

Bonus Question 2

Best definition for borborygmi is:

- A tropical fruit used for nausea
- Stomach rumbling
- Gastric reflux
- Treatment for constipation

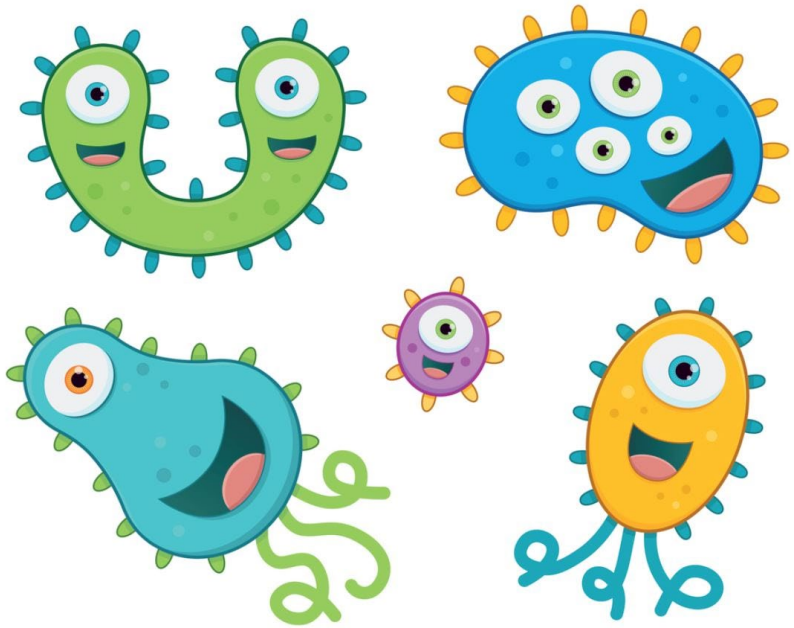
What Happens in Stomach?

- Food in fundus – serves as a holding and mixing area
- Gastric juice start breaking down larger particles.
- Bolus moved to lower regions and broken into smaller particles through stomach acid and motility.
- Gurgling and stomach rumbling is audible reflection of movement.
- Usual meal takes about 4 hours to pass through or 1-4 kcals per minute.
- Carbs take a few hours to pass through.
- Protein/fatty meals can take up to 6 hours.

Digestion Time based on Calories

- 400 cals
  - 4 cals a minute
  - 100 minutes or
  - 1 hour 40 minutes to digest
- 1000 cals
  - 4 cals a minute
  - 250 minutes or
  - 4 hours and 10 minutes

Stomach Issues



- H. Pylori infection
- Gastroparesis
  - G-POEM
- Metabolic surgery

Nob
Gas

The Nob

Medicine

BREAKTHROUGHS

July 16 | 2020

He Poisoned Himself to Find a Cure for Stomach Ulcers -- And Won a Nobel Prize

Sarah Watts

History | Feature Story

Dr. Barry Marshall (along with a collaborator) discovered that the bacteria H. Pylori, pictured, caused stomach ulcers.

(Photo credit: Barry Marshall on Twitter and UEG)

H. Pylori Infection Symptoms

- 50% of world's population co-exist with H. Pylori
  - Causes inflammation in a small percentage of people
- Main Symptom - An aching or burning pain in abdomen which may be worse with an empty stomach.
- H. pylori infection symptoms include:
  - Feeling of fullness or bloating with fluid and solid food
  - Hunger and empty feeling in the stomach, often 1 to 3 hours after meal
  - Mild nausea that may go away with vomiting
  - Loss of appetite
  - Weight loss without trying
  - Burping
  - Bloody or dark, tarry stools or bloody vomit
- About 10% to 15% of people infected with *H pylori* develop peptic ulcer disease.
- About 1-3% develop stomach cancer

People with diabetes at risk for H. pylori and vice versa.

Quick Question 3: Bloating & Post Meal Hypo

- JR has lived with type 1 diabetes for over 30 years and has been complaining that they feel full and bloated after eating and experiencing more post-meal hypoglycemia.
- **Based on this information, what is the most appropriate recommendation for JR?**

a. Evaluate transglutaminase levels.

b. Encourage small, frequent, low fiber meals.

c. Suggest a consult for a gastric pacemaker.

d. Recommend they try avoiding foods with gluten for a few weeks to see if they feel better.

Gastroparesis

- Gastroparesis: affects 20 – 30% of individuals with longstanding diabetes
- Delayed emptying of stomach contents due to nerve damage
- S/S include early satiety, fullness, postprandial hypo, vomiting
- Diagnosis: gastric emptying studies, post-prandial hypoglycemia
- Tx: improve BG, small, low fat & fiber meals & meds

Nutrition for Gastroparesis

- Dietary changes are a high priority in treatment
- Consider the following dietary modifications:
  - Decrease fiber (may lead to bezoar formation)
  - Evaluate fat intake
    - Fat is a good/high source of calories so limit only after other measures are exhausted
    - Liquid fats may be tolerated better

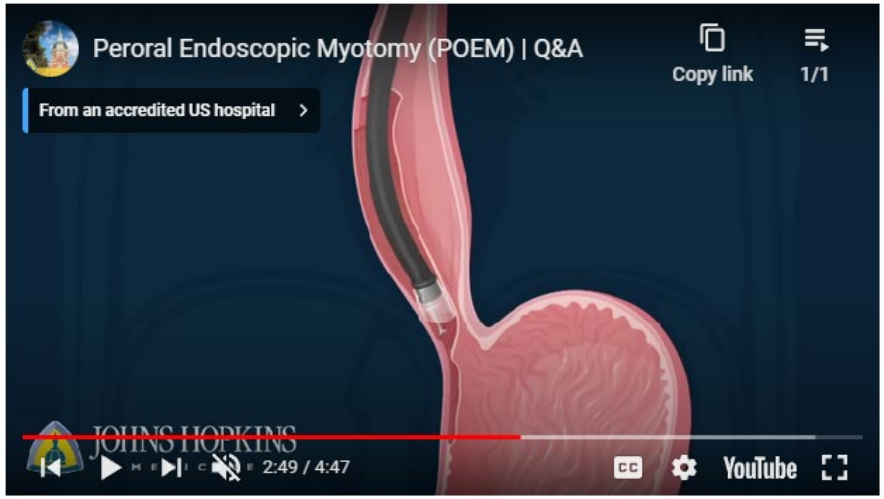
Nutrition for Gastroparesis

- Consider dietary modifications:
  - Multi supplement if intake is insufficient
  - Small and frequent meals
  - Liquid/pureed calories
    - May need to try liquid calories later in the day
  - Chew foods well
  - Sit up for 1-2 hours after eating

Gastric peroral endoscopic myotomy or G-POEM

- The gateway from the small intestine to the duodenum is the pylorus.
- Food knocks of the pyloric sphincter for admission to duodenum
- Doors usually easily open, with limited resistance.
- With gastroparesis, pyloric sphincter is stiff and closed shut.

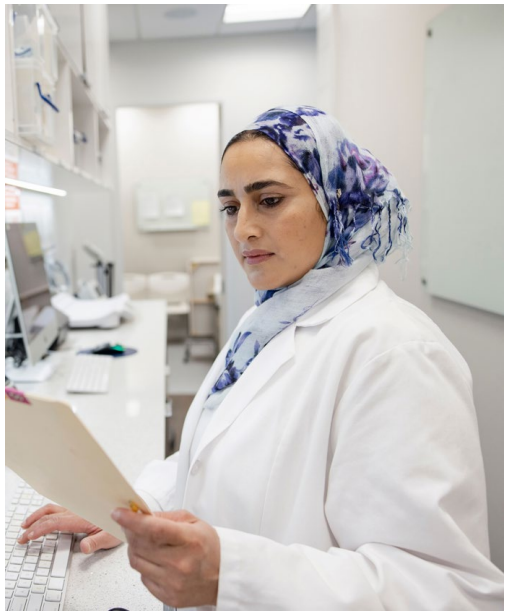
https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/peroral-endoscopic-myotomy



- This endoscopic G-POEM procedure cuts the muscles near the pyloric sphincter (a myotomy).
- Helps to permanently relax the sphincter, so food can empty freely.

Gut Hormones

- Gut hormones secreted by the L-cell of the intestine. Some in the small intestine, but more the larger intestine.
- People with type 2 make about 50% less gut hormones, but new study shows that people with type 1 may benefit from GLP-1 therapy early in diagnosis.
- Can slow peristalsis down too much, and lead to an intestinal blockage – Ozempic warning.



GLP-1 & GIP Hormones

Glucagon-like Peptide-1 Receptor Agonism

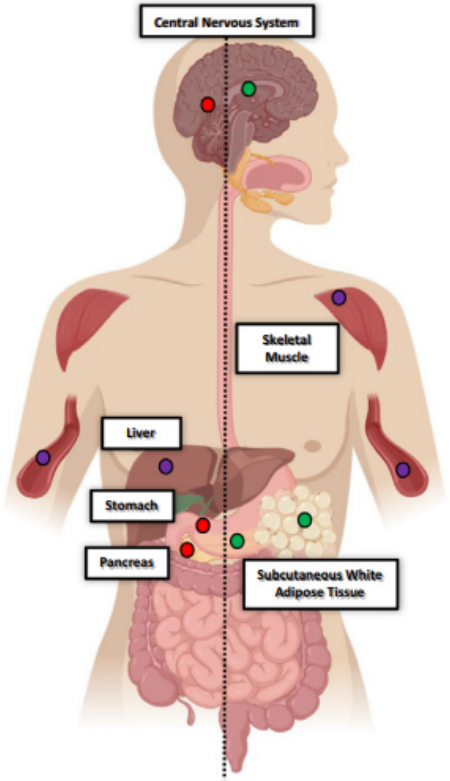
Central Nervous System
- ↑ Satiety
- ↓ Food Intake
- ↑ Nausea
- ↓ Body Weight

Pancreas
- ↑ Insulin
- ↓ Glucagon

Stomach
- ↓ Gastric Emptying

Systemic
- ↓ Hyperglycemia

Liver
- ↑ Insulin Sensitivity
- ↓ Hepatic Glucose Production
- ↓ Ectopic Lipid Accumulation



Glucose-dependent Insulinotropic Polypeptide Receptor Agonism
Glucagon-like Peptide 1 Receptor Agonism
Indirect Action

Glucose-dependent Insulinotropic Polypeptide Receptor Agonism

Central Nervous System
- ↓ Food Intake
- ↓ Nausea
- ↓ Body Weight

Pancreas
- ↑ Insulin
- ↑ Glucagon

Subcutaneous White Adipose Tissue
- ↑ Insulin Sensitivity
- ↑ Lipid Buffering Capacity
- ↑ Blood Flow
- ↑ Storage Capacity
- ↓ Proinflammatory Immune Cell Infiltration

Systemic
- ↓ Hyperglycemia
- ↓ Dietary Triglyceride

Skeletal Muscle
- ↑ Insulin Sensitivity
- ↑ Metabolic Flexibility
- ↓ Ectopic Lipid Accumulation

Samms RJ, Coghlan MP, Sloop KW. How May GIP Enhance the Therapeutic Efficacy of GLP-1? Trends Endocrinol Metab. 2020 Jun;31(6):410-421.

Pocket Card: GLP-1 & GIP RA

GLP-1 & GIP Receptor Agonists

Class/Main Action	Name	Dose Range	Considerations
GLP-1 RA - Glucagon Like Peptide Receptor Agonist **"Incretin Mimetic"** • Increases insulin release with food • Slows gastric emptying • Promotes satiety • Suppresses glucagon	exenatide (Byetta)	5 and 10 mcg BID	**Side effects:** nausea, vomiting, weight loss, injection site reaction. Report signs of acute pancreatitis or intestinal blockage (ileus) and stop med. **Black box warning:** Thyroid C-cell tumor warning (avoid if family history of medullary thyroid tumor). *Significantly reduces risk of CV death, heart attack, and stroke. §Approved to reduce risk of CKD †Approved for pediatrics 10-17 yrs Lowers A1C 0.5 – 1.6% Weight loss: 4-6% body weight loss.
	exenatide XR† (Bydureon)	2 mg 1x a week Pen injector - Bydureon BCise	
	liraglutide*† (Victoza)	0.6, 1.2 and 1.8 mg daily	
	dulaglutide*† (Trulicity)	0.75, 1.5, 3.0 and 4.5 mg 1x a week pen injector	
	semaglutide*§ (Ozempic)	0.25, 0.5, 1.0 and 2.0 mg 1x a week pen injector	
	(Rybelsus) Oral tablet	3, 7, 14 mg - Original dosing. 1.5, 4, 9 mg - New dosing. AM dose, pre-food, w/ water sip	
GLP-1 & GIP Receptor Agonist Activates receptors for GLP-1 (see above) & Glucose-dependent Insulinotropic Polypeptide (GIP).	Tirzepatide (Mounjaro)	2.5, 5.0, 7.5, 10, 12.5 and 15 mg 1x a week prefilled single dose pen Increase dose by 2.5 mg once monthly to reach targets.	**Side effects:** nausea, diarrhea, injection site reaction. Report pancreatitis, signs of intestinal blockage. **Black box warning:** Avoid if family history of medullary thyroid tumor. Lowers A1C ~ 1.8 - 2.4% Weight loss: 7-13% body weight loss at max dose.

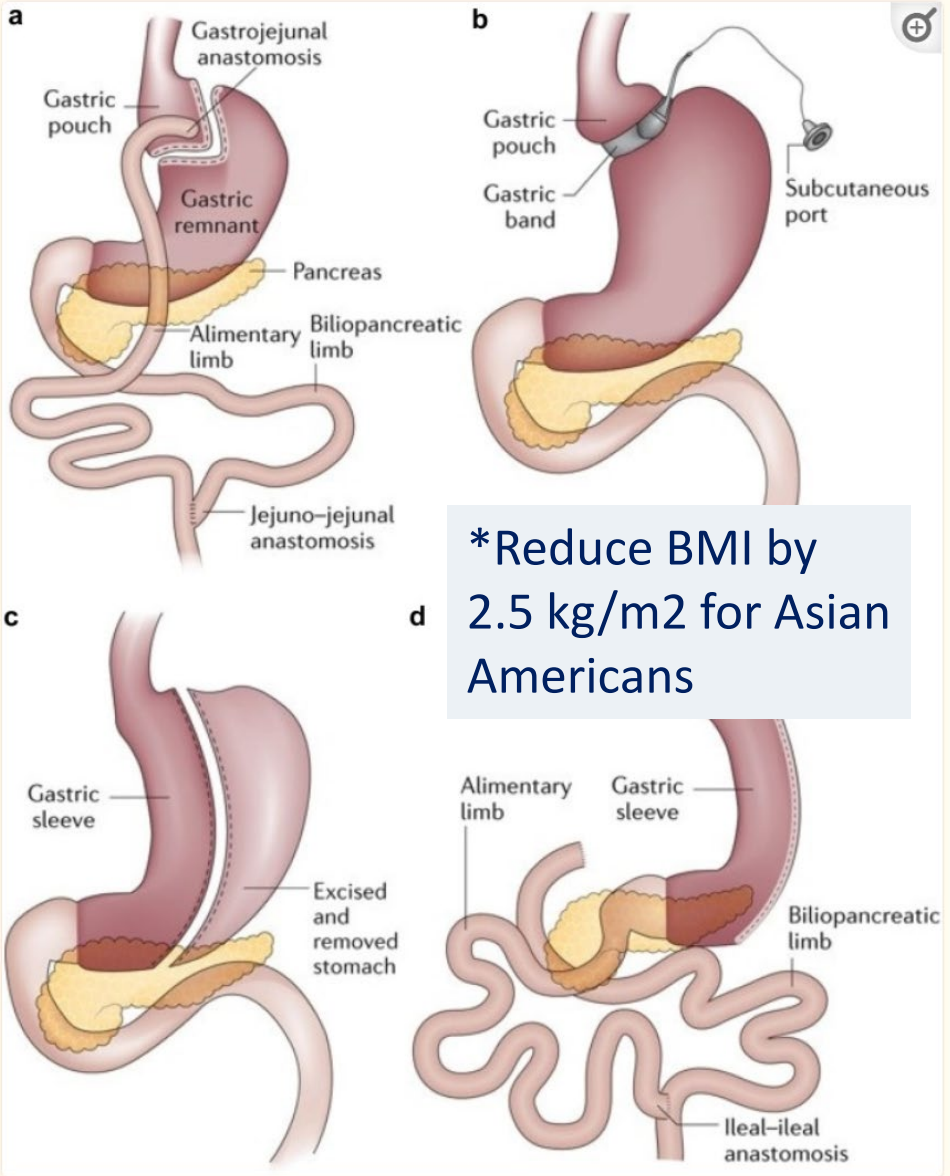
Metabolic Surgery for Weight Loss

- **Considered* as an option to treat T2DM for screened surgical candidates with:
  - BMI 30 – 34.9 kg/m^2 for those who don't achieve wt. loss w/ nonsurgical methods

- **Recommended* as an option to treat T2DM for screened surgical candidates with:
  - BMI ≥ 40 kg/m^2
  - BMI 35 - 39.9 kg/m^2 for those who don't achieve wt. loss w/ nonsurgical methods

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC634

atus%20after%20bariatric%20surgery,is%20achieved



*Reduce BMI by 2.5 kg/m2 for Asian Americans

Metabolic Surgery for Weight Loss

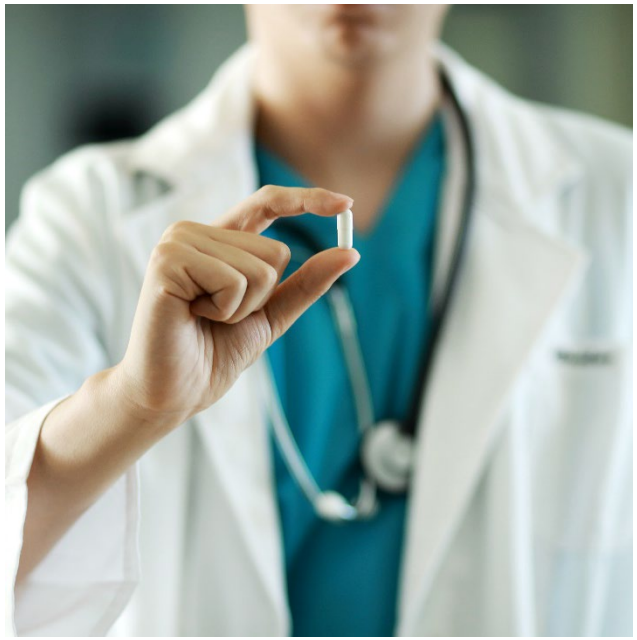
Advantages in T2DM

- Diabetes remission in 30-63% of those with RYGB.
  - 35-50% of those who go into remission experience recurrence, but median disease-free period is 8.3 years.
- Many with diabetes will sustain glycemic improvement for 5-15 years.
- Additional health benefits

Disadvantages

- Costly (but likely cost effective)
- Long-term concerns: dumping syndrome, anemia, osteoporosis, severe hypoglycemia, nutrient deficiency.
- Increased risk of substance use, new-onset depression/anxiety

Metformin helps gut microbiota in diabetes

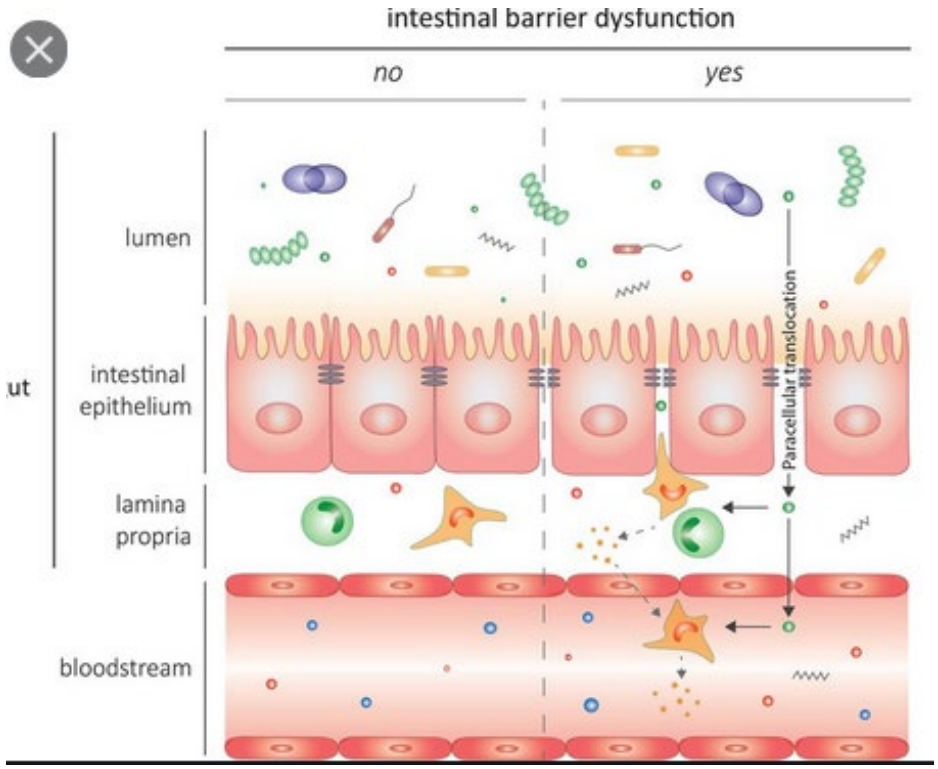


Especially increases Akkermansia and Bifidobacterium.

- Induces GLP-1 secretion
- Changes in *Bacteroidetes/Firmicutes* ratio
- Capacity to induce mucin expression similar to *Akkermansia* muciniphila
- Improves the metabolic profile by lowering tissue inflammation in the presence of extra weight

https://www.frontiersin.org/journals/endocrinology/articles/10.3389/fendo.2021.626359/full

Akkermansia Muciniphila



A. muciniphila in our mucus lining is inversely correlated with obesity and diabetes in both mice and humans.

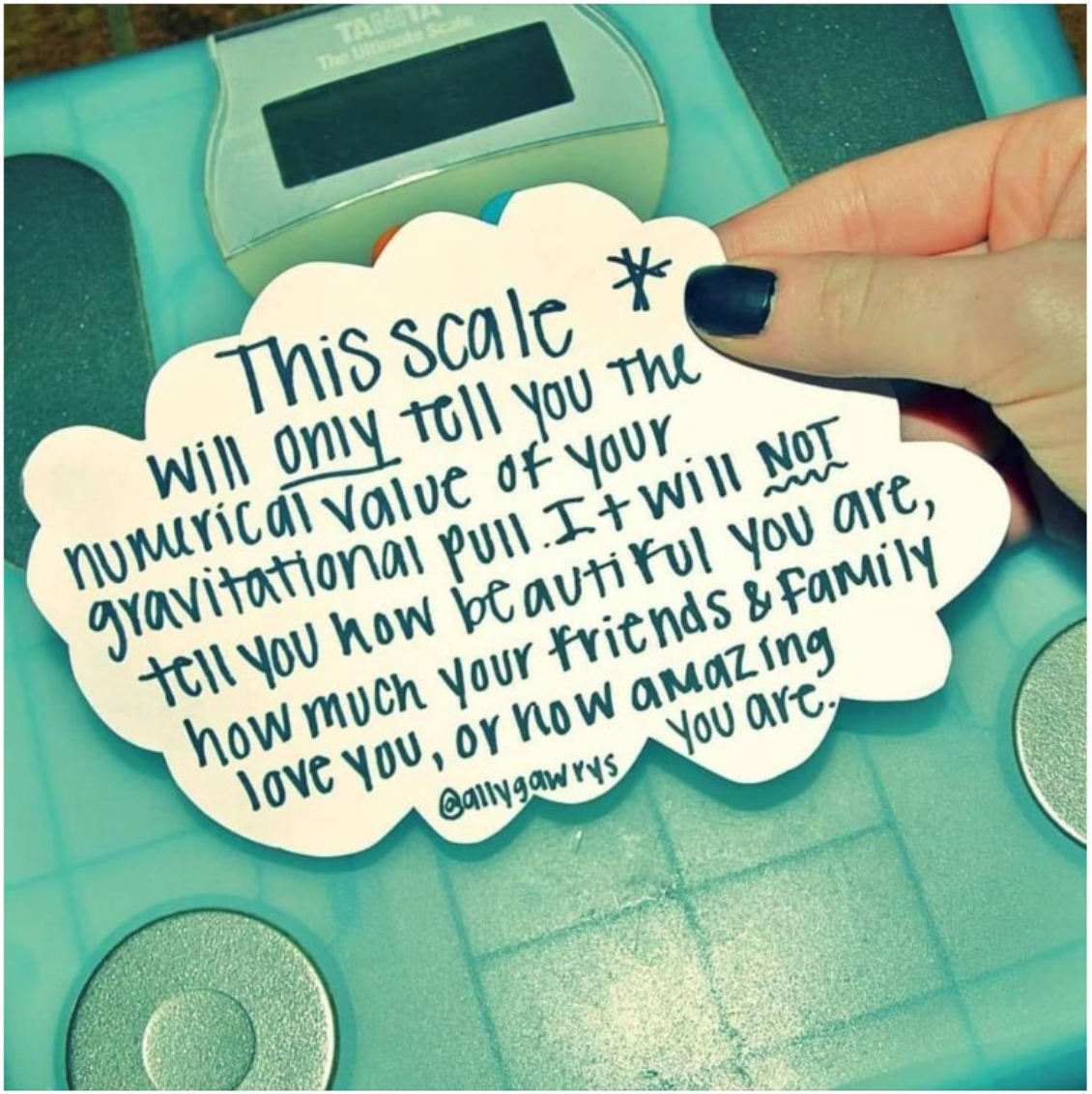
Mucus lining protector and increases presence of short chain fatty acids.

High levels of A. muciniphila is associated with improved health.

"AKK" is associated with enhanced intestinal barrier function and incretin secretion from intestinal endocrine cells. Together, these actions suppress obesity, insulin resistance, and intestinal inflammation.

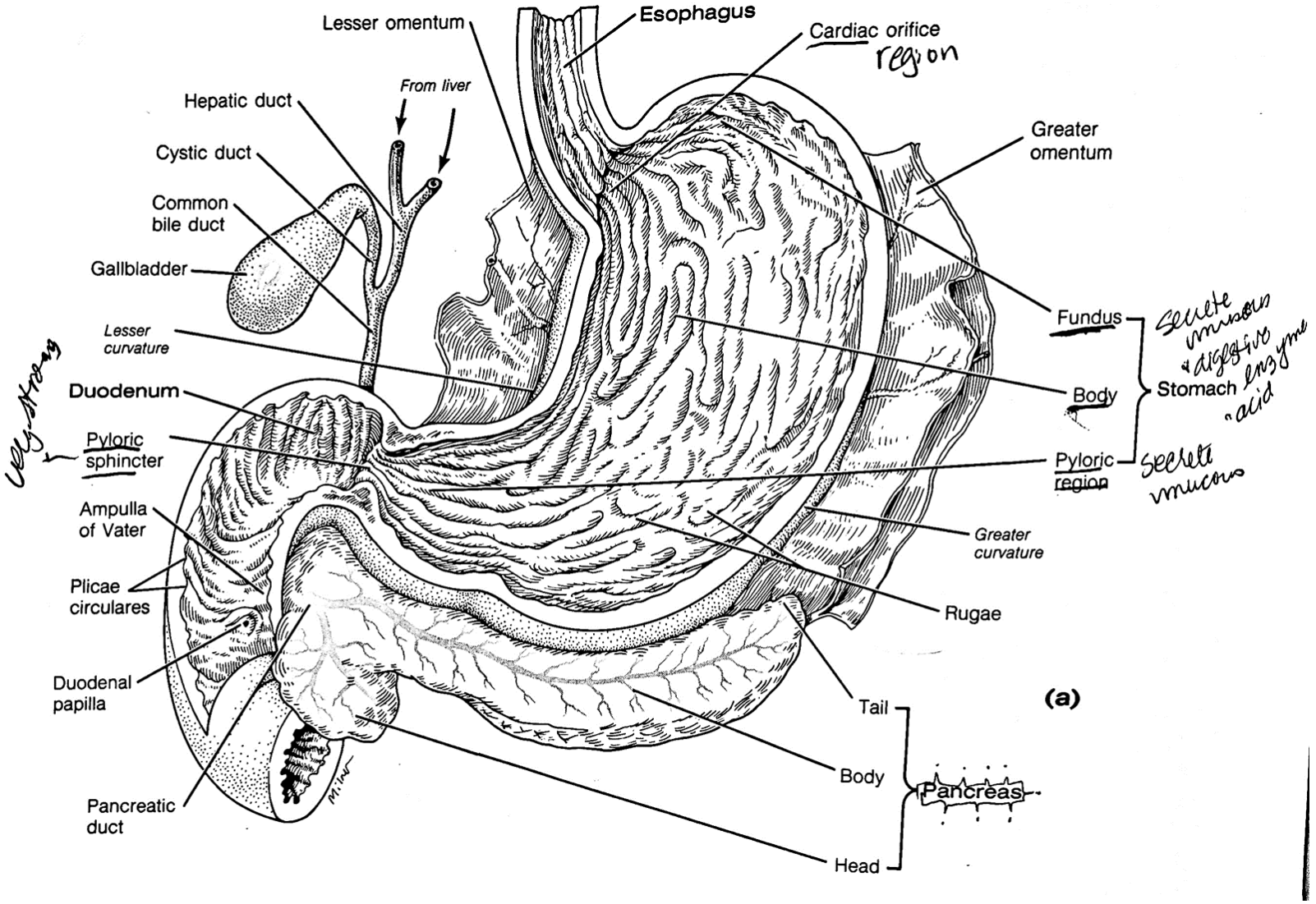
Depommier C, Everard A, Druart C, et al. Supplementation with *Akkermansia muciniphila* in overweight and obese human volunteers: a proof-of-concept exploratory study. *Nat Med*. 2019. doi: 10.1038/s41591-019-0495-2.

Weight is a Heavy Issue



Now to the Duodenum

Duodenum, gallbladder, pancreas



Type 3c Diabetes (Pancreatogenic)

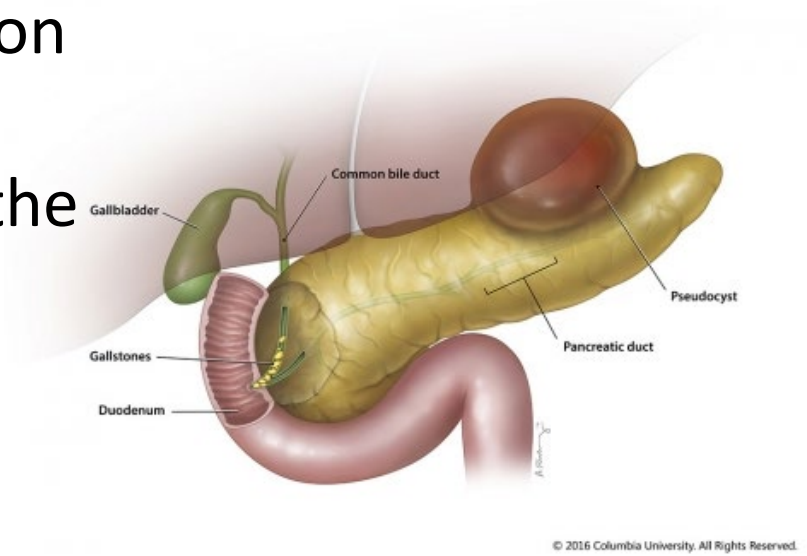
- Includes both structural and functional loss of insulin secretion in the context of exocrine pancreatic dysfunction.
- About 5-10% of diabetes, often misdiagnosed as type 2 diabetes.

- The diverse set of etiologies includes:
  - pancreatitis (acute and chronic) ~70%
  - trauma or pancreatectomy
  - neoplasia
  - cystic fibrosis
  - hemochromatosis
  - fibrocalculous pancreatopathy
  - rare genetic disorders, and idiopathic

4. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Care in Diabetes—2025. *Diabetes Care* 1 January 2025; 48 (Supplement_1): S59–S85. https://doi.org/10.2337/dc25-S004

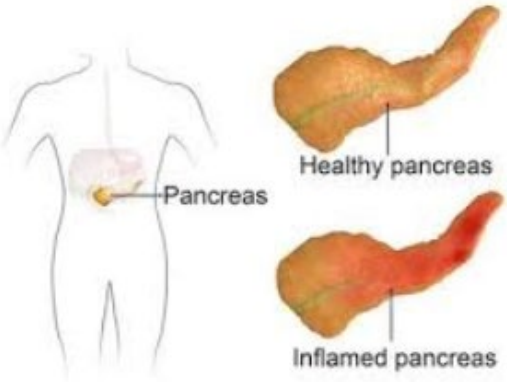
Pancreatitis

- Pancreatitis caused by digestion of the organ from pancreatic enzymes normally carried to the SI through pancreatic duct.
- Detected through elevated Amylase levels & pain
- Causes:
  - HIV meds and other meds
  - Alcohol ingestion
  - Gallstones blocking pancreatic enzyme flow to small intestine
  - Elevated triglycerides
  - Cancer, injury and other



Pancreatitis

- People with diabetes 2xs risk of acute pancreatitis
- After episode of pancreatitis, one third of people will get prediabetes or diabetes
  - About 25% to 80% of people with chronic pancreatitis develop Type 3c diabetes.
- Pancreatitis is an exocrine dysfunction:
  - Disrupts global architecture or physiology of pancreas
  - Results in both exocrine and endocrine dysfunction.



Healthy Pancreas vs Pancreatitis

2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes—2025 FREE

American Diabetes Association Professional Practice Committee

Exocrine Pancreatic Insufficiency

- Fatty stools
- Abdominal pain especially after high fat meals
- Can happen with both type 1 & 2 diabetes
- May need to take fat soluble vitamins, enzymes
- Avoid smoking, excess alcohol to protect pancreas.
- Cystic fibrosis
- Often associated with Type 3c diabetes

2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes—2025 FREE

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The American Cancer Society's estimates for pancreatic cancer in U.S. for 2023 are:

- About 64,050 people will be diagnosed with pancreatic cancer.
- About 50,550 people will die of pancreatic cancer.
- Pancreatic cancer accounts for about 3% of all cancers in the US and about 7% of all cancer deaths.

https://pancan.org/

Liver Nomenclature Update

AASLD
AMERICAN ASSOCIATION FOR THE STUDY OF LIVER DISEASES

Old Terms	New Terms
Fatty Liver Disease	Steatotic Liver Disease
Non-Alcoholic Steatohepatitis (NASH)	Metabolic Dysfunction-Associated Steatohepatitis (MASH)
Non-Alcoholic Fatty Liver Disease (NAFLD)	Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD)

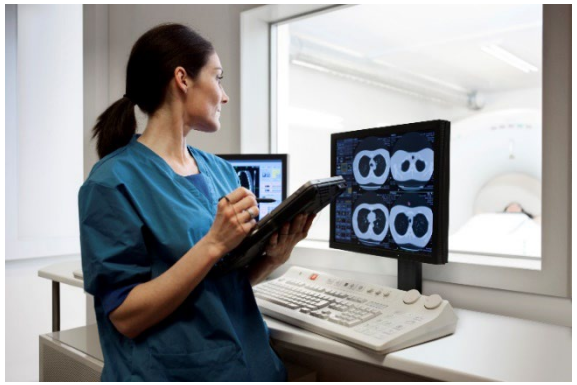
Steatotic Liver Disease (SLD)

MASLD* is when fat reaches 5% to 10% of the liver's weight

Adults with type 2 diabetes.

- MASLD is prevalent in >70%
  - Of those 50% have NASH*
- 12-20% have fibrosis

- Need evaluation for nonalcoholic steatohepatitis and liver fibrosis for those:
  - At high risk: type 2 or prediabetes with cardiometabolic risk factors
  - Elevated liver enzymes (ALT) or
  - Fatty liver on imaging or ultrasound



Associated with :

- Increased BMI (30+)
- Cardiometabolic risk factors
- Over 50 yrs
- ALT & AST 30 units/L +

*Now called MASH - Metabolic Dysfunction-Associated Steatohepatitis.

4. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Care in Diabetes—2025 FREE

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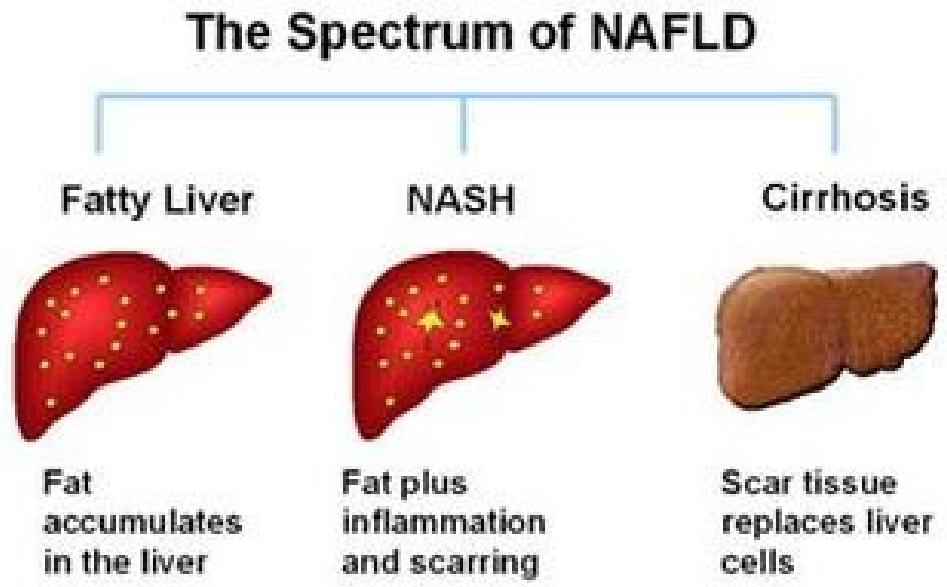
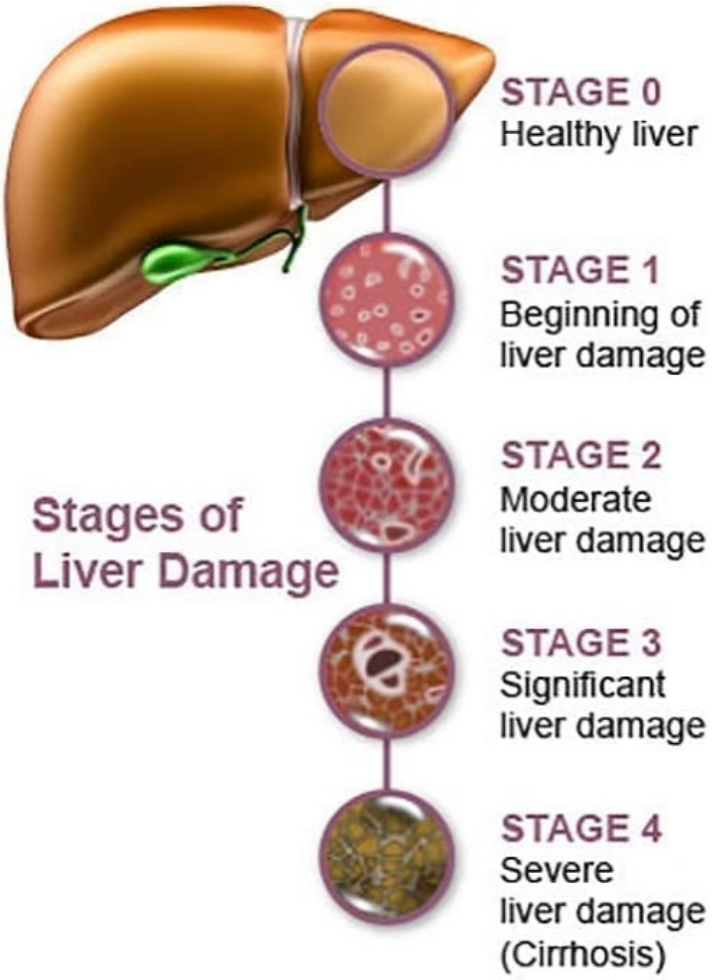
Natural History of MASLD* to MASH**





*Metabolic Dysfunction-Associated Steatotic Liver Disease

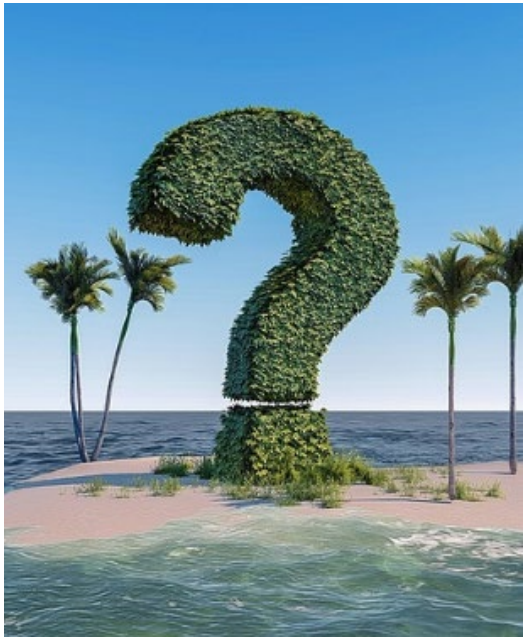
**Metabolic Dysfunction-Associated Steatohepatitis.

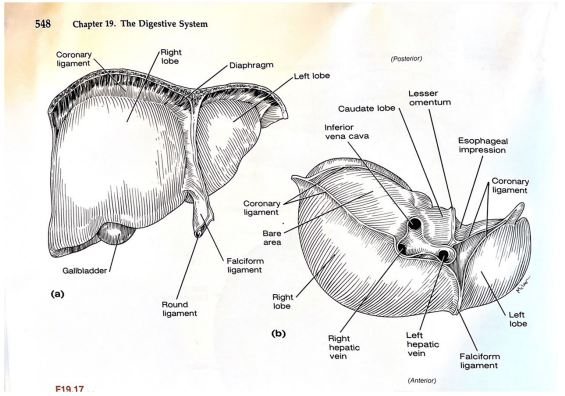
https://liverfoundation.org/wp-content/uploads/2020/11/StagesFibrosis.jpg

Quick Question 3: Detecting Steatosis

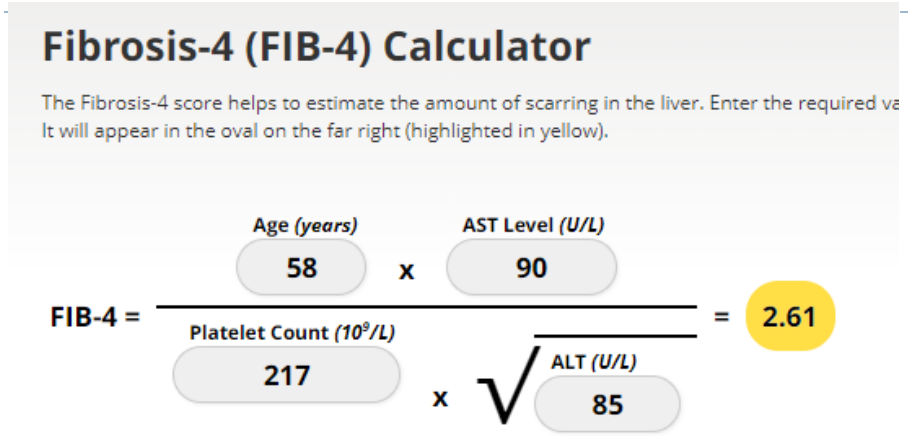
EV is 58 years old with type 2 diabetes and a BMI of 33. In addition, EV has hypertension and hyperlipidemia, with elevated liver enzymes (ALT and AST). To determine if EV is at risk for liver fibrosis and cirrhosis, which of the following would provide a risk calculation?

A. UACR
B. FIB-4
C. GAD or ICA
D. Weight in (kg) divided by the square of height in meters (m2)





Screening for NASH – FIB-4



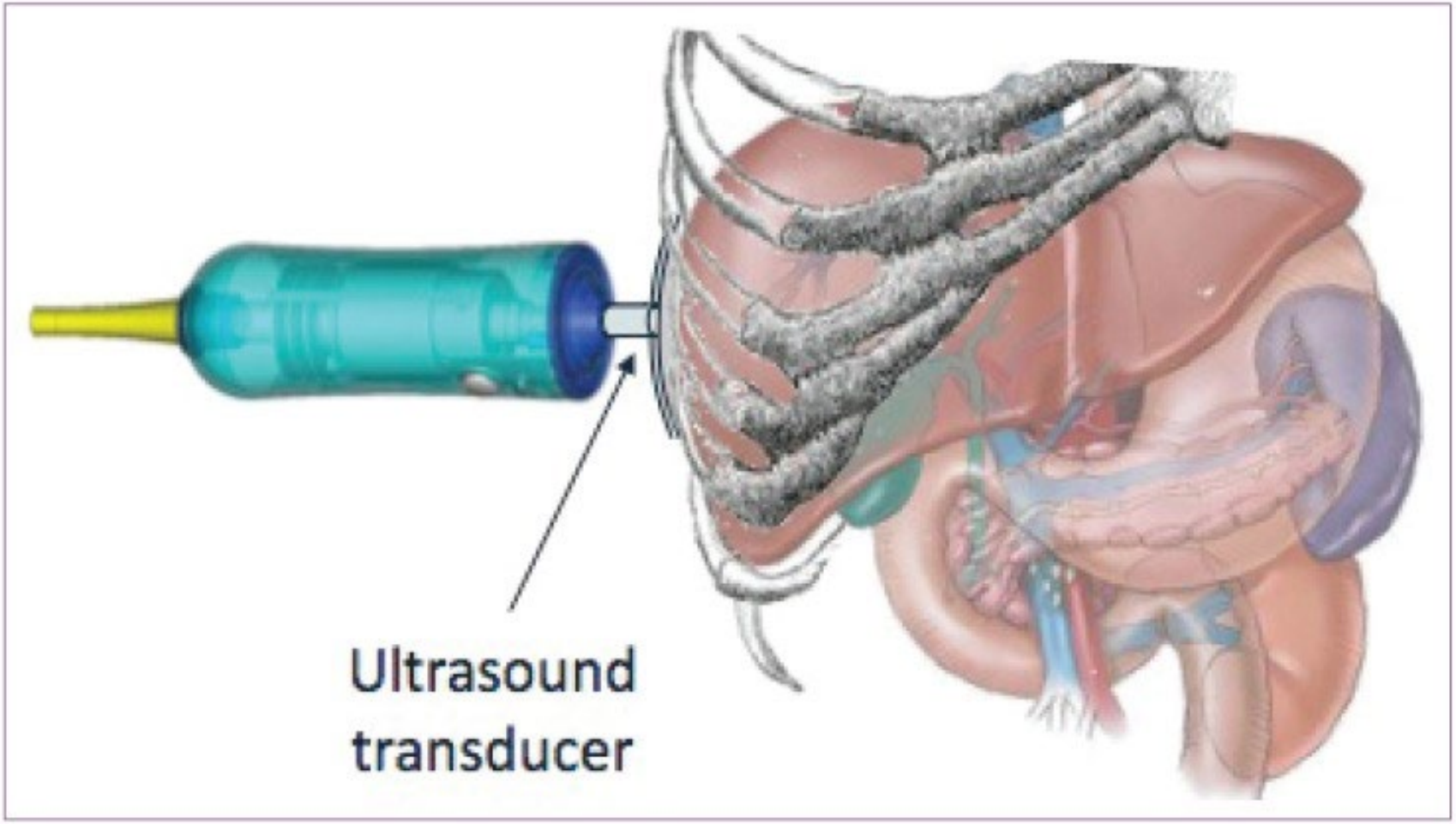
- The American College of Gastroenterology considers Upper limit of normal ALT levels:
- 29–33 units/L for males
- 19–25 units/L for female individuals

(mdcalc.com/calc/2200/fibrosis-4-fib-4-index-liver-fibrosis).

FIB-4 estimates risk of hepatic cirrhosis (age 35+):

- Calculated by imputing:
  - Age
  - plasma aminotransferases (AST and ALT)
  - and platelet count
- FIB-4 Risk Levels
  - Lower risk is <1.3
  - Intermediate 1.3 to 2.67
  - High risk >2.67
    - considered as having a high probability of advanced fibrosis (F3–F4).

Liver Elastography or FibroScan

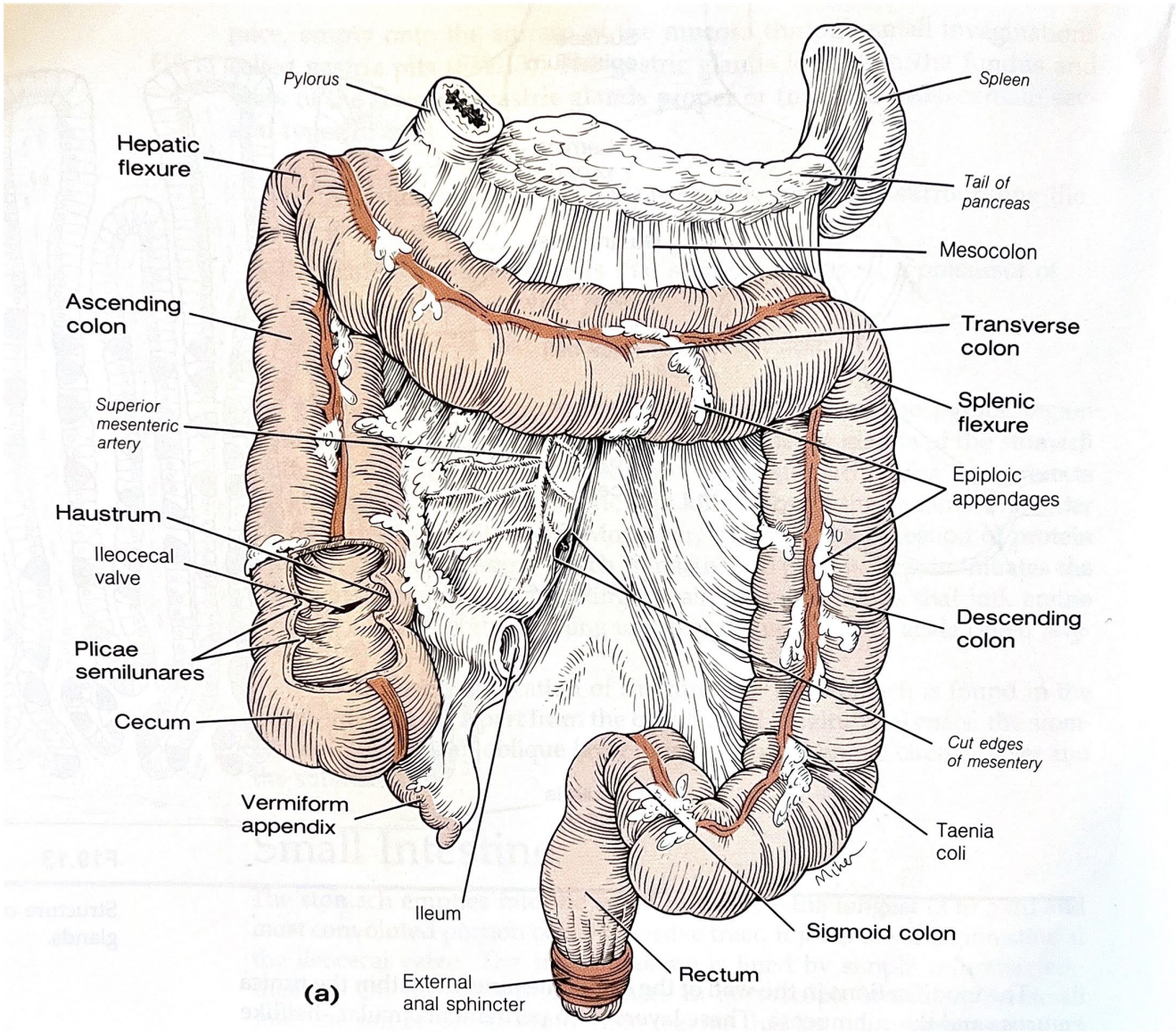


https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3594956/

Actions To Decrease Steatosis

- Increase activity
  - Strength training
  - Yoga or Thai Chi
  - Walking & aerobics
- Thoughtful eating
  - More fiber
  - Less processed foods & less added sugar (especially sugary beverages)
  - Less alcohol
  - See RDN
- Treatment
  - Pioglitazone (Actos)
  - GLP-1
  - Statins
- Prevention
  - Cancer Screenings
  - Decrease inflammation

Almost There – Ileum to Anus



Ileum to Anus

- Ileum last 2 meters of intestine. To move from the ileum to the cecum (first part of large intestine), food passes through the ileocecal valve.
- The appendix hangs out near this juncture. It traps harmful bacteria and contains lymphoid cells similar to tonsils. If appendix gets blocked with bacteria and white blood cells, can lead to appendicitis
- Large intestine – The bacterial party center of your GI Tract
  - Ascending
  - Transverse
  - Descending
  - Sigmoid colon makes and Sideway S as it enters the iliac fossa
  - Then the rectum
  - Anus – 2 sphincters internal and external
  - External sphincter anal skeletal muscle under voluntary control and internal anal muscle not

Bowel Issues - Diarrhea

Defined and Treatment

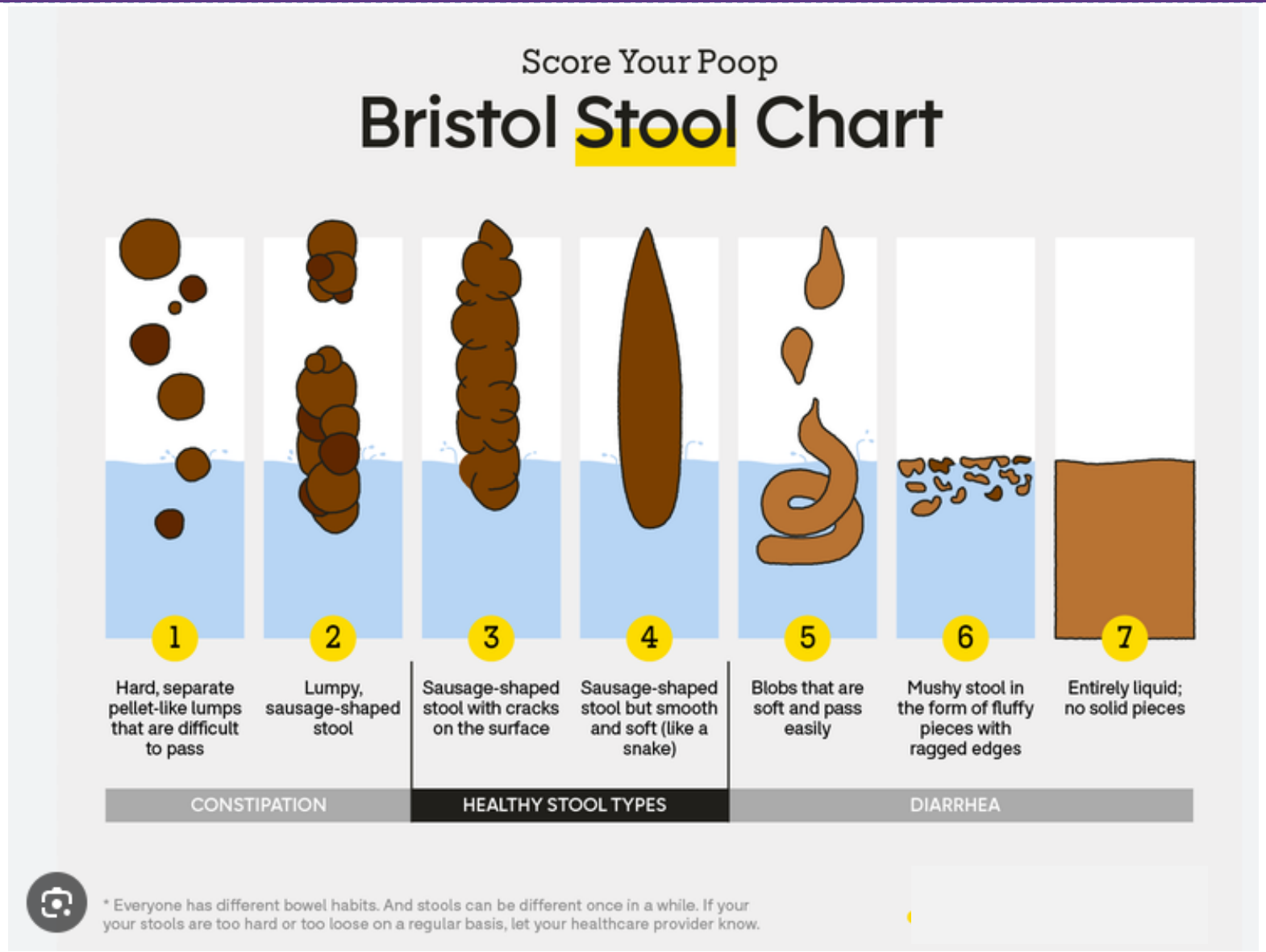
- 3 or more bowel movements a day
- **Treat & Determine Cause**
  - Improve glucose levels
  - Eat whole foods — including whole grains and fiber.
  - Drink plenty of water.
  - Get regular exercise.
  - Quit smoking and using tobacco products.
  - Limit alcohol.
  - Take medications as necessary.

- **Possible Causes**
  - Elevated glucose
  - Autonomic neuropathy
  - Metformin
  - GLP-1 RA's
  - Celiac disease
  - Bacterial /yeast infection
  - Exocrine pancreatic insufficiency
  - Irritable bowel syndrome
  - Sugar free foods
  - Other

Bowel Issues - Constipation

- Defined as less than 3 bowel movements a week.
- More common in diabetes
- GLP-1 RA can contribute
- Treatment
  - Get glucose to target
  - Increase fiber, activity, H2O
  - Bulking agents (psyllium)
  - Laxatives or other agents
  - Bathroom habits review

Look at your Poop – Stool Chart



Promoting Colon Health

- Nourish gut bacteria
- Get enough sleep
- Keep active
- Drinking enough fluids
- Consider alcohol intake
- Quit smoking
- Go outside
- Thoughtful antibiotic use
- Meditation may enhance helpful gut bacteria

Fiber – the New "F" Word

- Goal:
  - 14 gms / 1000 calories ~ 30 gms a day
- How?
  - Whole, intact grains, beans, fruits, veggies, nuts, avocados
- Why?
  - Associated with lower mortality for people with type 2.
  - Fiber intake inversely associated with type 2 diabetes
- Avoid highly processed foods
  - If label says 0-2gms of fiber per serving, low fiber food.

Nutrition Facts

99% Fat Free Vegetarian Chili with Beans

Serving Size 1.00 cup(247g)

Serving Per Container about 2

	Amount Per Serving	
Calories		190
Calories from Fat		10
		%DV
Total Fat	1g	2%
Saturated Fat	0g	0%
Trans Fat	0g	
Cholesterol	0mg	0%
Sodium	780mg	33%
Total Carbohydrate	35g	12%
Dietary Fiber	10g	40%
Sugars	6g	
Protein	11g	

Vitamin A 25% Vitamin C 0%

Calcium 6% Iron 15%

*Percentage Daily values are based on a 2,000 calorie diet.Your Daily values may be higher or lower depending on your calorie needs

GET Lots of Diverse Fiber Foods
Goal is 25 – 30 gms day

American Food Project

Full Plate Diet

- Helps increase fiber in usual meals

Fiber is suddenly hip. Grandma, it turns out, was just ahead of her time.

—*Health & Nutrition Letter*
Tufts University
February 2009

Getting to Better Gut Bacterial Health

Eat more PREbiotics

- Foods with indigestible fibers that nourish the good bacteria:
  - High fiber foods like, whole grains, fruits, veggies, nuts
  - High in prebiotic fibers include: Jerusalem artichokes, onions, kale, Brussels sprouts, bananas, dandelion greens & more

PRObiotics

- These foods contain healthy bacteria like *Bifidobacterium* and *lactobacillus.*
  - Yogurt, Kefir – look for "live or active cultures"
  - Fermented foods like: Sauerkraut, Kimchi, Miso soup, kombucha

Thank You

- Questions?
- Email info@diabetesed.net
- Web www.DiabetesEd.net
- Phone 530-893-8635