Primary Care Cardiovascular Society

Empowering primary care to deliver the best in cardiovascular health

PCCS Triglycerides QI programme

Triglycerides and lifestyle

Dr Sundhya Raman

This programme has been funded by Amarin Corp plc. Amarin were not involved in the development of the programme, content, selection of speakers or their arrangements. All content has been independently developed by the PCCS.

Dr Sundhya Raman background and disclosures

- MBBS
- PhD (D.Phil) in Genetics & Epigenetics
- Lifestyle Medicine

- Guys Kings & St Thomas's
- Oxford University
- International Board of Lifestyle Medicine
- British Society of Lifestyle Medicine

My Wellness Doctor

Lifestyle Medicine Doctor

MyWeightLossDoctor.clinic

Weight Loss Clinic

PCCS

Lifestyle Medicine Representative

Overview

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Lipids Overview:

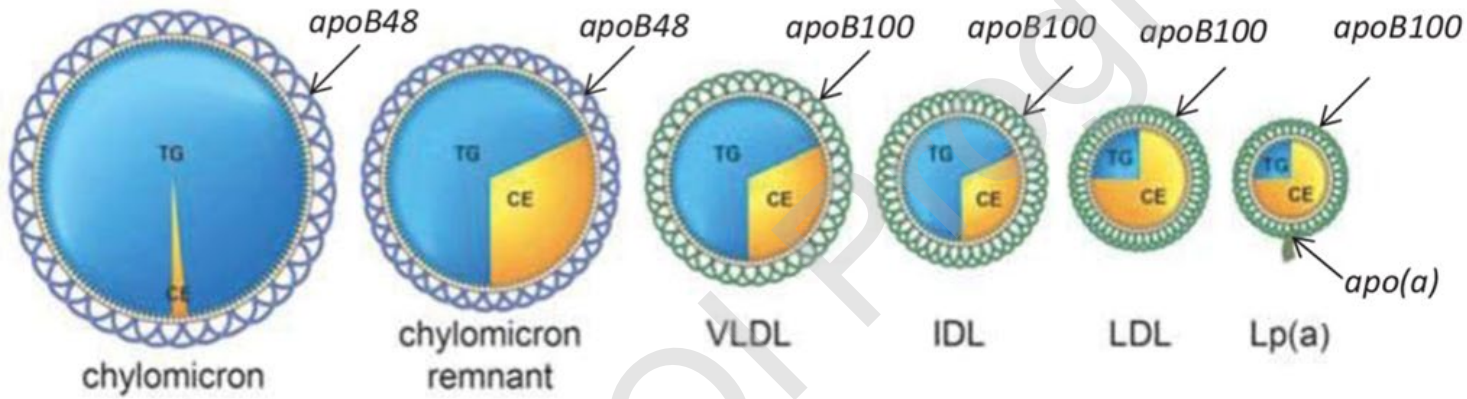
Cholesterol vs Triglycerides

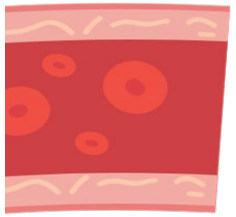
Metabolic Syndrome

Lifestyle & Triglycerides

Summary

Lipids overview

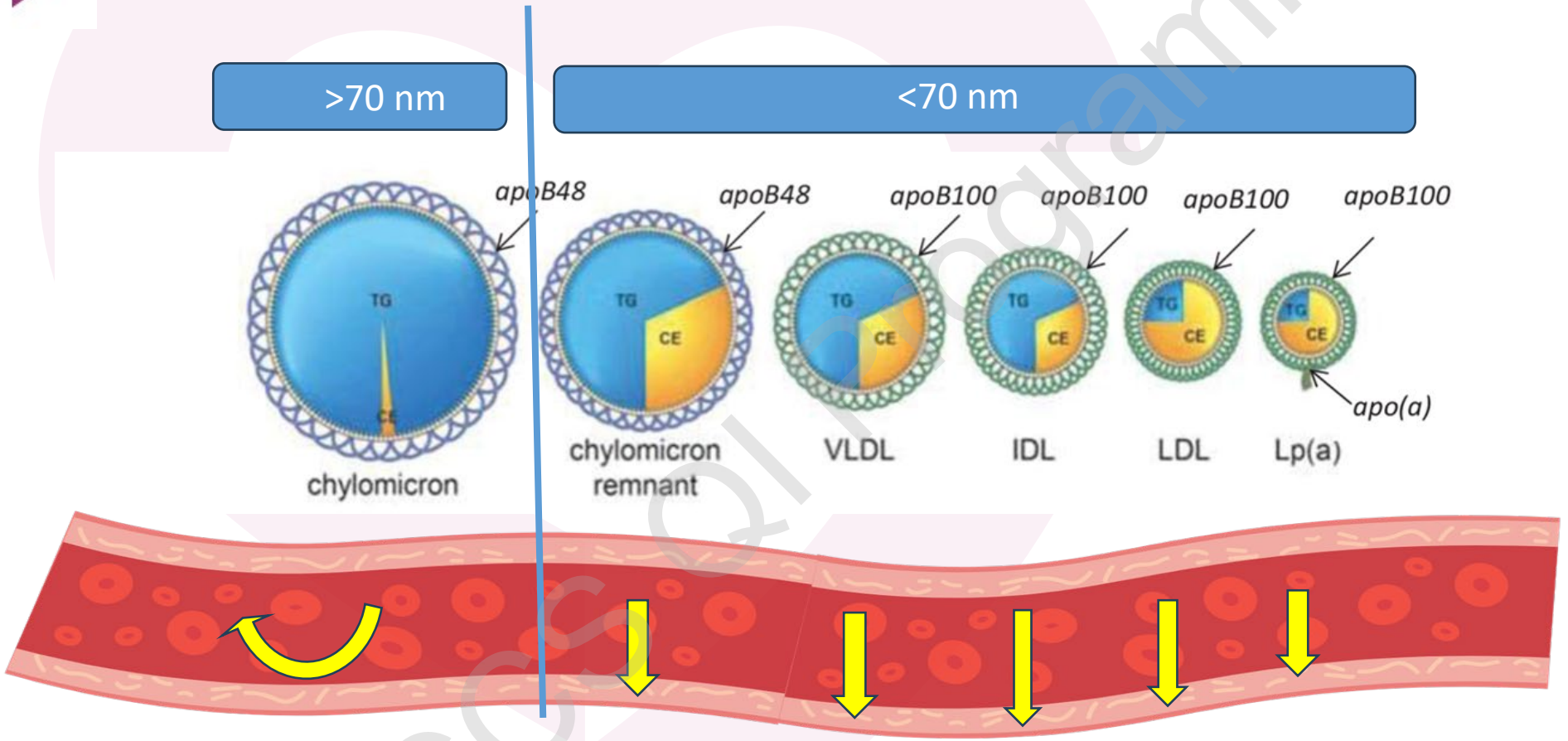




Vascular intima

Apo, apolipoprotein; CE, cholesteryl esters; IDL, intermediate-density lipoprotein; LDL, low-density lipoprotein; LDL-R, low-density lipoprotein receptor; Lp(a), lipoprotein (a); TG, triglycerides; VLDL, very-low-density lipoprotein.
Adapted from Sniderman AD, et al. JAMA Cardiol 2019;4(12):1287-1295.

Lipids overview



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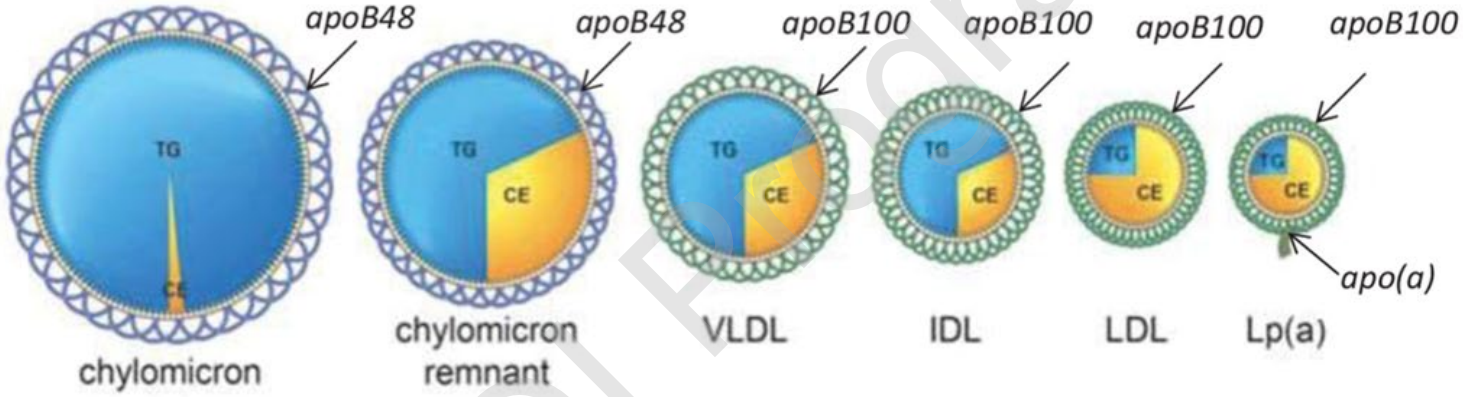
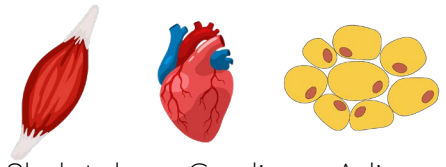
Lipids overview



Lipoprotein Lipase (LPL)



Skeletal Cardiac Adipose tissue

Fatty Acid Fatty Acid Fatty Acid Fatty Acid

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Lipids overview

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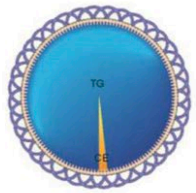
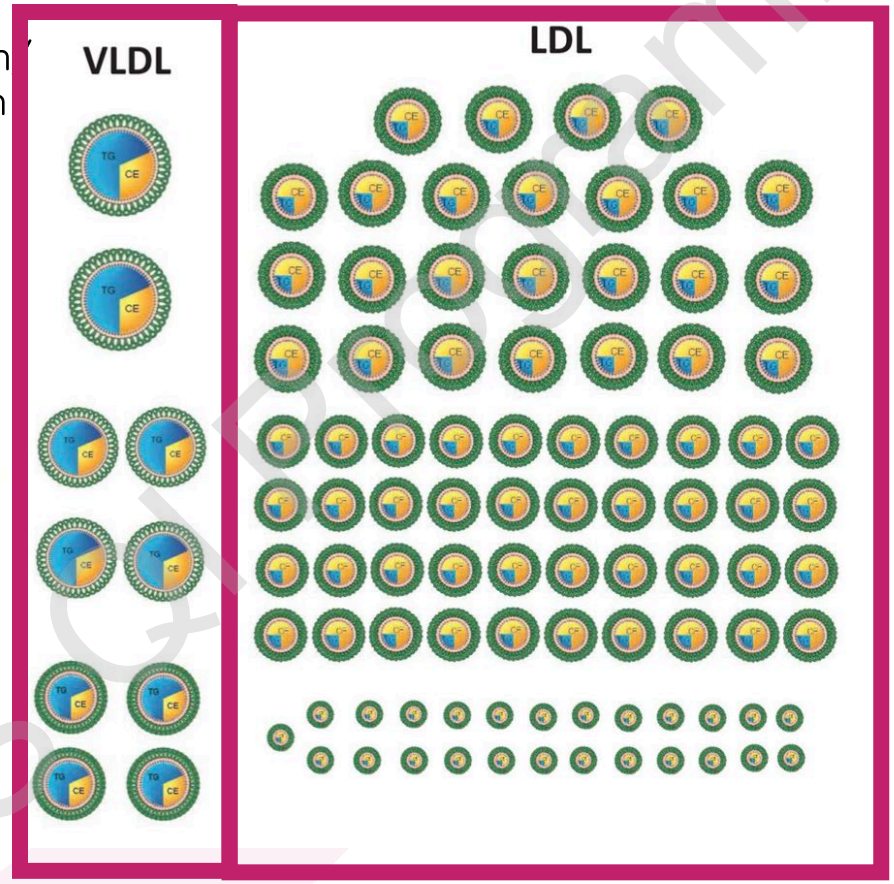
The relative numbers of apoB particles in plasma in the postprandial period.

VLDL: Triglyceride rich



Chylomicron / chylomicron remnant



LDL-C: Cholesterol rich

90% of circulating non-HDL particles are LDL-C

ApoB, apolipoprotein B; CE, cholesteryl esters; HDL, high-density lipoprotein; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides; VLDL, very-low-density lipoprotein.
Adapted from: Sniderman AD, et al. JAMA Cardiol 2019;4(12):1287–1295.

Cholesterol vs. triglycerides

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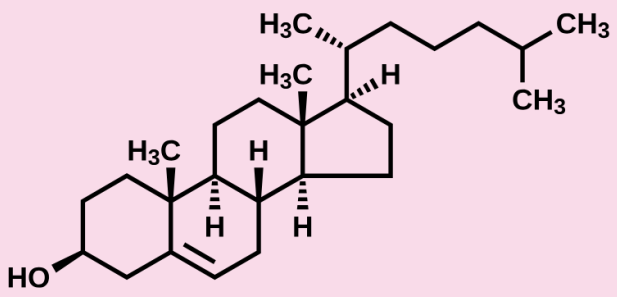
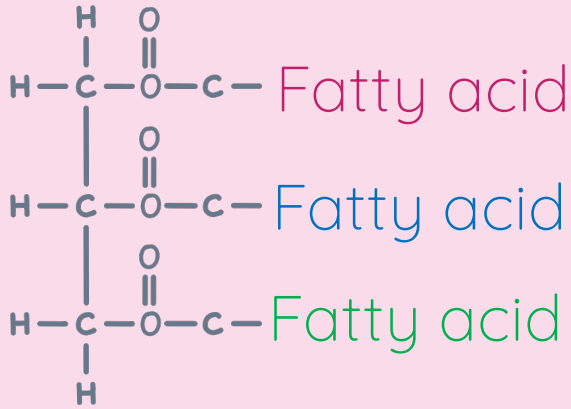


Cholesterol

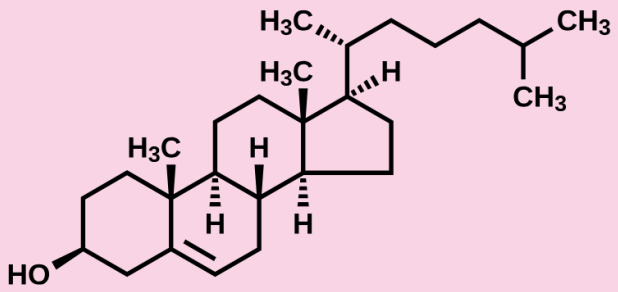
Function

Influence of lifestyle



Triglycerides

Cholesterol

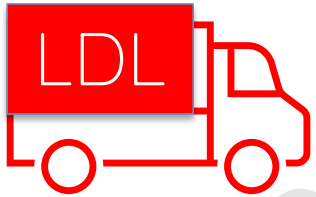


Makes **HORMONES**[1]

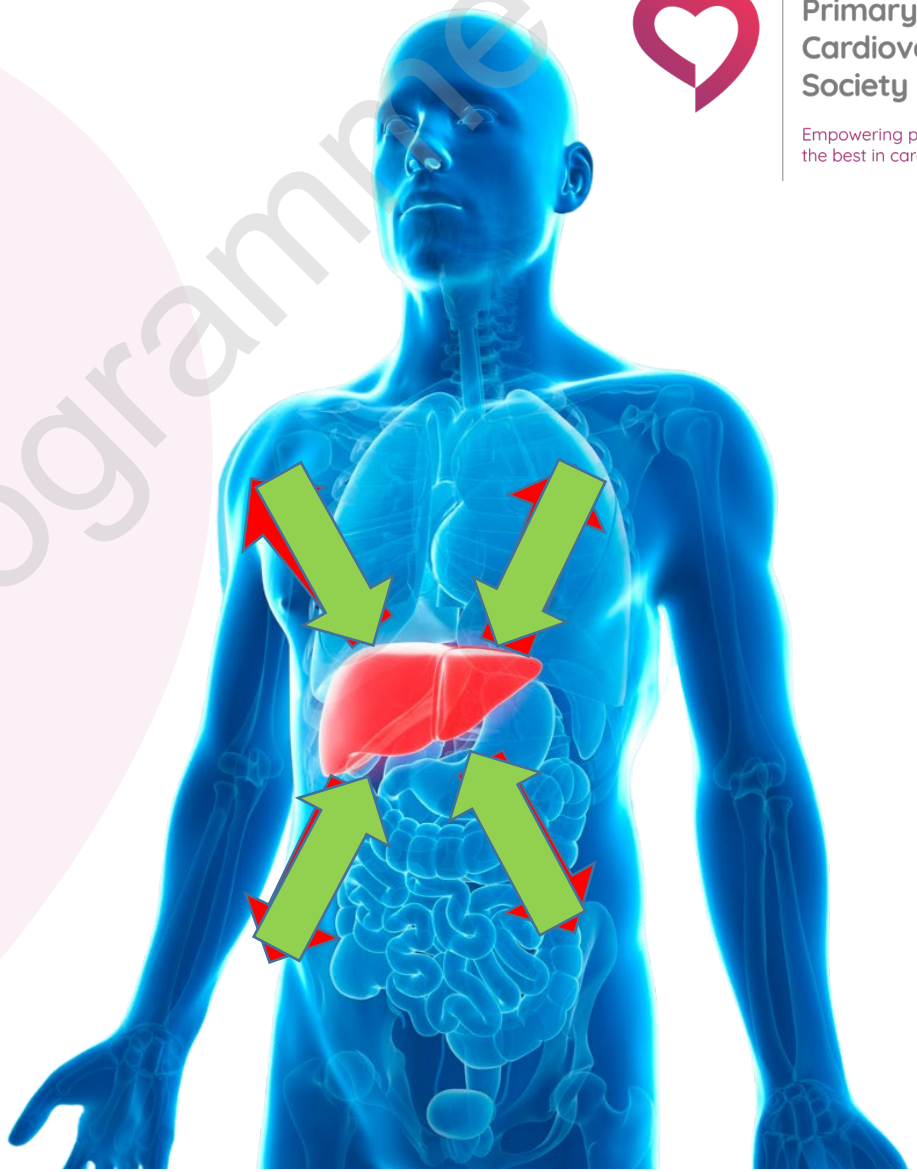
Makes **VITAMIN D**[1]

Cell **STRUCTURE**[1]

No dietary need



Non-HDL
including VLDL, IDL[2]



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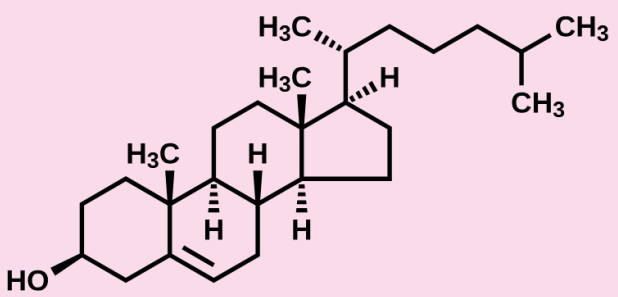
HDL, high-density lipoprotein; IDL, intermediate-density lipoprotein; LDL, low-density lipoprotein; VLDL, very-low-density lipoprotein.

1. Martin SS. Cholesterol in the Blood. Available at: https://www.hopkinsmedicine.org/health/conditions-and-diseases/high-cholesterol/cholesterol-in-the-blood#:~:text=Cholesterol%20is%20a%20fat%2Dlike,the%20cholesterol%20your%20body%20needs. Accessed February 2025; 2. Bhatt DL. What is non-HDL cholesterol? Available at: https://www.health.harvard.edu/heart-health/what-is-non-hdl-cholesterol#:~:text=A%20non%2DHDL%20cholesterol%20value,are%20eventually%20transformed%20into%20LDL. Accessed February 2025.

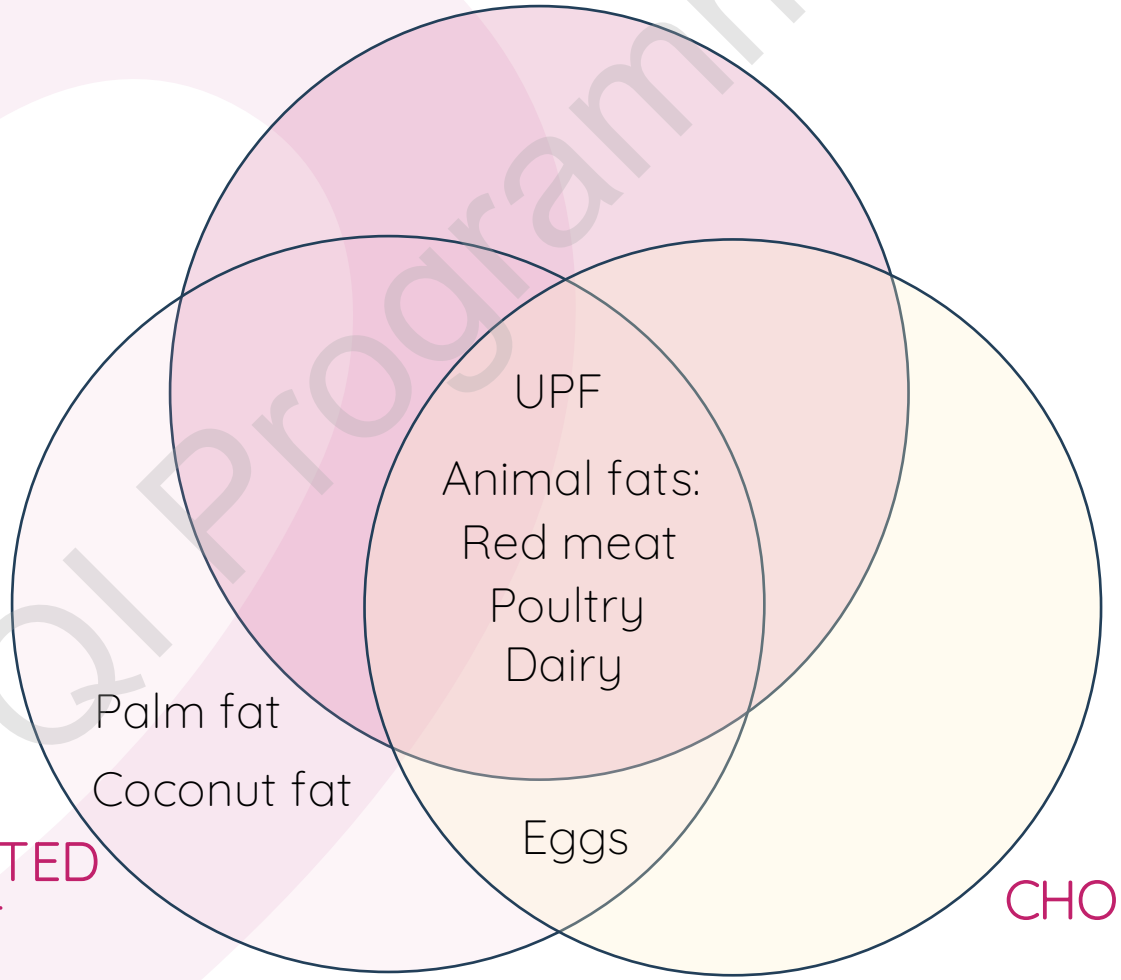
Cholesterol[1–4]



Makes **HORMONES**[1]

Makes **VITAMIN D**[1]

Cell **STRUCTURE**[1]



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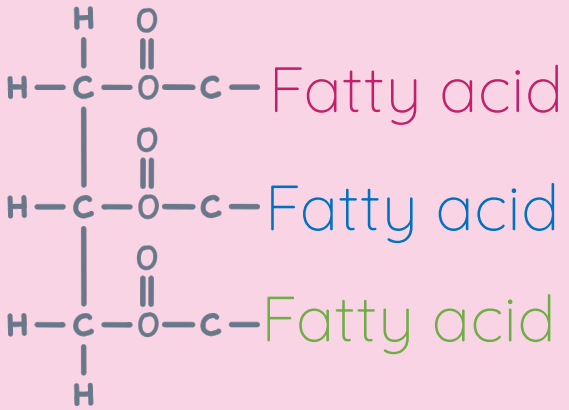
PCCS Academy Module: Lifestyle & CVD

CVD, cardiovascular disease; UPF, ultra-processed foods. 1. Martin SS. Cholesterol in the Blood. Available at: https://www.hopkinsmedicine.org/health/conditions-and-diseases/high-cholesterol/cholesterol-in-the-blood#:~:text=Cholesterol%20is%20a%20fat%2Dlike,the%20cholesterol%20your%20body%20needs. Accessed February 2025; 2. NHS. Fat: the facts. Available at: https://www.nhs.uk/live-well/eat-well/food-types/different-fats-nutrition/. Accessed February 2025; 3. healthline. Are Eggs, Meat, and Dairy Bad for High Cholesterol? Available at: https://www.healthline.com/health/eggs-and-cholesterol. Accessed February 2025; 4. Moll J. Which Foods Still Contain Trans Fats? Available at: https://www.verywellhealth.com/which-foods-contain-trans-fats-697735. Accessed February 2025.

Triglycerides



Used or stored for **ENERGY**[1]

Essential fats[6]

Alpha linolenic acid (ALA) (Ω 3)
Linoleic acid (LA) (Ω 6)

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Saturated fat[2,3]

Animal source (meat, eggs, dairy)
UPF
Palm fat, coconut fat

Mono-unsaturated fat[2,4]

Oils: Olive, rapeseed, sesame
avocados, nuts, seeds

Poly-unsaturated fat[2,5]

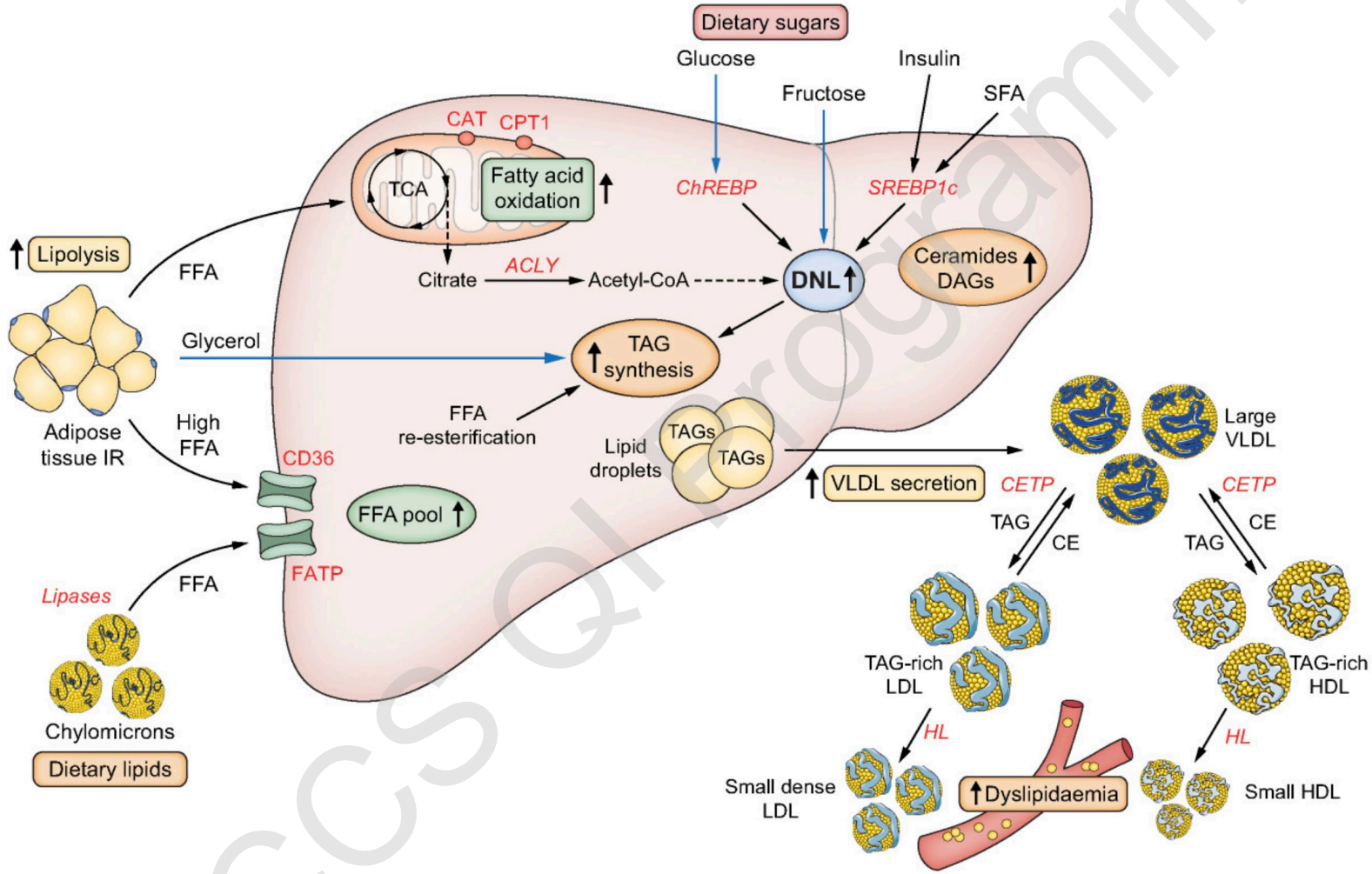
Oils: sunflower, soybean
Nuts, seeds
Oily fish

Ω3 Ω6

UPF, ultra-processed foods.

1. Smith Y. Triglycerides - What do they do? Available at: https://www.news-medical.net/health/Triglycerides-What-do-they-do.aspx. Accessed February 2025; 2. NHS. Fat: the facts. Available at: https://www.nhs.uk/live-well/eat-well/food-types/different-fats-nutrition/. Accessed February 2025; 3. BHF. Ultra-processed foods: how bad are they for your health? Available at: https://www.bhf.org.uk/informationsupport/heart-matters-magazine/news/behind-the-headlines/ultra-processed-foods. Accessed February 2025; 4. AHA. Monounsaturated Fats. Available at: https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/fats/monounsaturated-fats. Accessed February 2025; 5. AHA. Polyunsaturated Fats. Available at: https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/fats/polyunsaturated-fats. Accessed February 2025; 6. Das UN. Curr Pharm Biotechnol 2006;7:467–482.

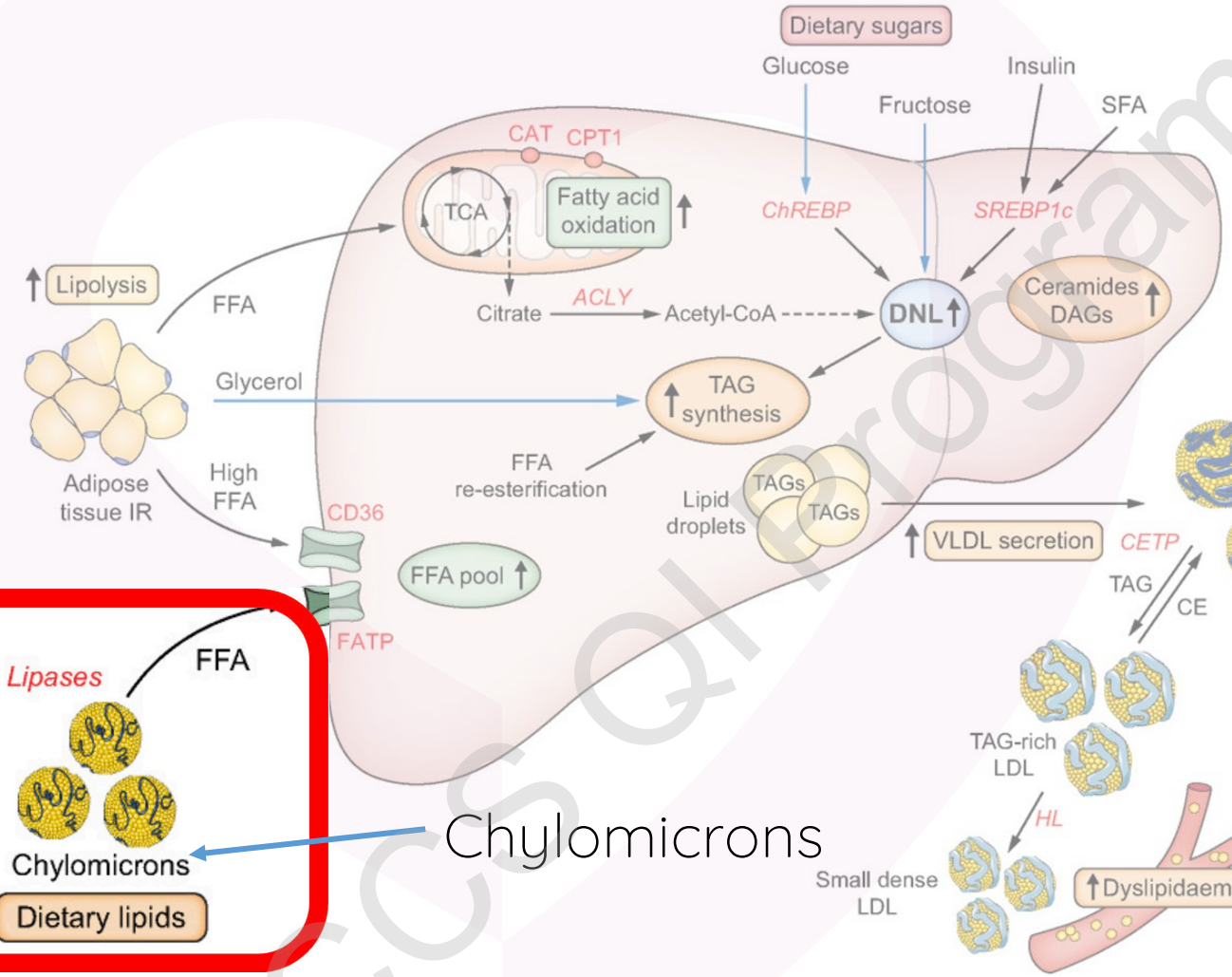
Triglycerides

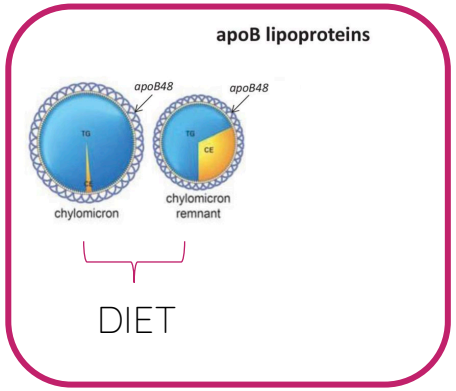


Acetyl-CoA, acetyl coenzyme A; ACLY, adenosine triphosphate-citrate lyase; CAT, carnitine acetyltransferase; CD36, cluster of differentiation 36; CE, cholesteryl esters; CETP, cholesteryl ester transfer protein; chREBP, carbohydrate response element-binding protein; CPT1, carnitine palmitoyltransferase 1; DAGs, diacylglycerols; DNL, de novo lipogenesis; FATP, fatty acid transport proteins; FFA, free fatty acids; HDL, high-density lipoprotein; HL, hepatic lipase; IR, insulin resistance; LDL, low-density lipoprotein; SFA, saturated fatty acid; SREBP1c, sterol regulatory element binding protein 1c; TAG, triacylglycerol; TCA, tricarboxylic acid cycle; VLDL, very-low-density lipoprotein.

1. Adapted from Carli F, et al. JHEP Rep 2024;6(12):101185.

TG from diet





Chylomicrons

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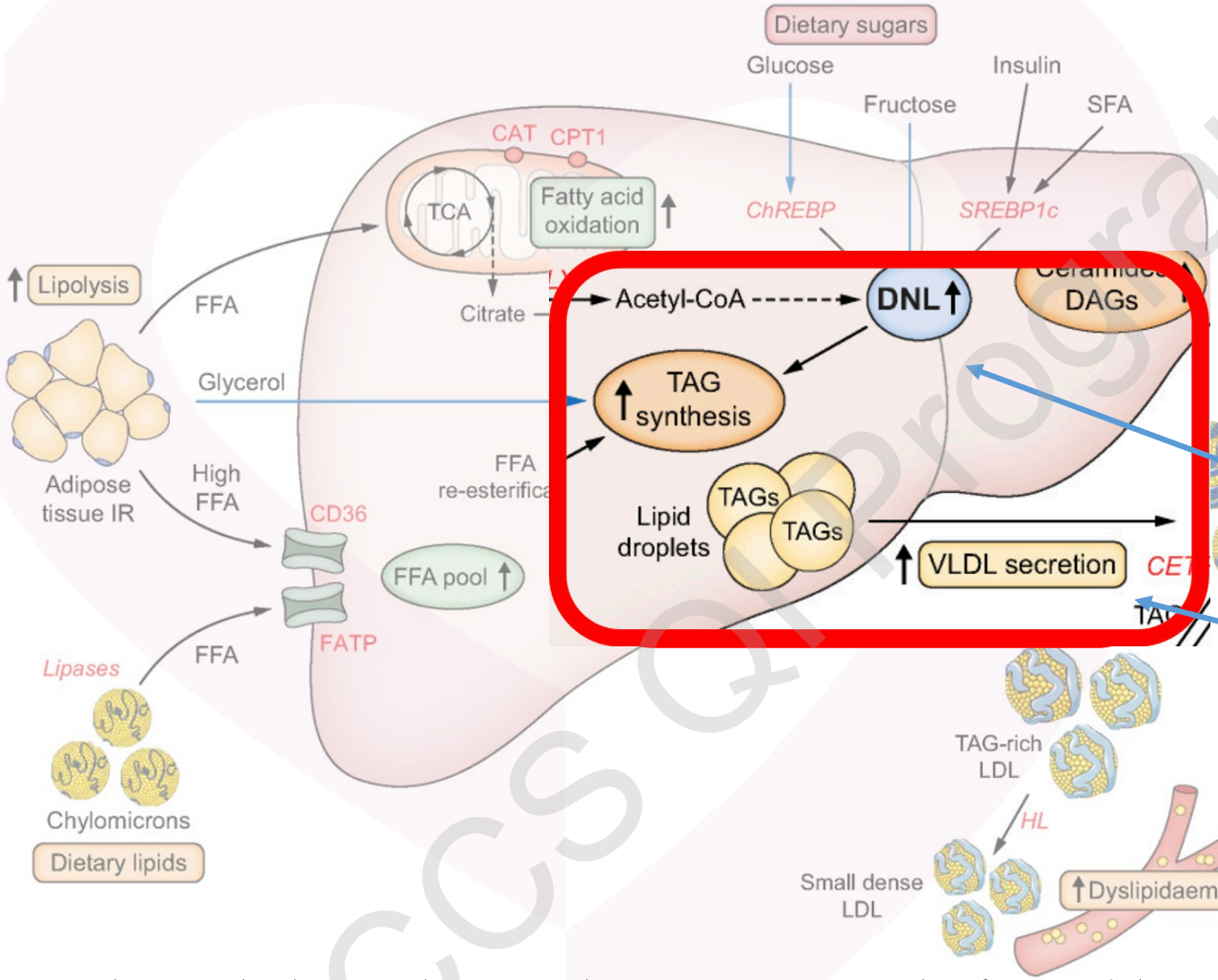
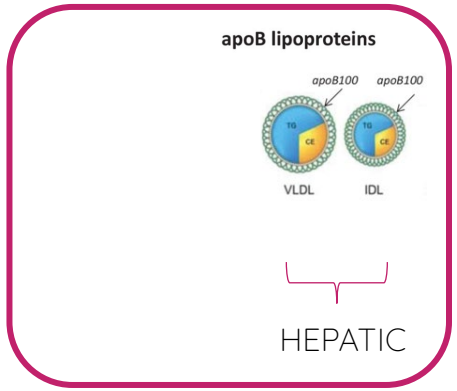
TG from liver





De novo Lipogenesis

VLDL

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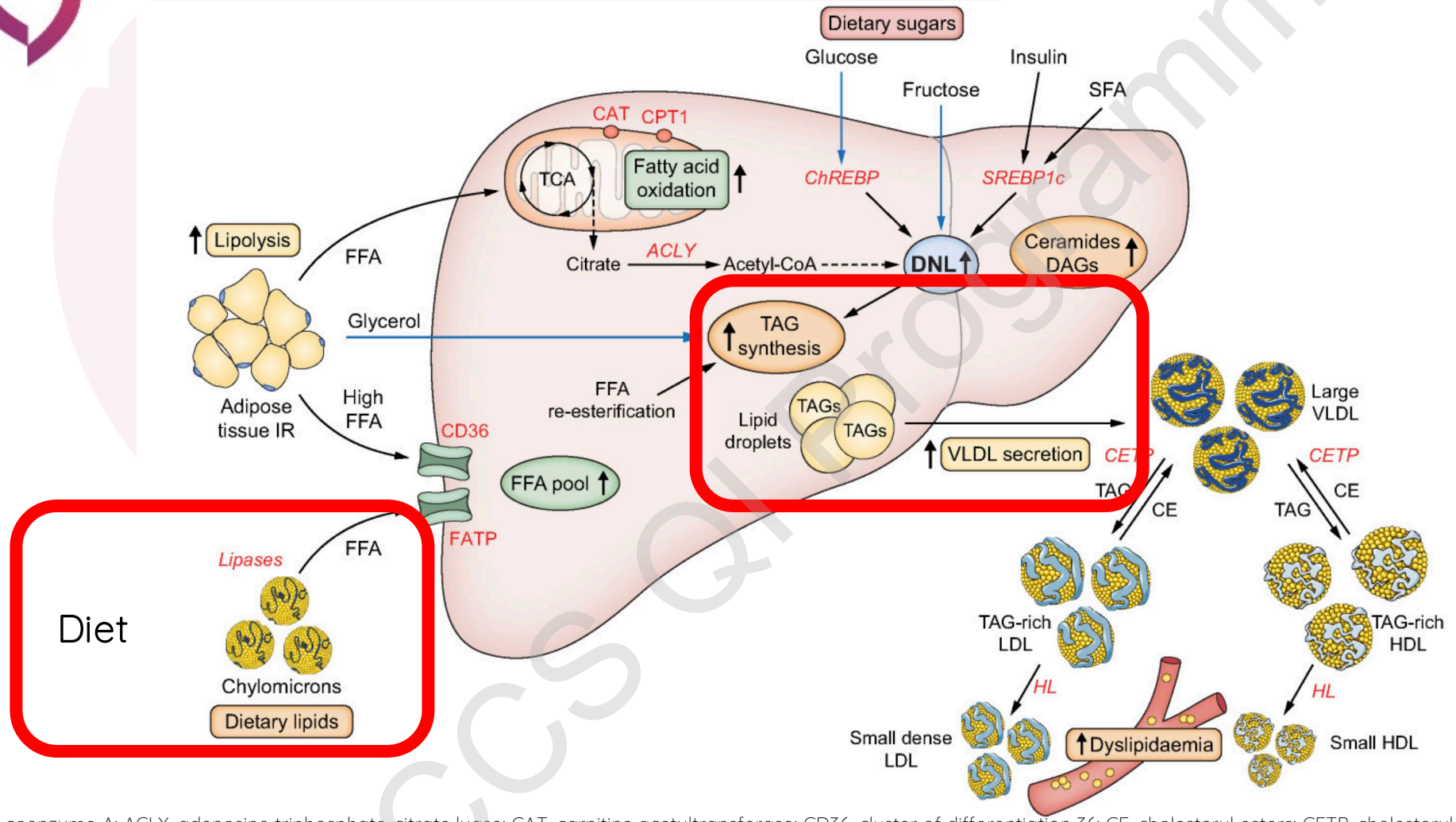
Triglycerides



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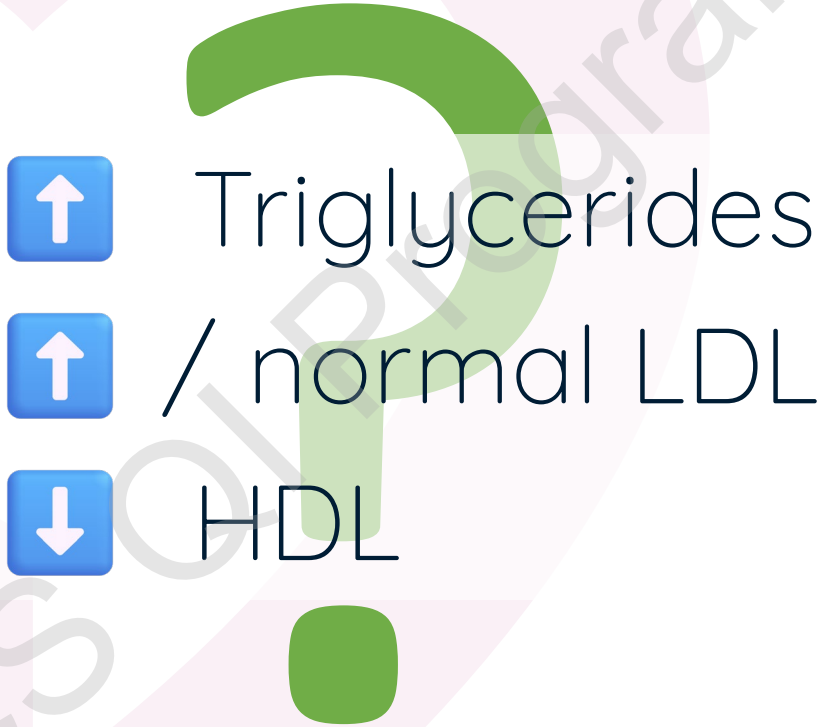
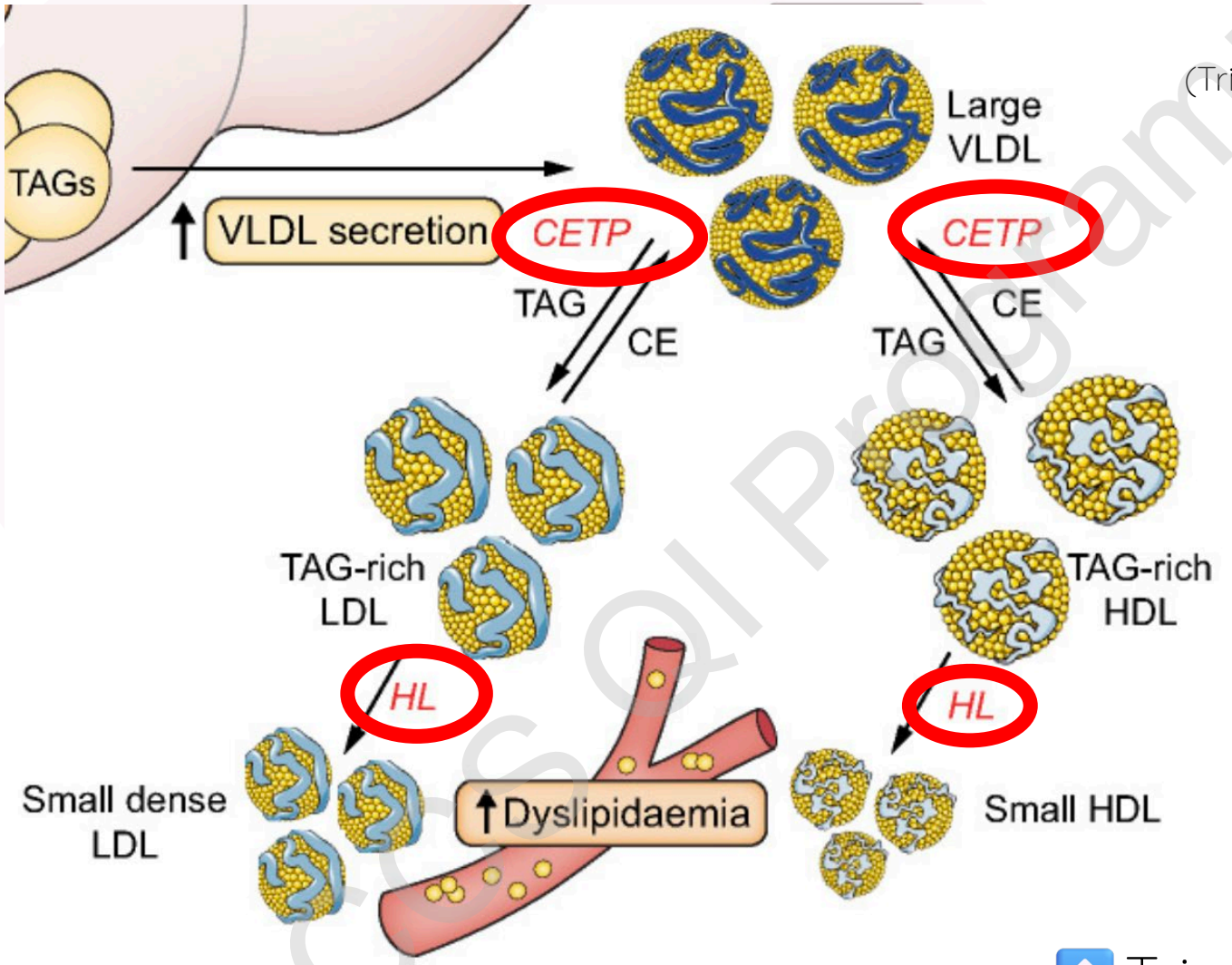
Metabolic syndrome



HDL, high-density lipoprotein; LDL, low-density lipoprotein.

1. Grundy SM. Am J Cardiol 1999;83:25F–29F; 2. Huang PL. Dis Model Mech 2009;2:231–237.

Metabolic syndrome



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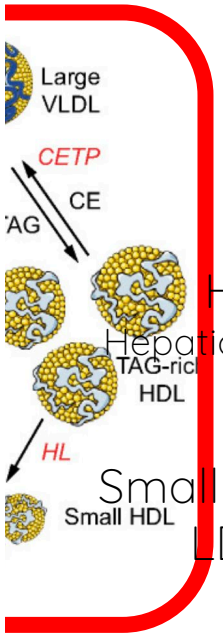
⬆ VLDL
(Triglyceride Rich)

CETP
Cholesteryl Ester Transfer Protein

Triglyceride –rich LDL & HDL



HL
Hepatic lipases

LPL
Lipoprotein lipase

Small dense LDL

Small HDL
(Cleared via kidneys)

⬆ Triglycerides, normal/ ⬆ LDL, ⬇ HDL

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Triglycerides & lifestyle

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Diet: 2 pathways

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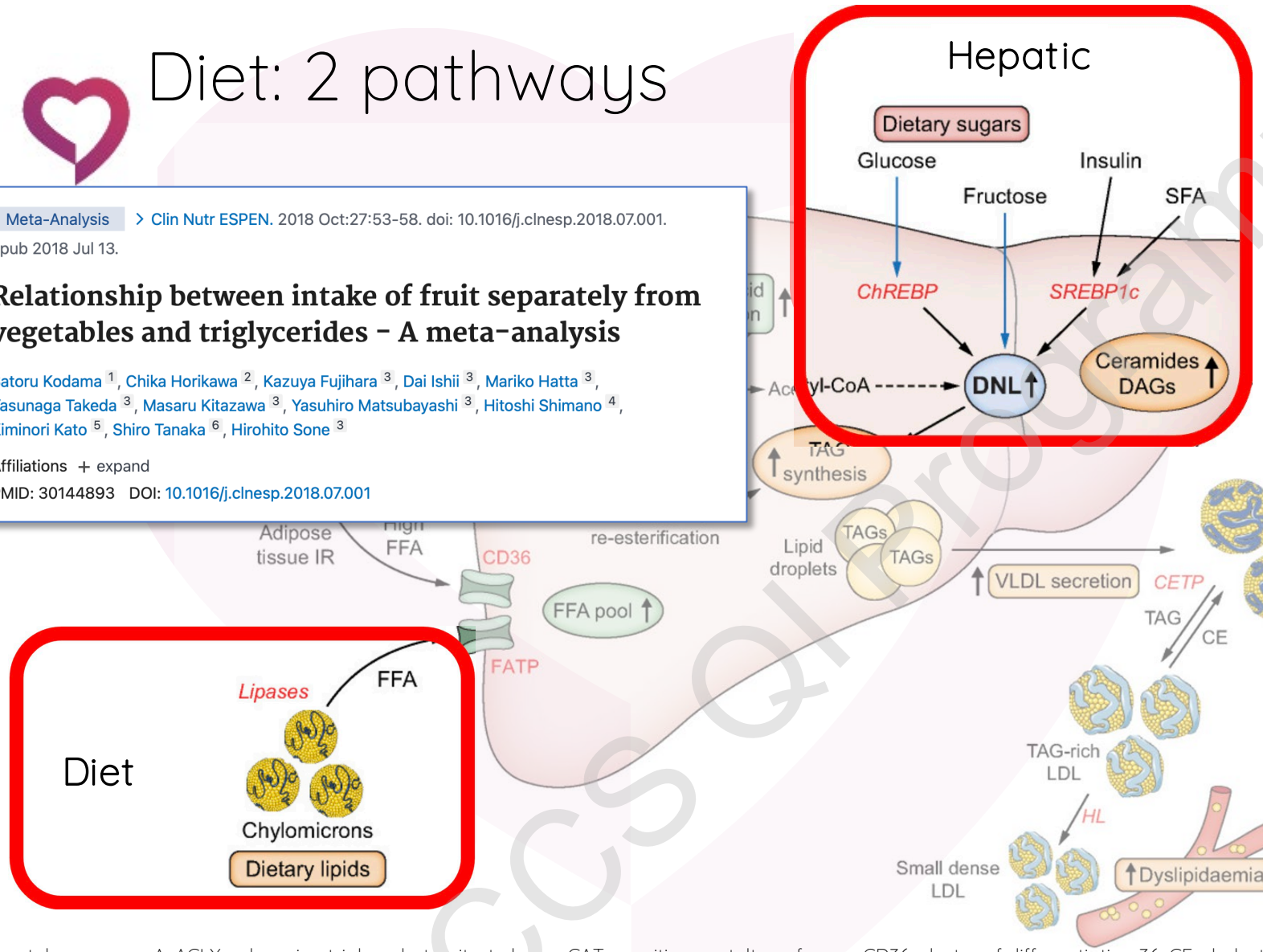
Meta-Analysis > Clin Nutr ESPEN. 2018 Oct:27:53-58. doi: 10.1016/j.clnesp.2018.07.001. Epub 2018 Jul 13.

Relationship between intake of fruit separately from vegetables and triglycerides - A meta-analysis

Satoru Kodama [1], Chika Horikawa [2], Kazuya Fujihara [3], Dai Ishii [3], Mariko Hatta [3], Yasunaga Takeda [3], Masaru Kitazawa [3], Yasuhiro Matsubayashi [3], Hitoshi Shimano [4], Kiminori Kato [5], Shiro Tanaka [6], Hirohito Sone [3]

Affiliations + expand

PMID: 30144893 DOI: 10.1016/j.clnesp.2018.07.001



Lower insulin

Lower refined carbohydrates

Reduces adiposity

LOW- CARB, NOT RECOMMENDED

↑ LDL-C

Pancreatitis risk

Acetyl-CoA, acetyl coenzyme A; ACLY, adenosine triphosphate-citrate lyase; CAT, carnitine acetyltransferase; CD36, cluster of differentiation 36; CE, cholesteryl esters; CETP, cholesteryl ester transfer protein; chREBP, carbohydrate response element-binding protein; CPT1, carnitine palmitoyltransferase 1; DAGs, diacylglycerols; DNL, de novo lipogenesis; FATP, fatty acid transport proteins; FFA, free fatty acids; HDL, high-density lipoprotein; HL, hepatic lipase; IR, insulin resistance; LDL-C, low-density lipoprotein cholesterol; SFA, saturated fatty acid; SREBP1c, sterol regulatory element binding protein 1c; TAG, triacylglycerol; TCA, tricarboxylic acid cycle; VLDL, very-low-density lipoprotein.

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ACC: Hypertriglyceridaemia

Adults with fasting TG ≥150 mg/dL or nonfasting TG ≥175 mg/dL

- Assess nonlifestyle secondary causes
- Assess lifestyle practices (body weight; diet, including amount and type of carbohydrates, alcohol, and long-chain omega-3 fatty acids; and physical activity)

Emphasize healthy dietary pattern* and increased physical activity

Implement shared decision-making intervention	<5.7 mmol/L TG <500 mg/dL†	5.7 – 11.2 mmol/L TG 500-999 mg/dL†	> 11.2 mmol/L TG ≥1000 mg/dL‡
Added sugars (percent calories)	<6%	<5%	Eliminate
Total fat (percent calories)	30%-35%	20%-25%§	10%-15%
Alcohol	Restrict	Abstain completely	Abstain completely
Aerobic activity	At least 150 min/wk of accumulated moderate-intensity or 75 min/wk of vigorous-intensity aerobic physical activity (or equivalent combination of both)‖		
Weight loss (percent body weight)	Recommended weight loss goal is 5%-10% for all patients with elevated TG		

- Monitor response to intervention
- Consider referral to RDN, exercise trainer, or other supportive services
- Continue intervention or adjust as indicated

ACC, American College of Cardiology; RDN, registered dietician nutritionist; TG, triglycerides; wk, week.
Virani SS, et al. JACC 2021;78(9): 960–993.

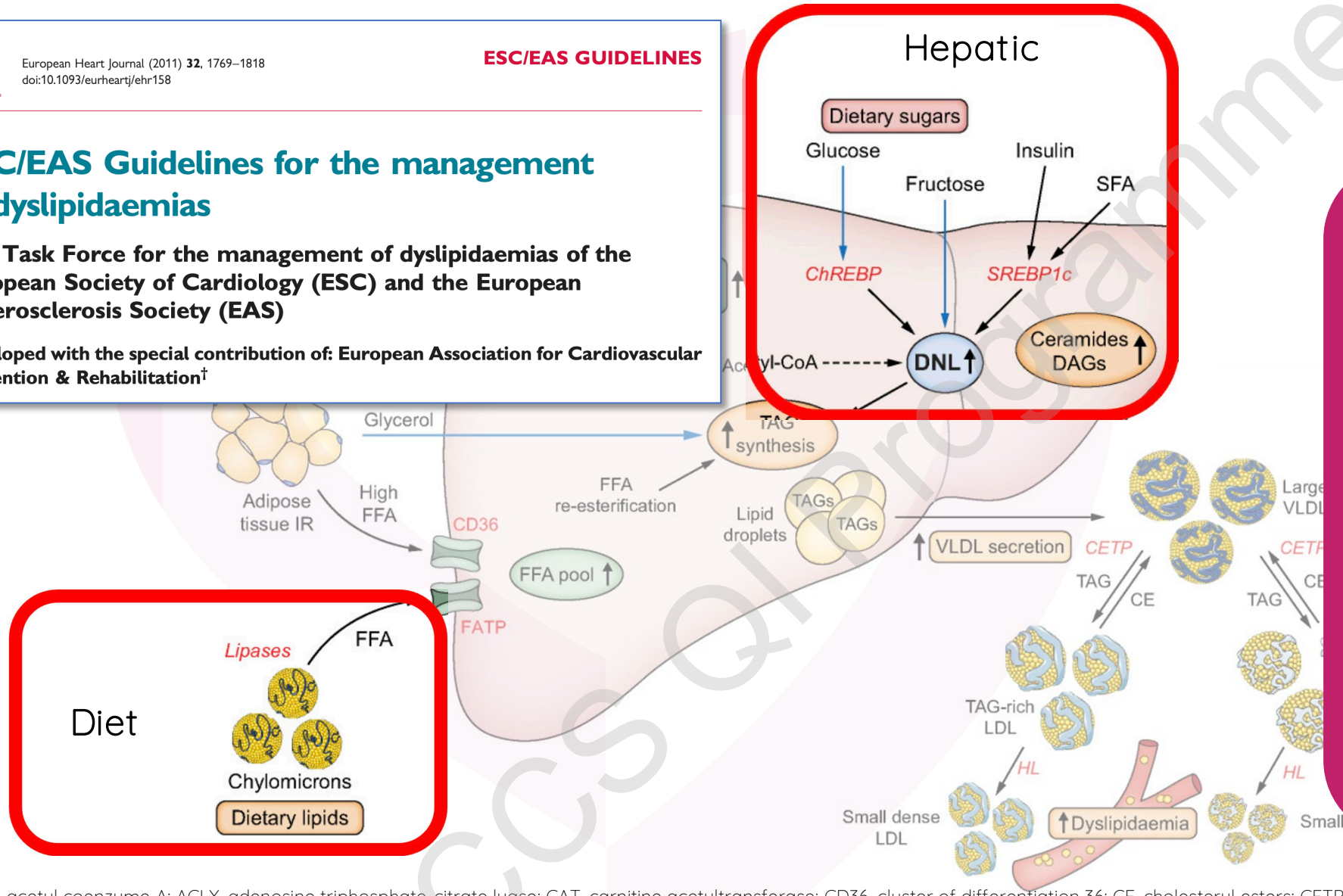
European Heart Journal (2011) **32**, 1769–1818
doi:10.1093/eurheartj/ehr158

ESC/EAS GUIDELINES

ESC/EAS Guidelines for the management of dyslipidaemias

The Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and the European Atherosclerosis Society (EAS)

Developed with the special contribution of: European Association for Cardiovascular Prevention & Rehabilitation†



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"no justification for the recommendation of a very low carbohydrate diet"

Saturated fat
replace with MUFA/PUFA

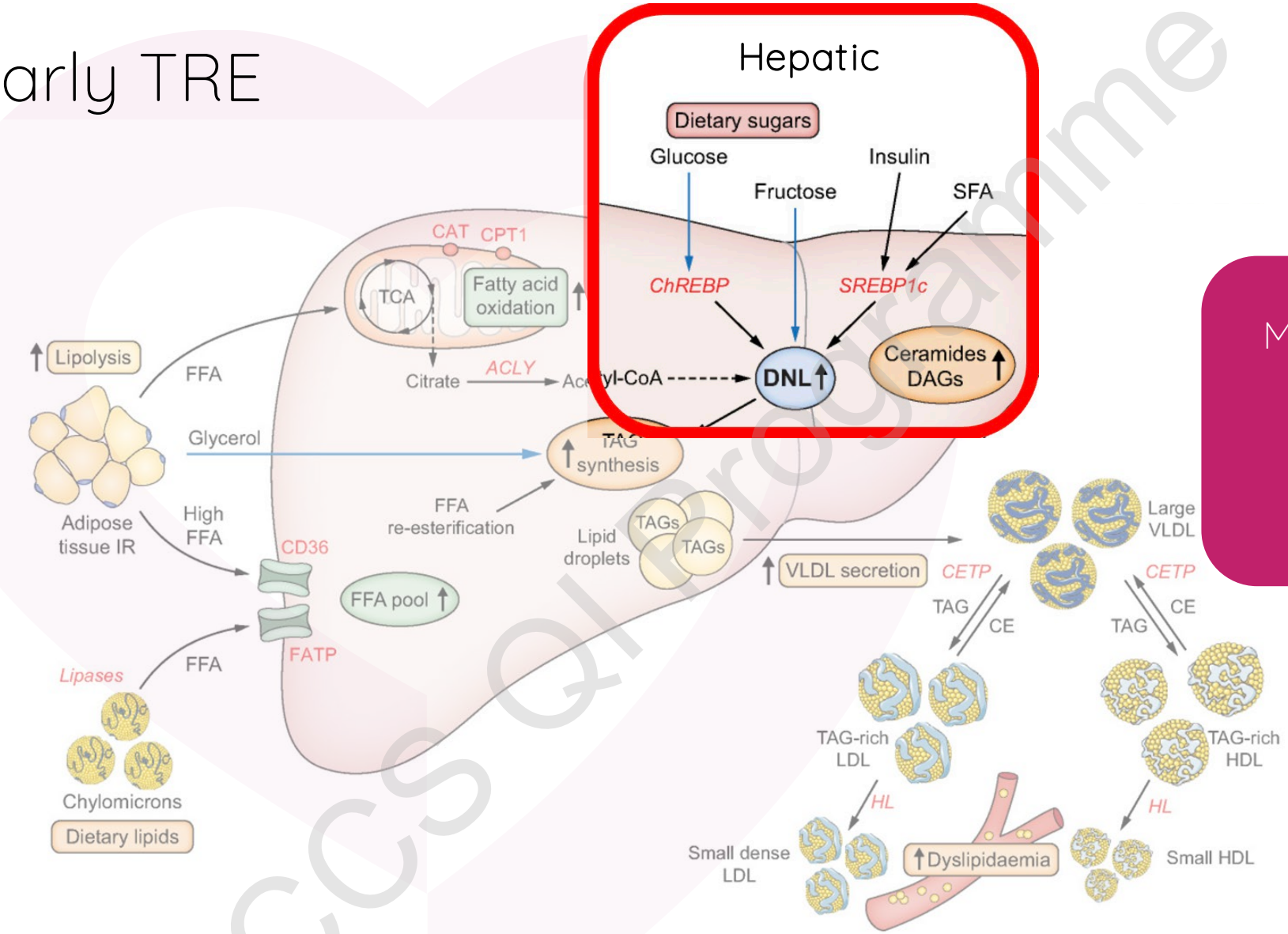
Reduce/avoid refined carbohydrates, added sugars

Increase fibre

Acetyl-CoA, acetyl coenzyme A; ACLY, adenosine triphosphate-citrate lyase; CAT, carnitine acetyltransferase; CD36, cluster of differentiation 36; CE, cholesteryl esters; CETP, cholesteryl ester transfer protein; chREBP, carbohydrate response element-binding protein; CPT1, carnitine palmitoyltransferase 1; DAGs, diacylglycerols; DNL, de novo lipogenesis; FATP, fatty acid transport proteins; FFA, free fatty acids; HDL, high-density lipoprotein; HL, hepatic lipase; IR, insulin resistance; LDL, low-density lipoprotein; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid; SREBP1c, sterol regulatory element binding protein 1c; TAG, triacylglycerol; TCA, tricarboxylic acid cycle; VLDL, very-low-density lipoprotein.

1. Adapted from Carli F, et al. JHEP Rep 2024;6(12):101185; 2. Reiner Z, et al. Eur Heart J 2011;32:1769–1818.

Early TRE



Mechanism:

Insulin sensitivity

Weight loss

Acetyl-CoA, acetyl coenzyme A; ACLY, adenosine triphosphate-citrate lyase; CAT, carnitine acetyltransferase; CD36, cluster of differentiation 36; CE, cholesteryl esters; CETP, cholesteryl ester transfer protein; chREBP, carbohydrate response element-binding protein; CPT1, carnitine palmitoyltransferase 1; DAGs, diacylglycerols; DNL, de novo lipogenesis; FATP, fatty acid transport proteins; FFA, free fatty acids; HDL, high-density lipoprotein; HL, hepatic lipase; IR, insulin resistance; LDL, low-density lipoprotein; SFA, saturated fatty acid; SREBP1c, sterol regulatory element binding protein 1c; TAG, triacylglycerol; TCA, tricarboxylic acid cycle; TRE, time-restricted eating; VLDL, very-low-density lipoprotein.

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Early TRE

Original Article
CLINICAL TRIALS: BEHAVIOR, PHARMACOTHERAPY, DEVICES, SURGERY

Obesity

High Caloric Intake at Breakfast vs. Dinner Differentially Influences Weight Loss of Overweight and Obese Women

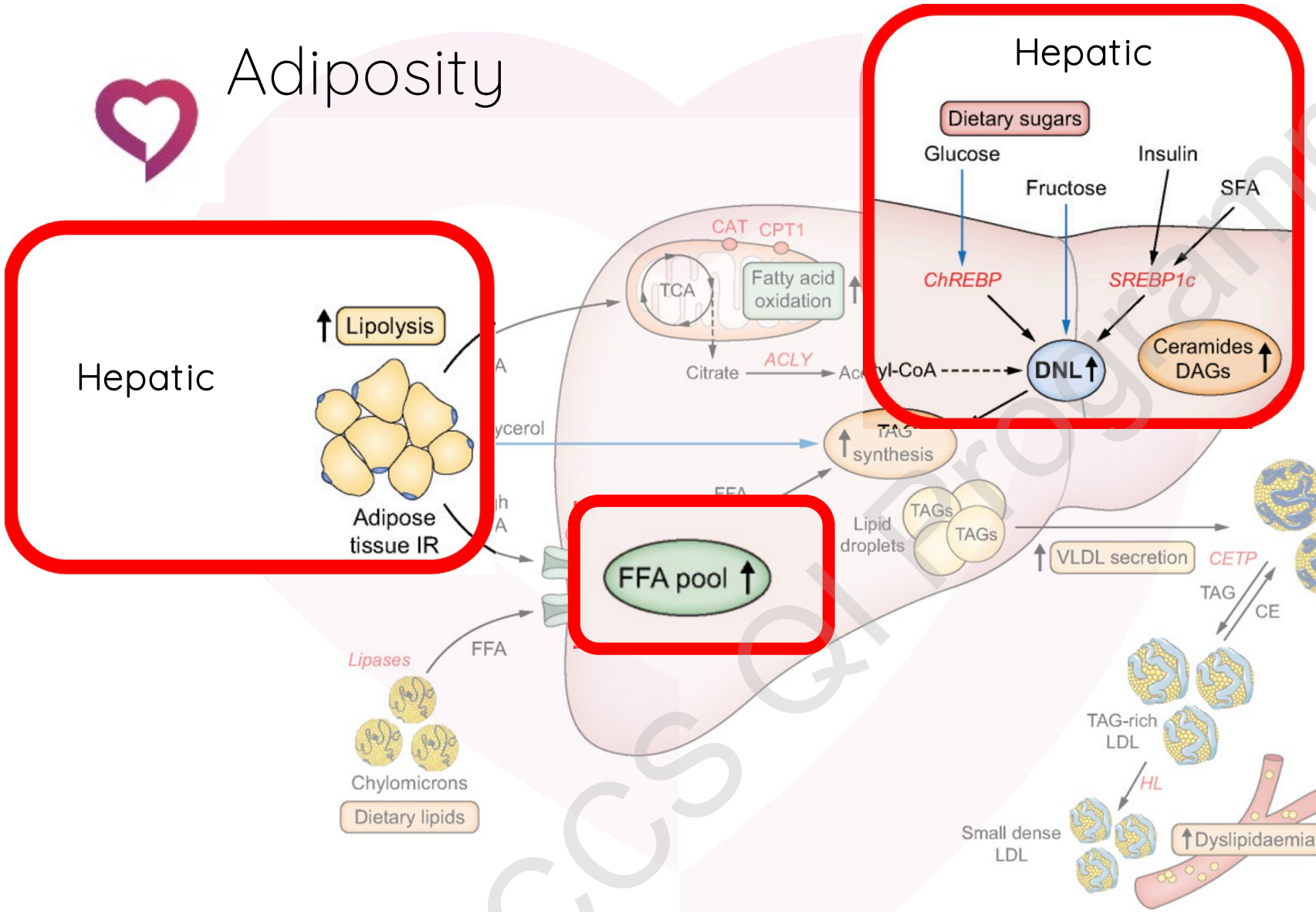
Daniela Jakubowicz,[1] *Maayan Barnea*,[2] *Julio Wainstein*[1] *and Oren Froy*[2]

- 12-week RCT
- 93 women
- BMI: 24 – 37
- 1400 kcal/day

Calorie division: Breakfast/lunch/dinner	‘Breakfast’ group 700 / 500 /200 kcal	‘Dinner’ group 200 / 500 / 700 kcal
Triglycerides	↓ 33.6%	↑ 14.6%
Weight	↓ 8.7 kg	↓ 3.6 kg
Waist circumference	↓ 8.5 cm	↓ 3.9 cm

BMI, body mass index; RCT, randomised controlled trial; TRE, time-restricted eating.
Jakubowicz D, et al. Obesity 2013; 21(12):2504-2512.

Adiposity



Bidirectional relationship

Ectopic fat (visceral, abdominal)

All excess calories – stored as triglycerides

Drive insulin resistance

Increased fatty acid availability
→ drives de novo lipogenesis

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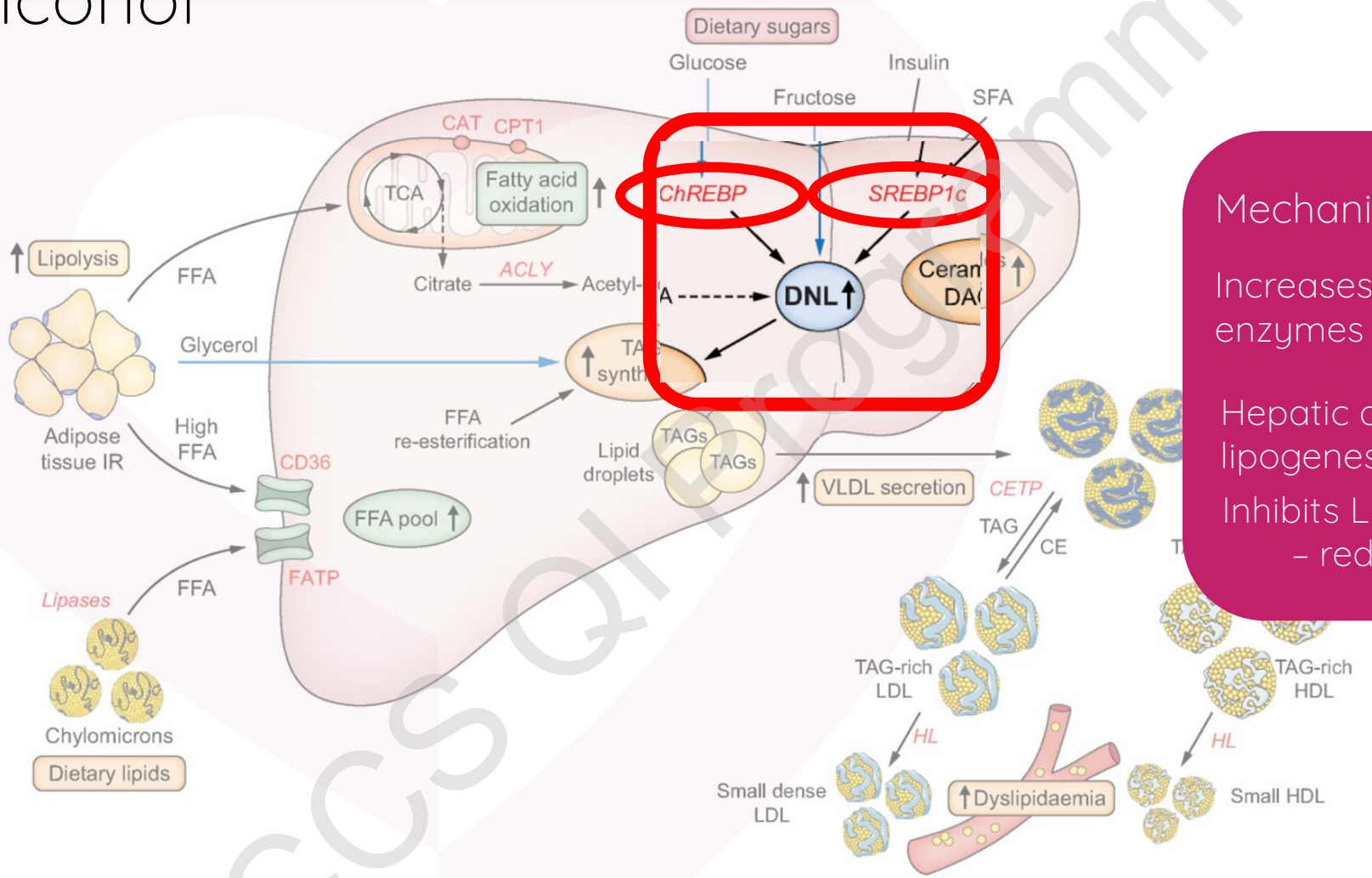
1. Adapted from Carli F, et al. JHEP Rep 2024;6(12):101185; 2. Sattar N, et al. Circulation 2022;146:77–79.

Alcohol



Mechanisms:

Increases activity of hepatic enzymes

Hepatic de novo lipogenesis

Inhibits LPL
– reduces clearance

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Physical Activity

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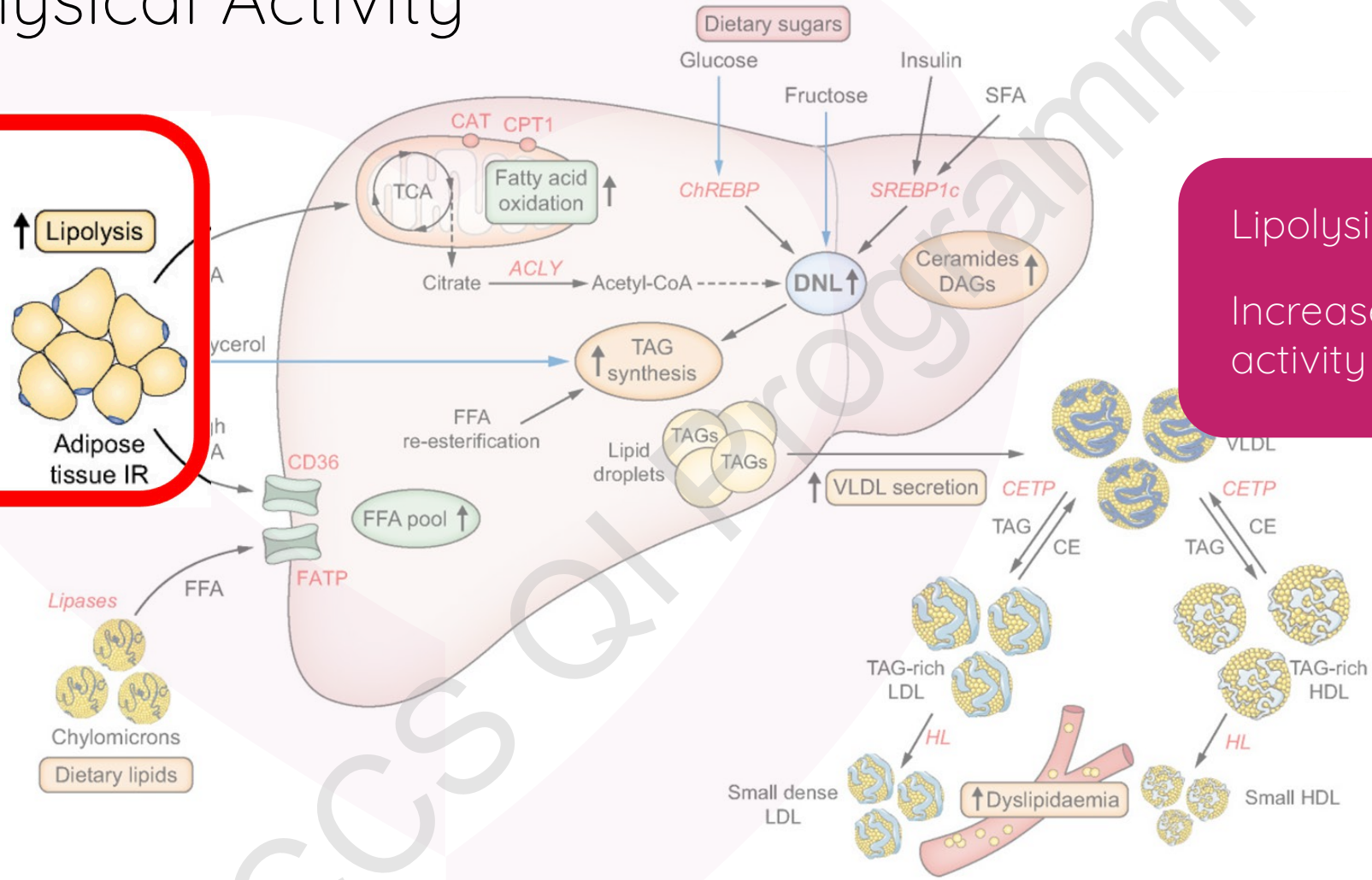
Hepatic



Lipolysis

Increased LPL activity & clearance

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Statins vs exercise: triglycerides

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Journal of Sport and Health Science 11 (2022) 567–577

Review

Effectiveness of statins *vs.* exercise on reducing postprandial hypertriglyceridemia in dyslipidemic population: A systematic review and network meta-analysis

Laura Alvarez-Jimenez, Alfonso Moreno-Cabañas, Miguel Ramirez-Jimenez, Felix Morales-Palomo, Juan F. Ortega, Ricardo Mora-Rodriguez *

Exercise Physiology Lab at Toledo, Sports Science Department, University of Castilla-La Mancha, Toledo 45004, Spain

Received 18 November 2020; revised 15 February 2021; accepted 21 June 2021
Available online 21 July 2021

- 37 RCTs
- 595 individuals
- Statin vs aerobic exercise

	STATIN	EXERCISE
Post prandial TG (high fat test meal)	0.65 mmol/l	0.46 mmol/l
Fasting TG	0.53 mmol/l	0.22 mmol/l

RCTs, randomised controlled trials; TG, triglycerides.
Alvarez-Jimenez L, et al. J Sport Health Sci 2022;11:567–577.

Omega 3: RCTs

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REDUCE-IT[1,2]	STRENGTH[3]
8179 pts, 4.9 yr f/u CVD/DM+RF On statins	13,078 pts, 3.5 yr f/u High CV risk On statins
25% reduction in CVD 20% reduction in triglycerides	Terminated early due to lack of clinical benefit
4g EPA Placebo: mineral oil	4g EPA +DHA Placebo: corn oil
AF hospitalisation 3.1% vs 2.1%	New onset AF: 2.2% vs 1.3%

AF, atrial fibrillation; CV, cardiovascular; CVD, cardiovascular disease; DHA, docosahexaenoic acid; DM, diabetes mellitus; EPA, eicosapentaenoic acid; f/u, follow-up; pts, patients; RCTs, randomised controlled trials; RF, risk factors; yr, year.

1. Bhatt DL, et al. N Engl J Med 2019;380:11–22; 2. Bhatt DL, et al. N Engl J Med 2019;380:11–22 (Supplementary Appendix); 3. Nicholls SJ, et al. JAMA 2020;324:2268–2280.

Omega 3 & diet

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(Essential)

TYPES	Alpha linolenic Acid (ALA)	Eicosapentaenoic acid (EPA)	Docosahexaenoic acid (DHA)
SOURCE	Seeds, nuts, oils, fruit, veg[1,2]	Oily fish[3]	Oily fish[3]
SUPPLEMENT		Mix of EPA & DHA ACC: "not been demonstrated to have cardiovascular outcomes benefits and are not recommended for ASCVD risk reduction."[4]	

ACC, American College of Cardiology; ASCVD, atherosclerotic cardiovascular disease.

1. Rajaram S. Am J Clin Nutr 2014;100(suppl 1):443S–448S; 2. Bajramova A and Spégel P. JFCA 2022;122:104657; 3. BDA. Omega-3. Available at: https://www.bda.uk.com/resource/omega-3.html#:~:text=Fish%20and%20especially%20oily%20fish,lower%20levels%20than%20oily%20fish. Accessed March 2025; 4. Virani SS, et al. JACC 2021;78(9):960–993.

Omega 3 & diet

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Associations of Fish Consumption With Risk of Cardiovascular Disease and Mortality Among Individuals With or Without Vascular Disease From 58 Countries

Deepa Mohan, PhD[1]; Andrew Mente, PhD[2,3]; Mahshid Dehghan, PhD[2]; et al

» Author Affiliations | Article Information

JAMA Intern Med. 2021;181(5):631-649. doi:10.1001/jamainternmed.2021.0036

- 191 558 people
- 58 countries
- Median follow-up 7.5 years

Dietary fish consumption

- No reduction in major CVD incidence
- 2+ servings fish/week - reduction in CV mortality

CV, cardiovascular; CVD, cardiovascular disease.
Mohan D, et al. JAMA Intern Med 2021;181:631–649.

Summary

- Lifestyle factors have a significant impact on triglyceride levels
- Prioritise advice around alcohol intake and weight reduction if relevant
- Emphasise a whole food diet low in saturated fats and added sugars, high in fibre (unprocessed plant foods), low in refined grains and ultra-processed foods
- Replace saturated fats (animal fats, palm fat, coconut fat) with mono- or polyunsaturated fats including omega 3 (plant fats, fatty fish)
- Dietary omega 3 from food or supplements does not have sufficient evidence
- Both aerobic and resistance exercise lower triglycerides