



# HIGH FRUCTOSE CORN SYRUP

A CONTAMINANT OF EMERGING CONCERN

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# WHAT IS HFCS?



## LIQUID SWEETENER FOUND IN:<sup>1</sup>

- HFCS-42: PROCESSED FOOD, CEREALS, BAKED GOODS, SOME BEVERAGES
- HFCS-55: SUGAR SWEETENED BEVERAGES

## GLYCEMIC INDEX = NOT DEFINED YET

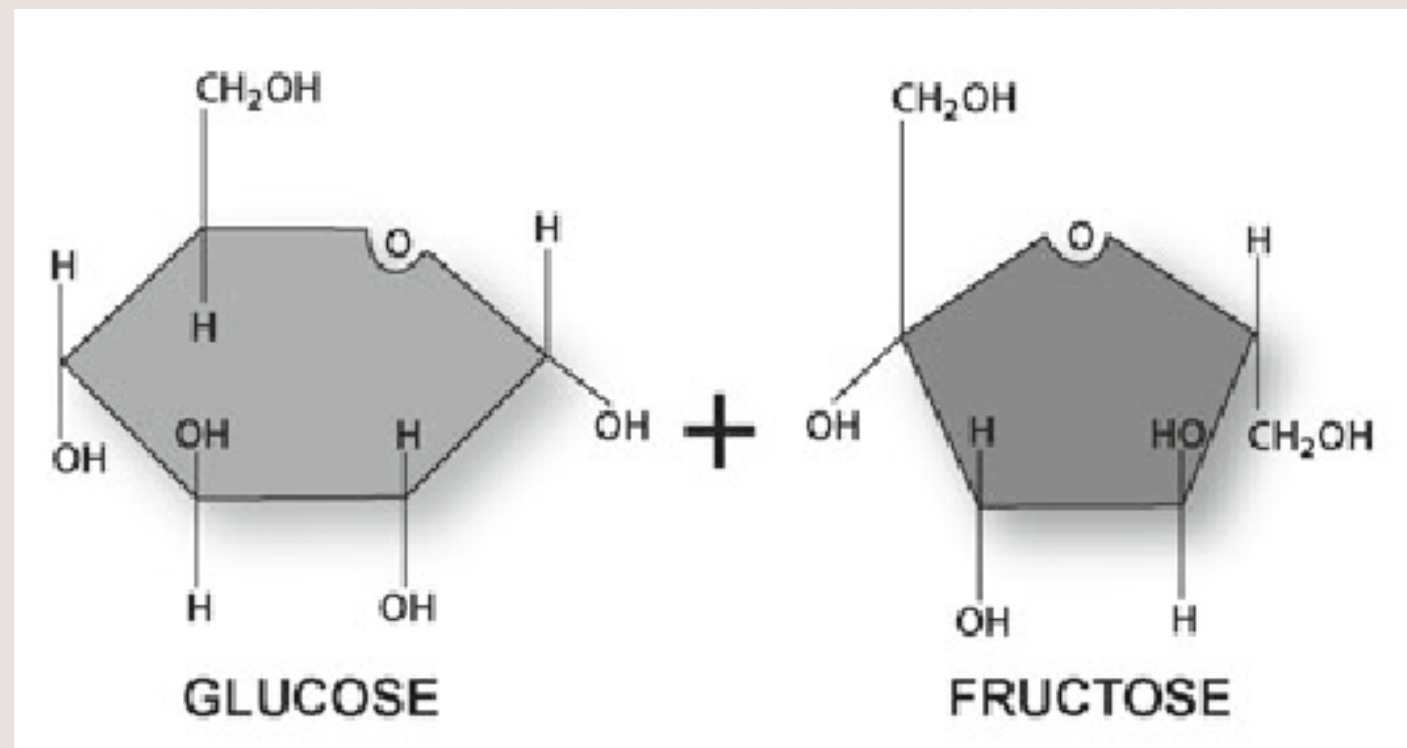
- STRUCTURE IS SIMILAR TO SUCROSE, SO GI IS SIMILAR
- USE LESS FOR SWEETER TASTE

## 4 KCAL/GRAM

## ALTERNATIVE TO SUCROSE (TABLE SUGAR)

## FAVORABLE TRAITS:<sup>2</sup>

- CHEAPER THAN SUCROSE, INCREASES SHELF LIFE, NON-CRYSTALLINE, EASIER TO TRANSPORT & PRESERVE



# HISTORY AND REGULATIONS

## HFCS COMMERCIALY INTRODUCED IN THE U.S. IN 1967

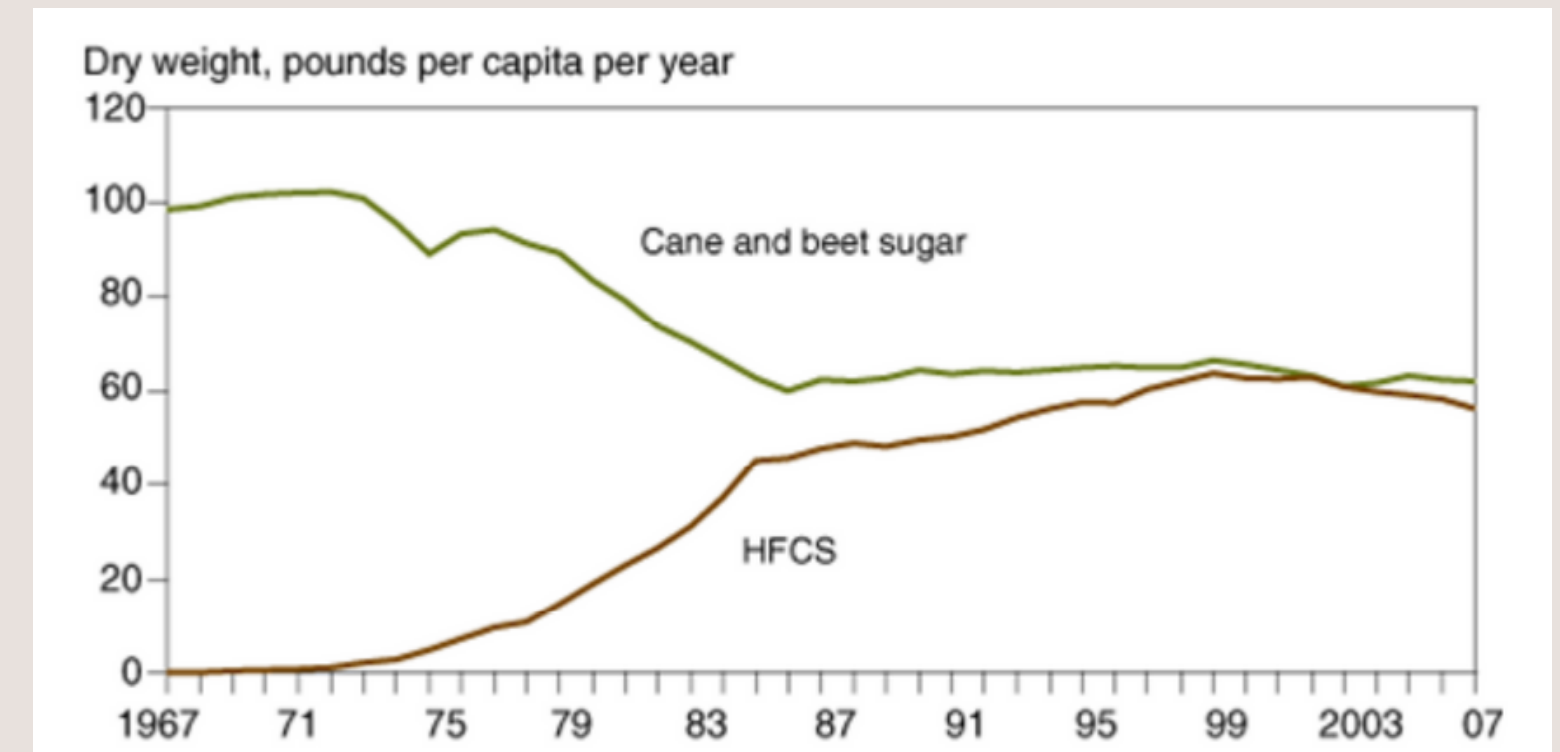
- **1970-1990:** CONSUMPTION INCREASED 1000%, WITH HFCS REPRESENTING ABOUT 40% OF ALL ADDED SWEETENERS<sup>5</sup>
- **1967-2006:** ANNUAL PER CAPITA INTAKE INCREASED FROM 0.3 TO 58.2 LBS<sup>6</sup>
- PEAKED IN 1999 WITH 9.5 MILLION TONS<sup>6</sup>
- **2000-2017:** PRODUCTION DECLINED 12% WITH 8.3 MILLION TONS IN 2017<sup>6</sup>
- **AVERAGE DAILY CONSUMPTION OF HFCS** = 50G/PERSON OR 316 KCAL/PERSON IN 2004<sup>5</sup>

## FOOD AND DRUG ADMINISTRATION:

- HFCS = GENERALLY RECOGNIZED AS SAFE (GRAS) IN 1983 AND REAFFIRMED IN 1996<sup>7</sup>

## USDA SUBSIDIZES CORN

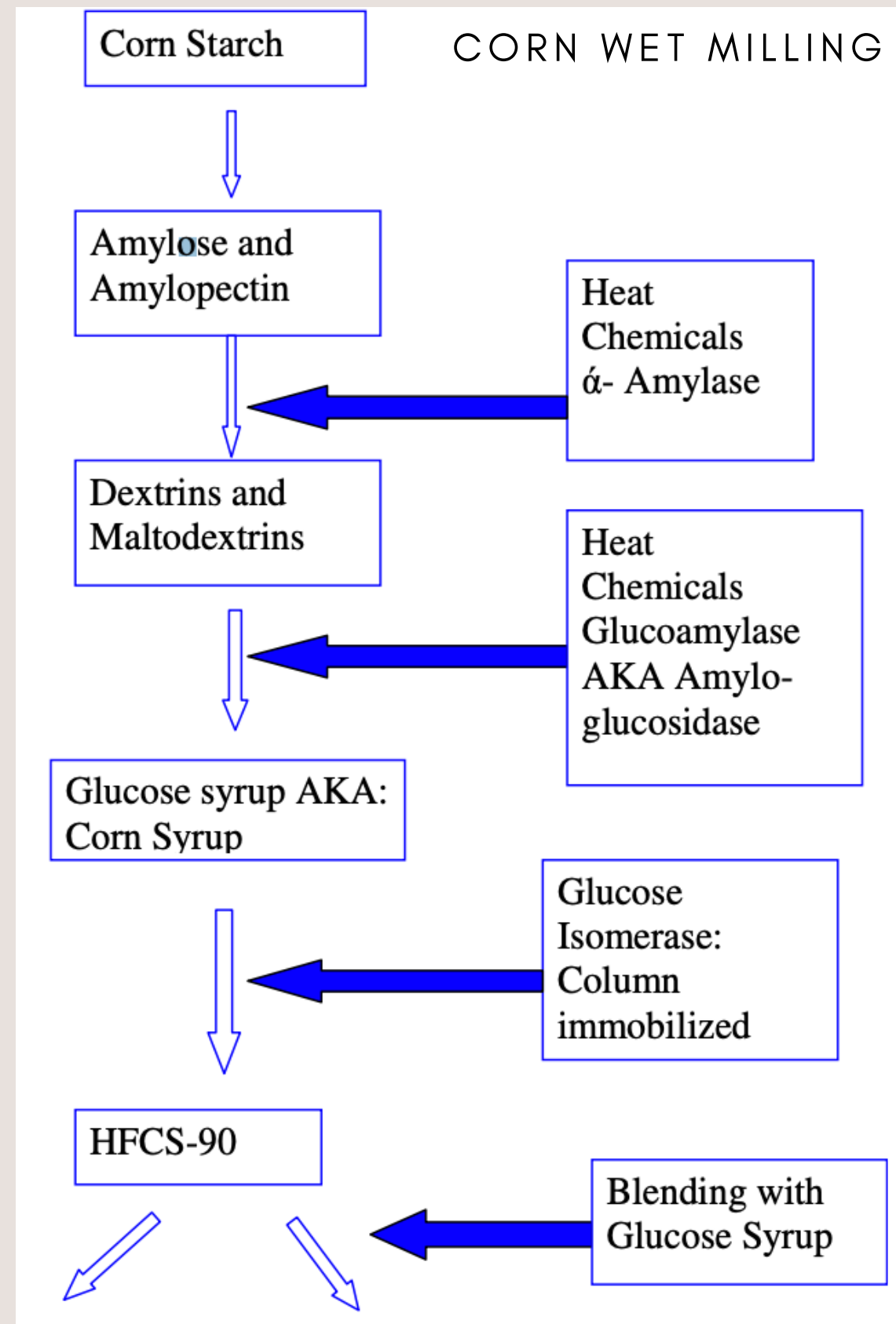
- 10% OF CONSUMER PRICES GOES TO FARMERS<sup>8</sup>
- GMO CORN INTRODUCED COMMERCIALY IN 1990S<sup>9</sup>



Graph from Parker et al. 2010

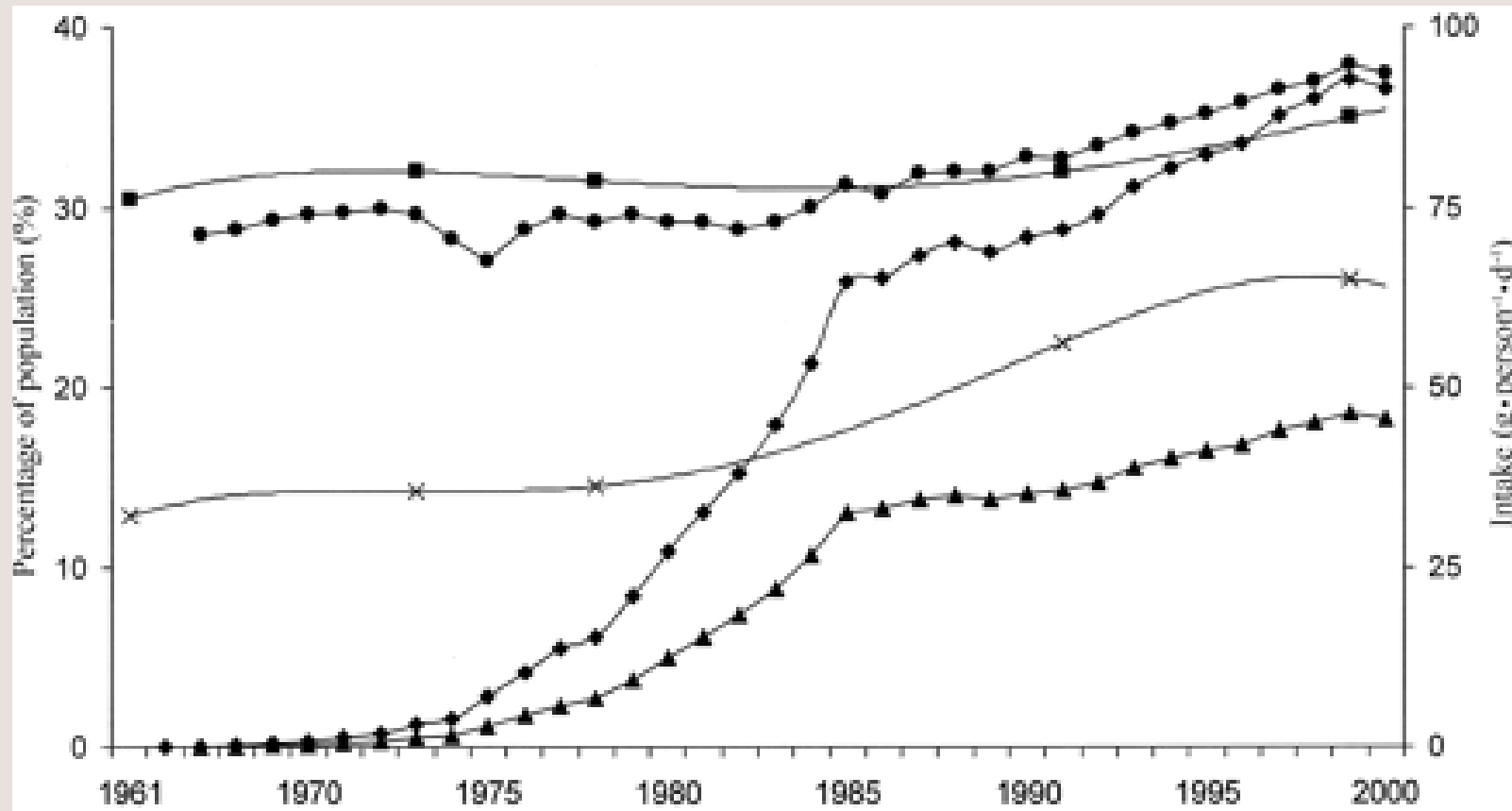
# HOW IS HFCS MADE?

STEEP CORN W/ H<sub>2</sub>O  
& SO<sub>2</sub> --> CORN WET  
MILLING



IN 2020, HFCS IS  
A \$3.9 BILLION  
INDUSTRY<sup>3</sup>

# WHY HFCS = CEC?



Graph from Bray et al. 2004

circle = total fructose, triangle = free fructose, diamond = HFCS, x= obesity, square = overweight

**CONFLICTING ARGUMENTS ON HFCS'S ROLE IN DIABETES AND OBESITY**

**ASSOCIATED WITH THE INCREASED INCIDENCE OF METABOLIC SYNDROMES AND CARDIOVASCULAR DISEASE <sup>4</sup>**

**MANY STUDIES ON FRUCTOSE & GLUCOSE EFFECTS; HOWEVER, MANY HAVE CONFOUNDING FACTORS:**

- SMALL STUDIES
- NOT TESTING FOR GLUCOSE + FRUCTOSE
- DESPITE WHAT IS KNOWN, THERE IS PUSH BACK FROM THE CORN REFINERS ASSOCIATION THAT WILL ELICIT DOUBT

# HOW IS HFCS METABOLIZED?

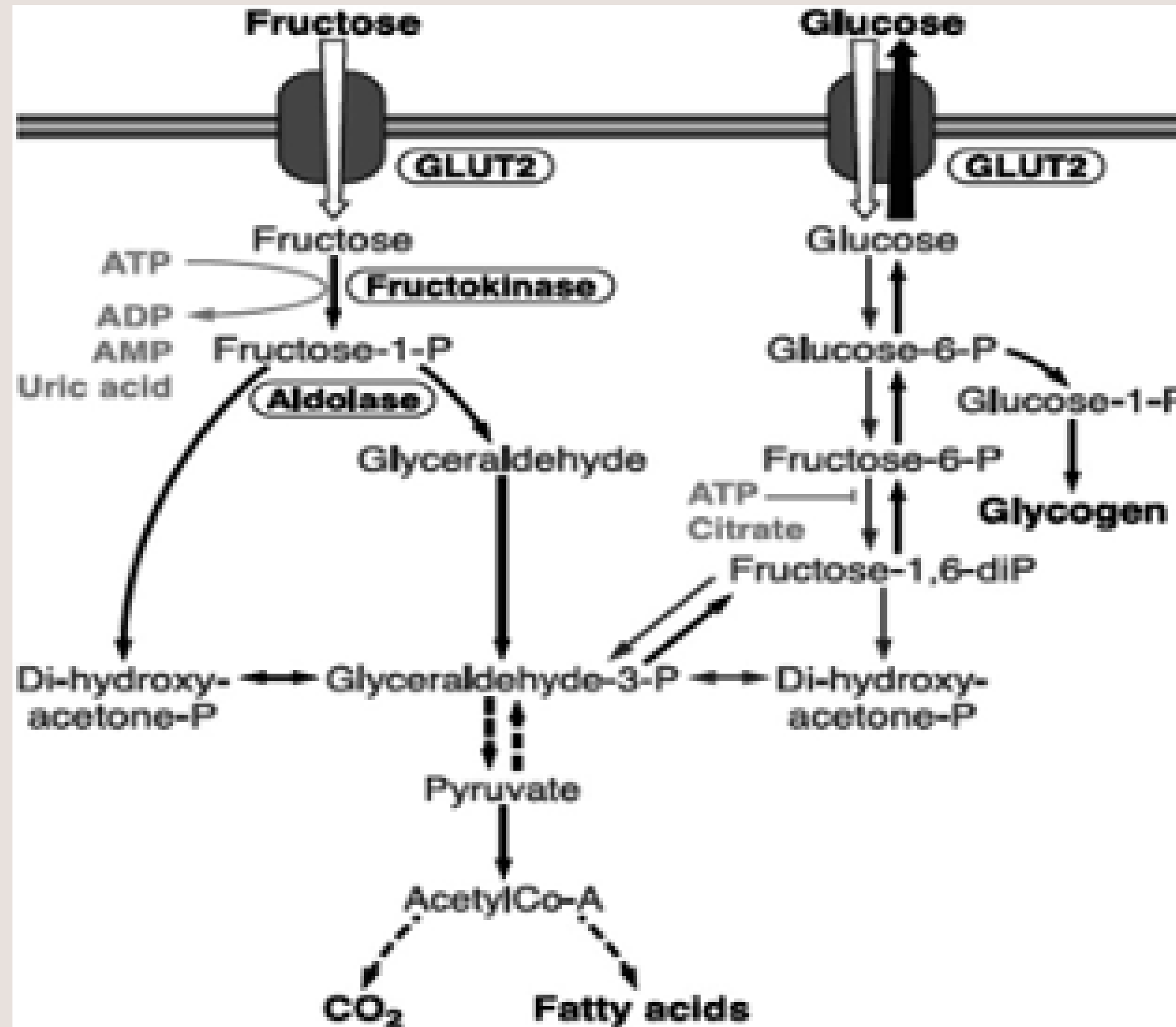


Diagram from Rippe & Angelopoulos 2013

# WHY IS HFCS A CONCERN TO HEALTH?

## **GLOBAL OBESITY HAS DOUBLED SINCE 1980**<sup>4</sup>

- 1980-2014: DIABETIC CASES QUADRUPLED TO 422 MILLION<sup>4</sup>

## **FRUCTOSE METABOLISM**

- FAVORS DE NOVO LIPOGENESIS --> PALMITIC ACID --> ATHEROSCLEROSIS<sup>4</sup>
  - INCREASE IN TRIGLYCERIDE
- STIMULATES INSULIN RESISTANCE --> TYPE 2 DIABETES<sup>4</sup>
- DECREASED LEPTIN SECRETION --> OBESITY<sup>5</sup>
- EXCESS BECAUSE OF HEREDITARY FRUCTOSE INTOLERANCE OR ABSENCE OF FRUCTOKINASE --> ABDOMINAL PAIN/DISCOMFORT --> EXCRETED IN URINE<sup>4</sup>
- GLUT5 DEPENDS ON GLUCOSE LEVELS<sup>4</sup>

## **GLUCOSE METABOLISM**<sup>4</sup>

- HIGH BLOOD GLUCOSE --> INSULIN RESISTANCE --> TYPE 2 DIABETES
- LEPTIN SECRETION
- GLYCOGEN STORED IN LIVER OR MUSCLE --> OBESITY
- EXCESS GETS EXCRETED IN URINE



# HOW IS HFCS TREATED IN WWTP?

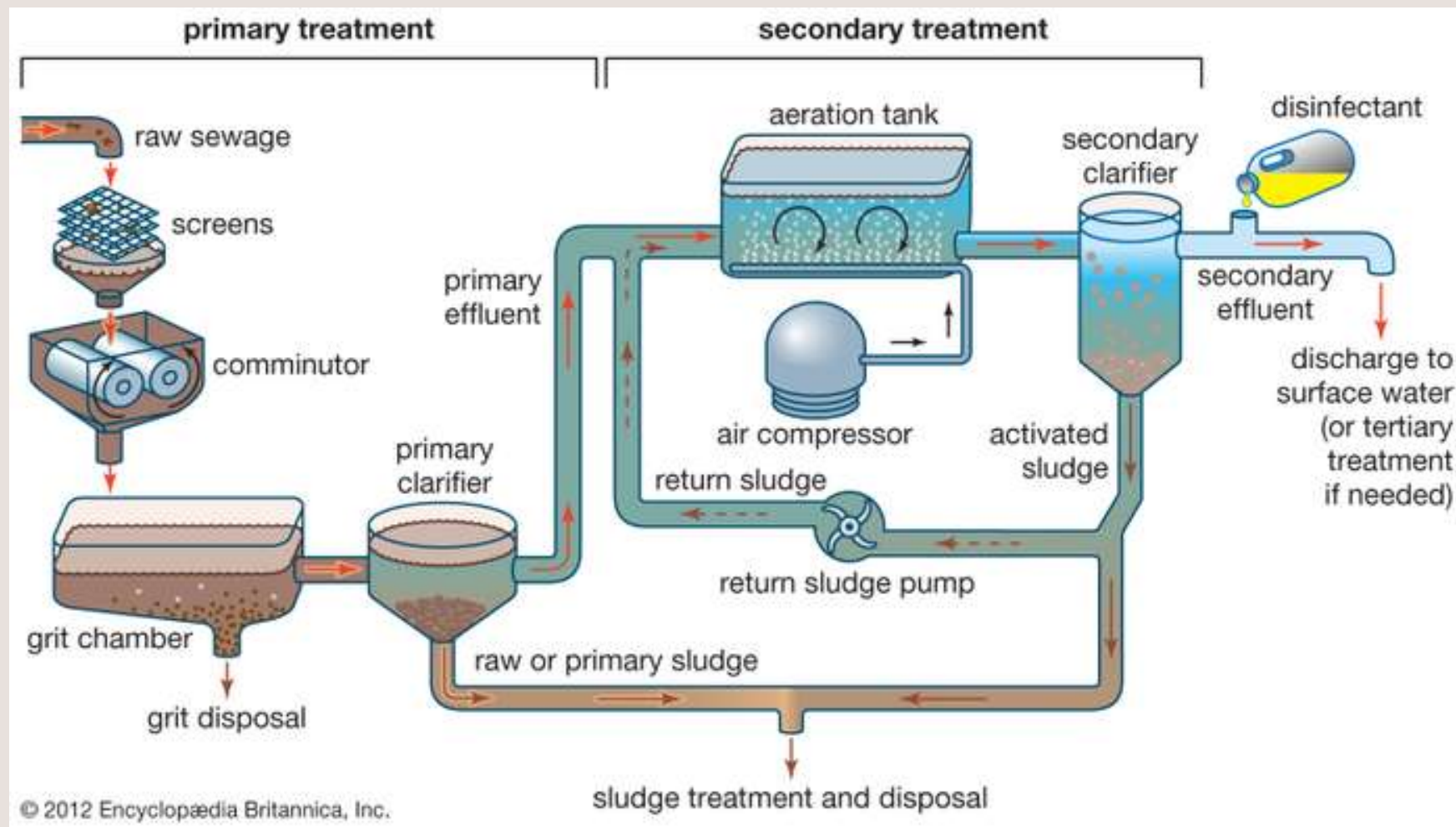


Image from Encyclopedia Britannica 2020

## PRIMARY SEDIMENTATION<sup>11</sup>

**SECONDARY TREATMENT:** 90% OF ORGANIC MATTER IS REMOVED<sup>11</sup>

- ATTACHED GROWTH PROCESS: TRICKLING FILTER (ROCKS/PLASTIC) OR SUSPENDED GROWTH PROCESS (AERATION TANKS)

**RESPIRATION:** ORGANICS ARE DESTROYED/CONVERTED BY MICROBES IF THERE'S SUFFICIENT OXYGEN



# HOW IS HFCS AFFECTING THE ENVIRONMENT?

## HONEY BEES

- HFCS IS FED TO BEES AFTER HARVEST OR LOW NECTAR PERIODS
- **HYDROXYMETHYLFURFURAL** IS FORMED WHEN HFCS GETS HEATED/DEHYDRATED TO ABOUT 45C<sup>12</sup>
- CAUSE BEES DYSENTERY-LIKE SYMPTOMS & POSSIBLE FACTOR FOR COLONY COLLAPSE DISORDER<sup>4</sup>

## MERCURY CONTAMINATION

- CAUSTIC SODA AND HYDROCHLORIC ACID PRODUCTION FOR HFCS USES MERCURY CELLS<sup>4</sup>
- IN DEFAULT ET AL.'S STUDY, 9/20 SAMPLES CONTAINED MERCURY LEVELS RANGING FROM 0.065-0.570 MICROG/GHFCS<sup>13</sup>
- CONCERNING FOR VULNERABLE POPULATIONS
- **2007:** PRESIDENT OBAMA INTRODUCED BILL TO AMEND THE TOXIC SUBSTANCE CONTROL ACT TO PHASE OUT MERCURY USE IN MANUFACTURING CAUSTIC SODA<sup>14</sup>

# SO WHAT?

**THERE IS PUBLIC CONCERN** WITH HFCS'S HEALTH & ENVIRONMENTAL EFFECTS;  
HOWEVER, PUSH BACK FROM GOVERNMENT ENTITIES PREVENTS FURTHER REGULATIONS  
ON HFCS

**MORE RESEARCH IS NEEDED** TO TEST FRUCTOSE AND GLUCOSE CO-INGESTION TO  
FURTHER UNDERSTAND HFCS'S EFFECTS ON OUR HEALTH

**LIMIT INTAKE OF HFCS** BECAUSE ITS ASSOCIATED WITH NONCOMMUNICABLE DISEASES

# THANK YOU!

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