

# Engineering the Perfect Diet: The Problem with Sugar and Artificial Sweeteners

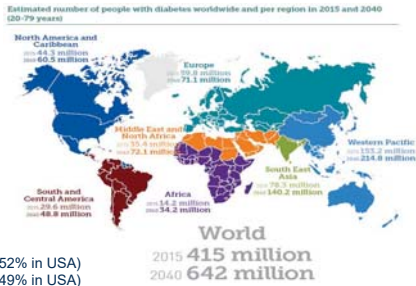
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 Assistant Professor  
 Department of Biomedical Engineering  
 Max McGee National Research Center  
 Center for Advancing Population Science  
 Cardiovascular Center  
 Medical College of Wisconsin  
 Marquette University



## Outline

- Diabetes Overview
- Implications of Chronic Sugar and Artificial Sweetener Consumption
- Forward Thinking: What can we do?

## Global Prevalence of Diabetes

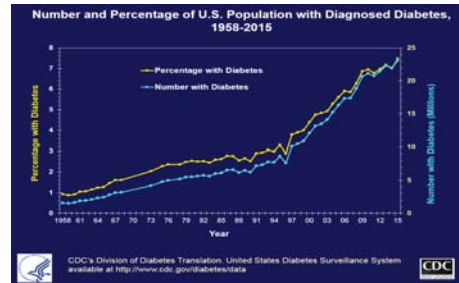


**GLOBAL COST:**  
 2015 – \$672 billion (52% in USA)  
 2040 – \$803 billion (49% in USA)

StatistaCharts (Source: International Diabetes Federation)  
 \*2040 Figures are Forecasts Based on Current Trends



## Rapid Rise in Diabetes



# Diabetes Complications



<https://www.umassmed.edu/doe/diabetes-education/complications/>

# Outline

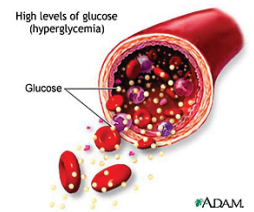
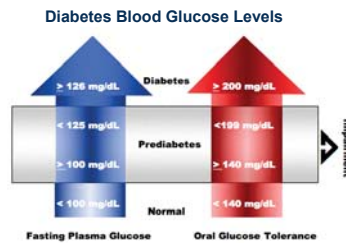
- Diabetes Overview
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- Forward Thinking: What can we do?

# Blood Glucose Regulation



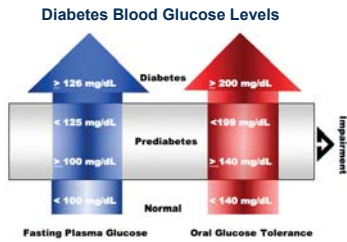
[http://www.healthy-diet-healthy-you.com/Low\\_Glycemic\\_Foods.html](http://www.healthy-diet-healthy-you.com/Low_Glycemic_Foods.html)

# Hyperglycemia (High Blood Glucose)



#ADAM

# Hyperglycemia (High Blood Glucose)



Spontaneous Sugar Modifications (Similar to Marinating Steak)

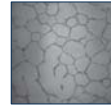


<https://anovaculinary.com/>

# High Glucose Cardiovascular Impairment

## Endothelial Cell Tube Formation Assay:

- Endothelial Cell Groups:
1. Normal Glucose (NG)
  2. High Glucose (HG)



#ADAM

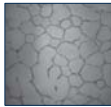
Dhanush Hespula (Postdoctoral Fellow)

# High Glucose Cardiovascular Impairment

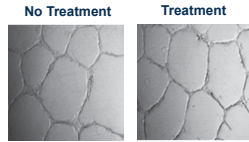
## Endothelial Cell Tube Formation Assay:

Endothelial Cell Groups:

1. Normal Glucose (NG)
2. High Glucose (HG)
3. NG plus PNGaseF (NG-PF)
4. HG plus PNGaseF (HG-PF)



Normal Glucose



High Glucose

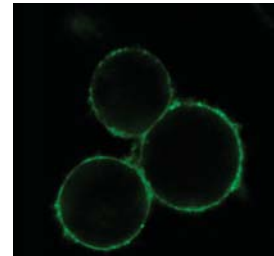
HG plus treatment vs. HG alone (p<0.05; 2 week 25 mM treatment)

PNGaseF (PF): Removes specific sugar modifications



Dhanush Hespula (Postdoctoral Fellow)

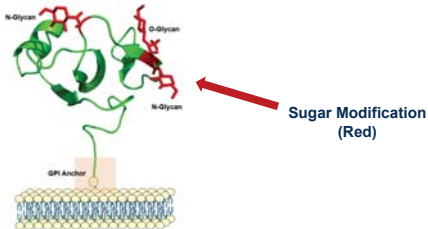
# Identify Sugar Modified Proteins in Cells



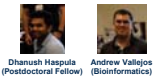
Identify Sugar Modified Proteins

## Sugar Modified Proteins

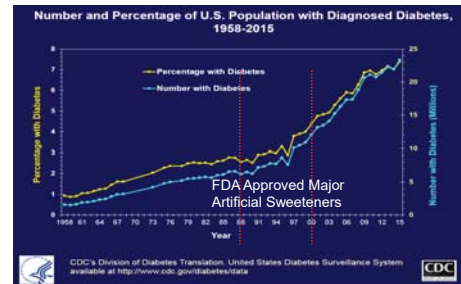
**CD59 Immunoprotective Protein**



Nevo et al. *Blood*, 2013 Jan 3;121(1):129-35.  
Qin et al. *Diabetes* 2004 Oct; 53(10): 2653-2661.

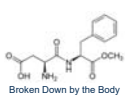


## What About Artificial Sweeteners?



## Sweetener Biochemical Variation

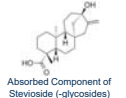
**Aspartame**



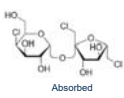
**Acesulfame K+**



**Steviol**



**Sucralose**



Evelyn Granados Centeno and George Ronan (MU BME Undergraduate Students)



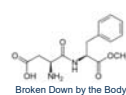
Dhanush Haspula (Postdoctoral Fellow) Laura Danner (UWM Undergraduate Student)

Isabelle Hoernke (SUPREMES Program)



## Sweetener Induced Changes

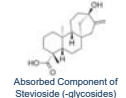
**Aspartame**



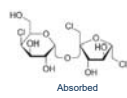
**Acesulfame K+**



**Steviol**



**Sucralose**



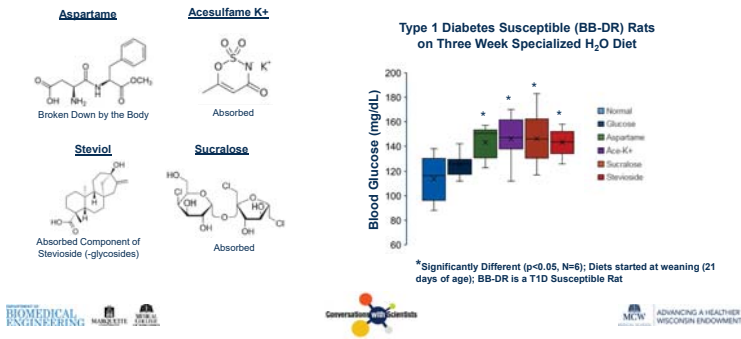
Added to Water



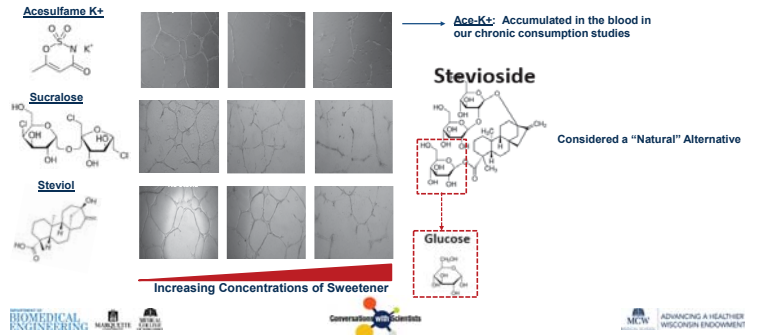
<https://stock.adobe.com/search/?q=labino+ratt>



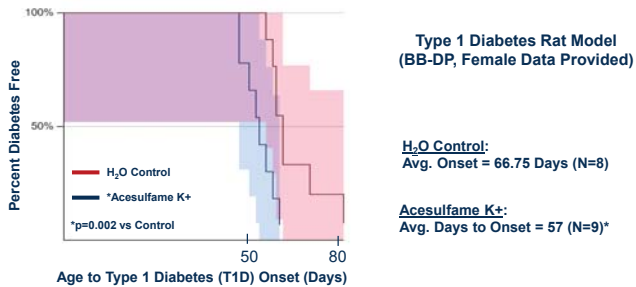
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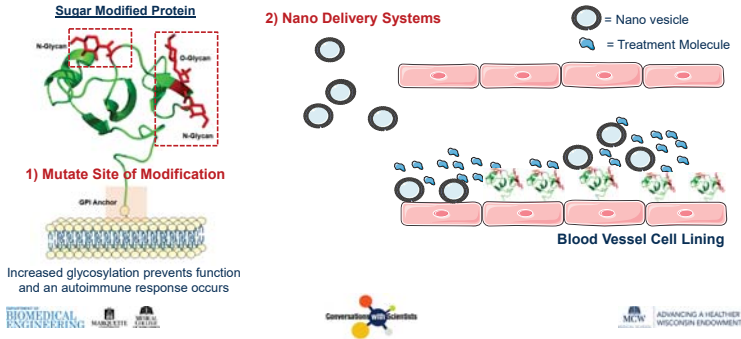
## Impact on Cardiovascular Function



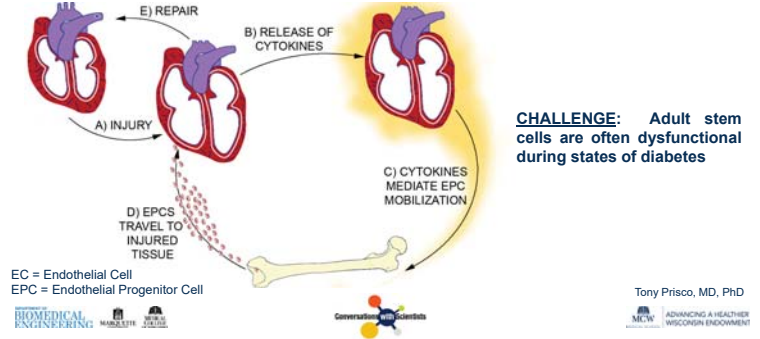
## Diabetes Susceptible Individuals



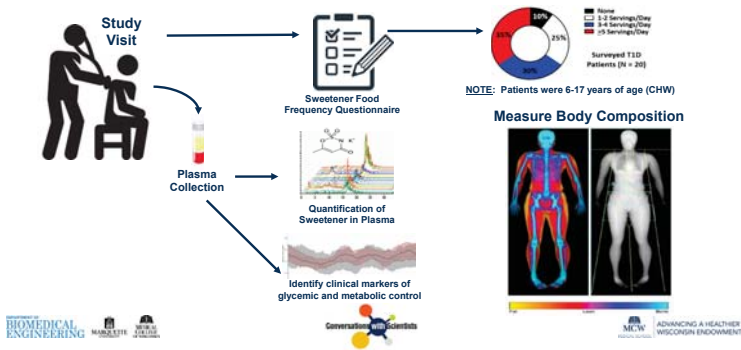
## Targeted Therapeutics



## Tissue Regeneration – Adult Stem Cells



## Translate Sweetener Studies to Patients



## Be Aware of Your Consumption

<p><b>BRAN MUFFIN</b></p> <p>Calories = 424 Protein = 5 grams Fat = 18 grams Fiber = 1 gram Sugar = 39 grams Sodium = 380 mg Cholesterol = 34 mg Vitamin K = 49% of Daily Value</p>	<p><b>GLAZED DOUGHNUT</b></p> <p>Calories = 269 Protein = 4 grams Fat = 15 grams Fiber = 1 gram Sugar = 15 grams Sodium = 202 mg Cholesterol = 19 mg Vitamin K = 8.2% of Daily Value</p>	<p><b>REGULAR SODA</b></p> <p>Calories = 170 Protein = 0 grams Fat = 0 grams Fiber = 0 grams Sugar = 46 grams Sodium = 45 mg</p> <p>NOTE: Contains glucose and fructose</p>	<p><b>DIET SODA</b></p> <p>Calories = 0 Protein = 0 grams Fat = 0 grams Fiber = 0 grams Sugar = 0 grams Sodium = 30 mg</p> <p>NOTE: Contains Sucralose, Acesulfame Potassium, Aspartame</p>
<p><b>SIGGI'S YOGURT</b></p> <p>Calories = 120 Protein = 16 grams Fat = 0 grams Fiber = 0 grams Sugar = 9 grams Sodium = 60 mg Calcium = 15% of Daily Value</p>	<p><b>LIGHT &amp; FIT YOGURT</b></p> <p>Calories = 80 Protein = 12 grams Fat = 0 grams Fiber = 0 grams Sugar = 7 grams Sodium = 45 mg Calcium = 15% of Daily Value</p> <p>NOTE: Contains Sucralose, and Acesulfame Potassium</p>	<p><b>DANNON FRUIT YOGURT</b></p> <p>Calories = 150 Protein = 6 grams Fat = 1.5 grams Fiber = 0 grams Sugar = 25 grams Sodium = 105 mg Calcium = 20% of Daily Value</p>	

Logos: BIOMEDICAL ENGINEERING, MAMBLETH, UNIVERSITY OF WISCONSIN, CONVERSATION SCIENTISTS, ADVANCING A HEALTHIER WISCONSIN ENDOWMENT

## Be Mindful of Reporting



**Artificial sweetener triggers metabolic changes in rats**

Wisconsin: Research Shows Negative Health Effects Linked To Artificial Sweeteners



**Artificial sweeteners can still lead to obesity and diabetes, study claims**

Medical College of Wisconsin: Artificial Sweeteners Linked To Obesity, Diabetes, Study Shows



**Why artificial sweeteners can still lead to diabetes**

Artificial sweeteners may be linked to obesity and diabetes, study shows



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Conversations with Scientists



MCEW | ADVANCING A HEALTHIER WISCONSIN ENDOWMENT

## Nutritional Balance


IN




**METABOLISM**  
"Why is every party like this?"

http://mitrafarmand.com/elephant-in-the-room/


OUT



BME | ADVANCING A HEALTHIER WISCONSIN ENDOWMENT



Conversations with Scientists



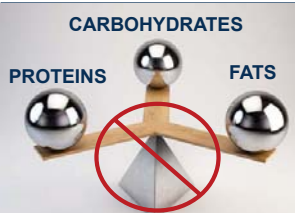
MCEW | ADVANCING A HEALTHIER WISCONSIN ENDOWMENT

## Nutritional Balance

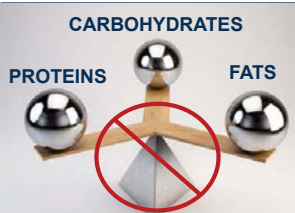
IN

**CARBOHYDRATES**

**PROTEINS**



**FATS**




**OUT**


http://mitrafarmand.com/elephant-in-the-room/

OUT


Metabolic Syndrome and Diabetes



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Conversations with Scientists



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