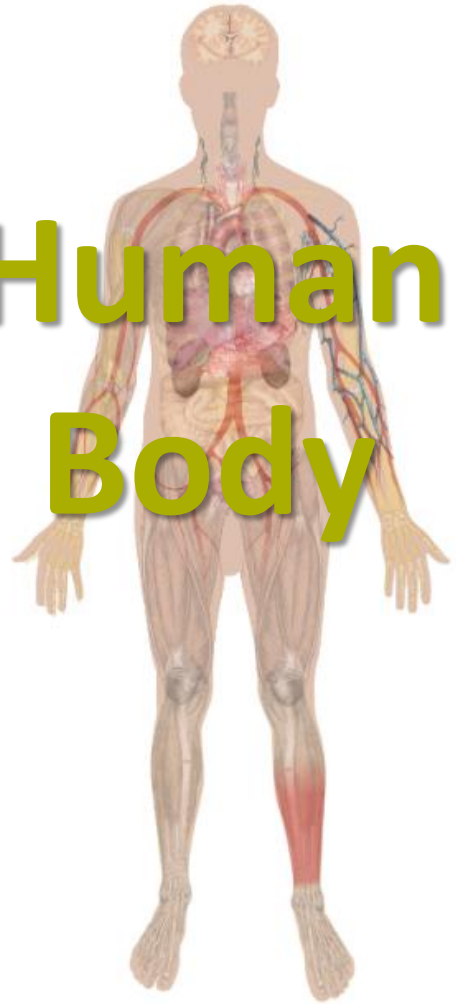
What is AD?

Flávio Ascenco
Technical Support Manager
Flavio.Ascenco@adbioresources.org

ADBA | Anaerobic Digestion and Bioresources Association

Let's compare

Human Body



Size
Type
Digestion sequence
Outputs
Types of food/feedstock
Energy potential
What else affects it,
Monitoring/testing
Challenges

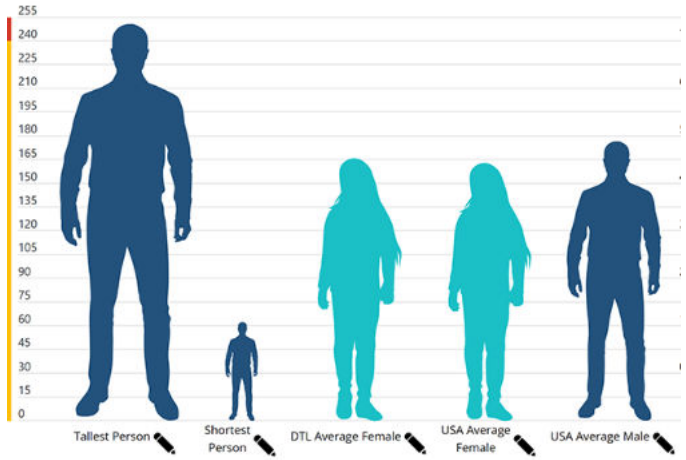
Anaerobic Digestion

SIZE

Human Body

Individual Size
Consider the Weight and Height

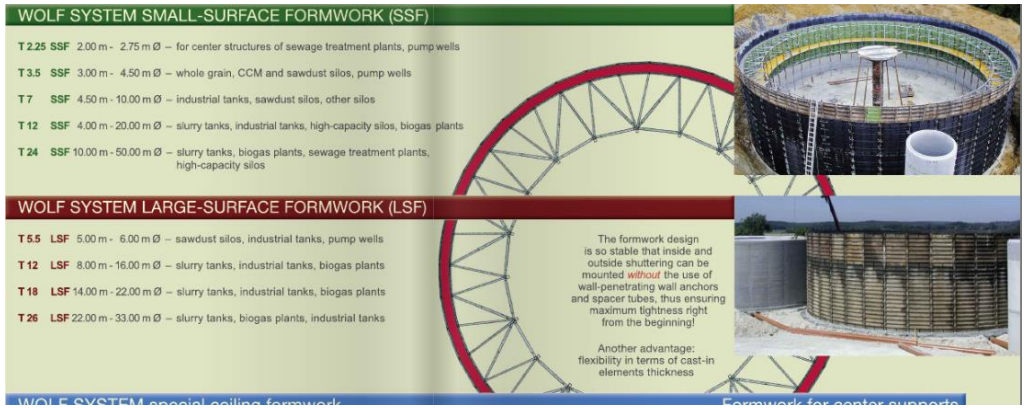
From 50 kg to 120 kg
From 150 cm to 230 cm



Anaerobic Digestion

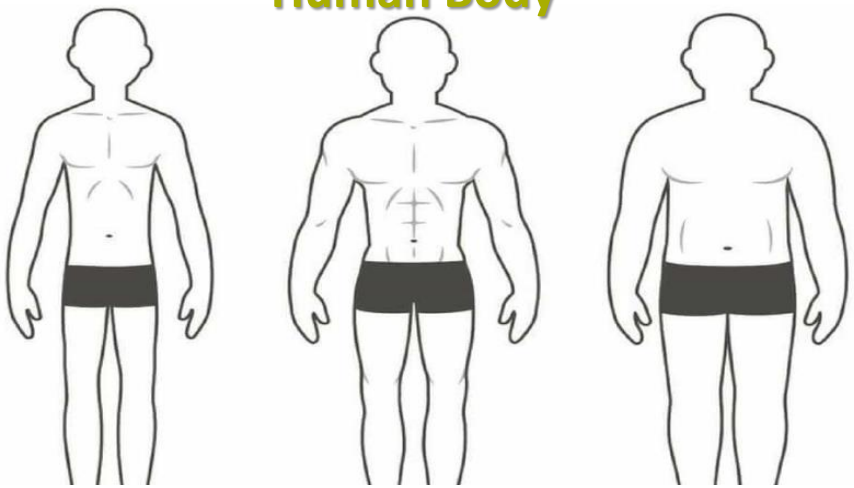
Tank size
Consider the Weight and the Height

From 500 tonnes to 6000 tonnes
From 2 meters to 30 meters



TYPE

Human Body

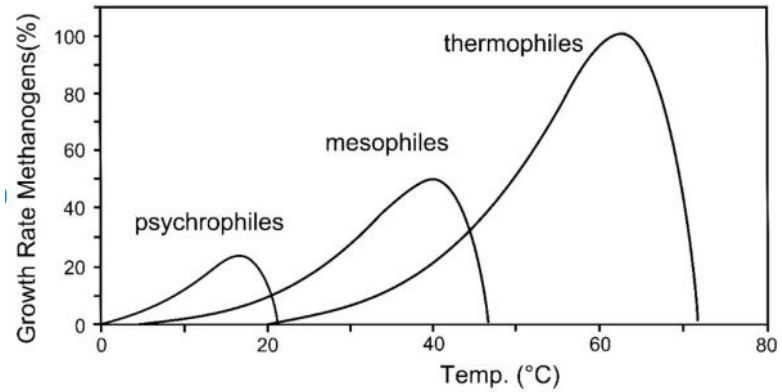


Ectomorph Body Type
Typical Characteristics:
- Long and lean
- Delicate frame
- Difficult to build muscle and fat
- Body like a marathon runner
- Fast metabolism

Mesomorph Body Type
Typical Characteristics:
- Middle of the body types
- Can be lean and muscular simultaneously
- Natural athletics build with well-defined muscles

Endomorph Body Type
Typical Characteristics:
- Stocky build
- Wider body
- Stores fuel (both muscle and fat)
- Has more muscle as well but usually, this comes with more fat
- Has the best strength advantage out of the three different body types but may find it difficult to stay lean
- Slow metabolism

Anaerobic Digestion



psychrophilic

Psychrophilic bacteria are defined as cold-loving bacteria. Temperatures are 20 °C for maximal growth, 15 °C or lower for optimal growth, and 0 °C or lower for minimum growth.

mesophilic

Mesophilic bacteria – easy to control
- Temperature range: 32°C? ….36°C – 44°C

Typically operated around 38 - 40°C, optimal for most methanogenic activity.
Rich variety of groups, greater adaptability to changes in digester conditions
Good gas yields with acceptable retention time.

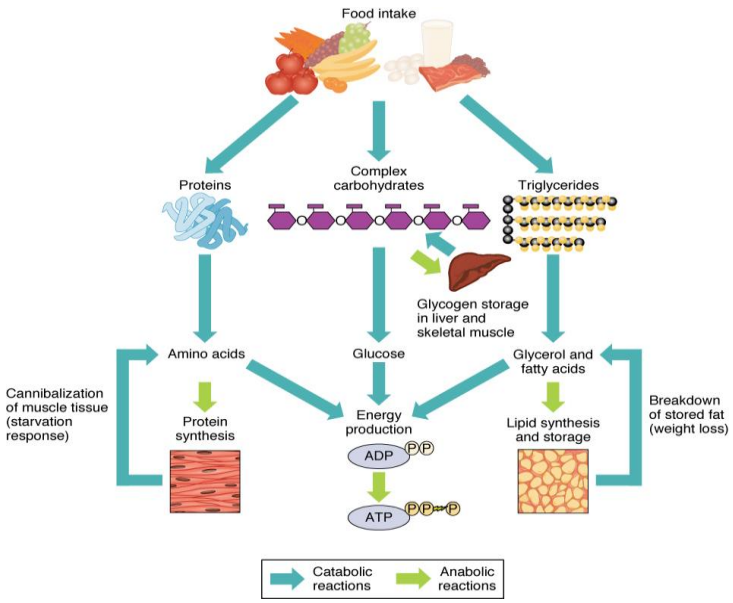
thermophilic

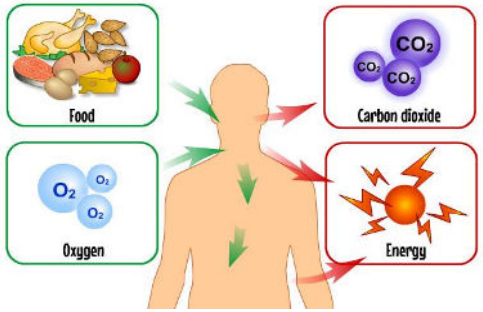
Thermophilic bacteria - difficult to control
- Temperature range: 45°C – 52°C … 58°C?

Typically operated around 48 - 50°C
Less variety of groups, biology is more sensitive to changes in digester conditions and toxic compounds
High, rapid gas yield after short retention time

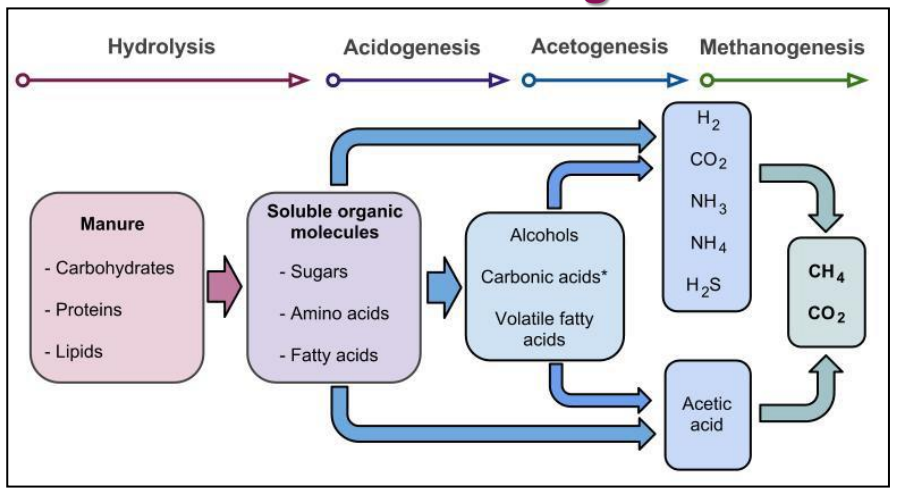
DIGESTION SEQUENCE

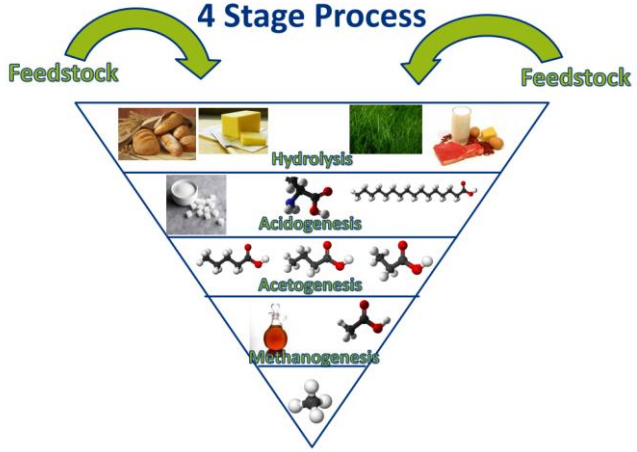
Human Body





Anaerobic Digestion





OUTPUTS

Human Body

- Mechanical movements
- Radiant heat
- Sweat

As part of the process

- Energy
- Carbon dioxide
- Faeces
- Urine

Anaerobic Digestion

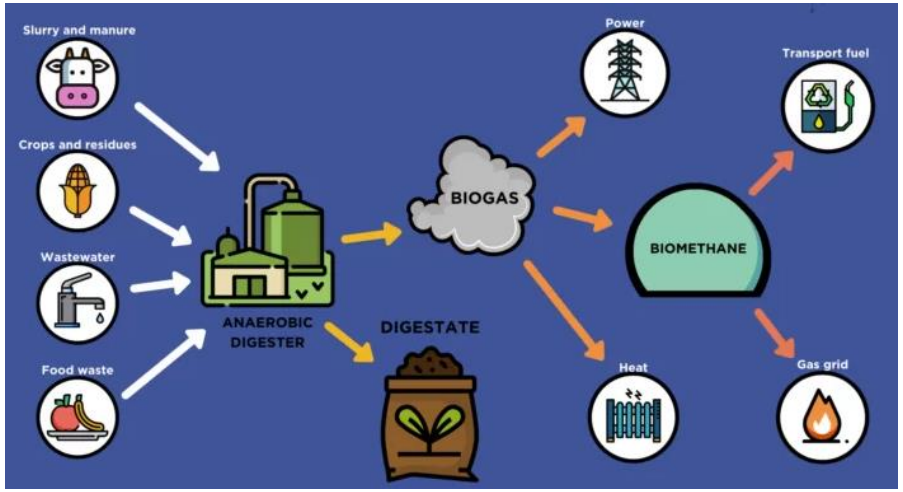
- Natural breakdown
- Radiant heat
- Sweat

As part of the process

- CH4 (methane)
- H2S
- Carbon dioxide

BIOGAS

- Digestate rich in Nitrogen
- Digestate rich in Nitrogen (may contain Sulphur)



TYPES OF FOOD / FEEDSTOCK

Human Body

Most common method of measuring the energy consumption is calories

1 person on average eat 2500 calories

Feedstock	DM%	ODM %	Calories per 100g	Energy for (active)
Cereal	33	30	365	3.5 hours
Bread	65	60	265	3 hours
Avocado	28	27	200	2 hours
Mixed food	17	15	200	2 hours

Anaerobic Digestion

Most common method of measuring the energy potential is the Organic Dry matter % (always less then the Dry matter)

1 Mwh production will require 400 kg of OM

Feedstock	DM%	ODM %	Biogas Yield (m3 /t)	Biomethane Yields +/- CH4
Bioenergy crops	33	30	350	180
Bread	65	60	480	300
Avocado	28	27	440	250
Mixed Food waste	17	15	150	80

ENERGY POTENTIAL

Human Body

Most common method of measuring the energy consumption is calories

1 calorie = 4.1 kilo Joules or 4100 Joules

1 individual on a push bike for 1 hour cycling
600 calories = 2460 Kilo Joules = 683 Watts
150 cyclists on tour the France cycling for 3 hours will produce 306Kw or **3.06e-7** in numbers is written as 0.000000306 TWh

1 McDonalds meal = 1500 calories = 6.150 kilo Joules
This include 1 burger (250g) 1 chips (100g) and Drink (500ml) = Weight 850g.

Anaerobic Digestion

Most common method of measuring the energy consumption is Watts

1 watthour = 3.6 kilo Joules or 3600 Joules

1 tonne of ODM will provide 2.2Mwh

Informative:
To make 1 TWh we will need 1.464,128,843 cycling for 3 hours
1.5 Billion

How many McDonalds meals will we need to power up a 500kw (500000 watts) CHP for 1 hour ?

- 126 (0.10 tonnes food waste)
- 292 (0.25 tonnes food waste)
- 365 (0.31 tonnes food waste)
- 1198 (1 tonnes of food waste)

1 TWh = 1000 GWh = 1000,000 MWh = 1000,000,000 KWh = 1000,000,000,000 Wh

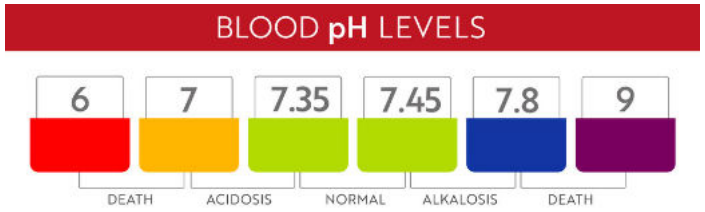
WHAT ELSE AFFECTS IT

Human Body		Anaerobic Digestion
how fast the body will process the calories present in the food, every individual will have a different metabolic rate.	**Metabolism**	how fast the bacteria will process the organic material present on the feedstock, every AD will have a different process capability
time that will take for food to be processed/digested.	**Retention time**	time that will take for feedstock to be processed or digested when inside the tank
potential on the food, protein, carbs, and other vitamins.	**Nutrition on food**	potential on the feedstock, protein, carbs, and other vitamins. Bioenergy crop ad likely to require trace elements
the load of organic material that the body will be able to process.	**Organic Load Rate**	the load of organic material that the AD is able to process – called design mass balance
affects performance when in excess, lower levels could assist blood flow and sense of energy will be present.	**Alcohol**	increases momentarily gas production (spike) and then stop production, lower levels could assist biological process.
energy rush, energy available for a short period of time.	**Sugar**	rapid effect on AD, gas production will raise rapidly but will not be sustained for long periods
caffeine rush, energy provided without calories.	**Coffee**	caffeine rush, biogas production of high quality, short duration and affects biology in the long run
empower momentarily with addiction results and affect performance, killing body from the inside.	**Drugs**	empower momentarily with addiction results and affect performance, killing biology from the inside.

MONITORING / TESTING

Human Body

Body temperature
Urine colour/smell
Changes in shape (getting fat or skinny)
Feeling poorly
Sugar levels testing
Blood test
PH levels
Test for infections
Others



Anaerobic Digestion

Temperature
Odour/ Colour
Changes in the thickness or biogas quality
Loss of production
FOS/TAC testing
PH levels
Nutrient testing
Others

$$\text{FOS/TAC} = \frac{\text{Flüchtige Organische Säuren}}{\text{Tota l Anorganic Carbon}}$$

- German origin, in English means VOA/TIC
- Meaning Volatile Organic Acids divided by Total Inorganic Carbon
- This parameters inform us about the degradability of substrates during the AD process.

CHALLENGES

Human Body

- Poison foods
- Allergies
- Presence of toxins
- Inhibitors such as salts
- Irregular feeding
- Mechanical functions on body not operating as they should
- Obesity
- Stress
- Illness
- Changes of temperature

Anaerobic Digestion

- Contaminants on the waste
- Presence of toxins or chemicals
- Inhibitors, salt
- Overfeed and underfeed
- Different populations of bugs not in the correct populations range
- Overfeed of organic material
- Overload bacteria through temperature changes,
- Change of temperature, poison food.
- Out of operational ranges from temperature recommended

We are not so different after all, are we?

THANK YOU!