Lesson

Matter and Energy

- Ecosphere How To Guide

Every cell needs matter and energy to live and grow.

- What do you **know** about how cells get the matter and energy that they need to grow and move?

- What do you **wonder** about how cells get the matter and energy they need to grow and move?

Laws of Matter and Energy

- What rule about **matter** should we follow when investigating biochemical reactions?

Law of Conservation of Matter/Mass

Matter can NOT be created or destroyed.

Matter CAN be transferred or change forms!

- **Must start and end with the same amount**
- **<u>Example</u>**




Log	+	Fire	→	Ashes	+	Smoke
30 kg		1 kg		28 kg		3 kg

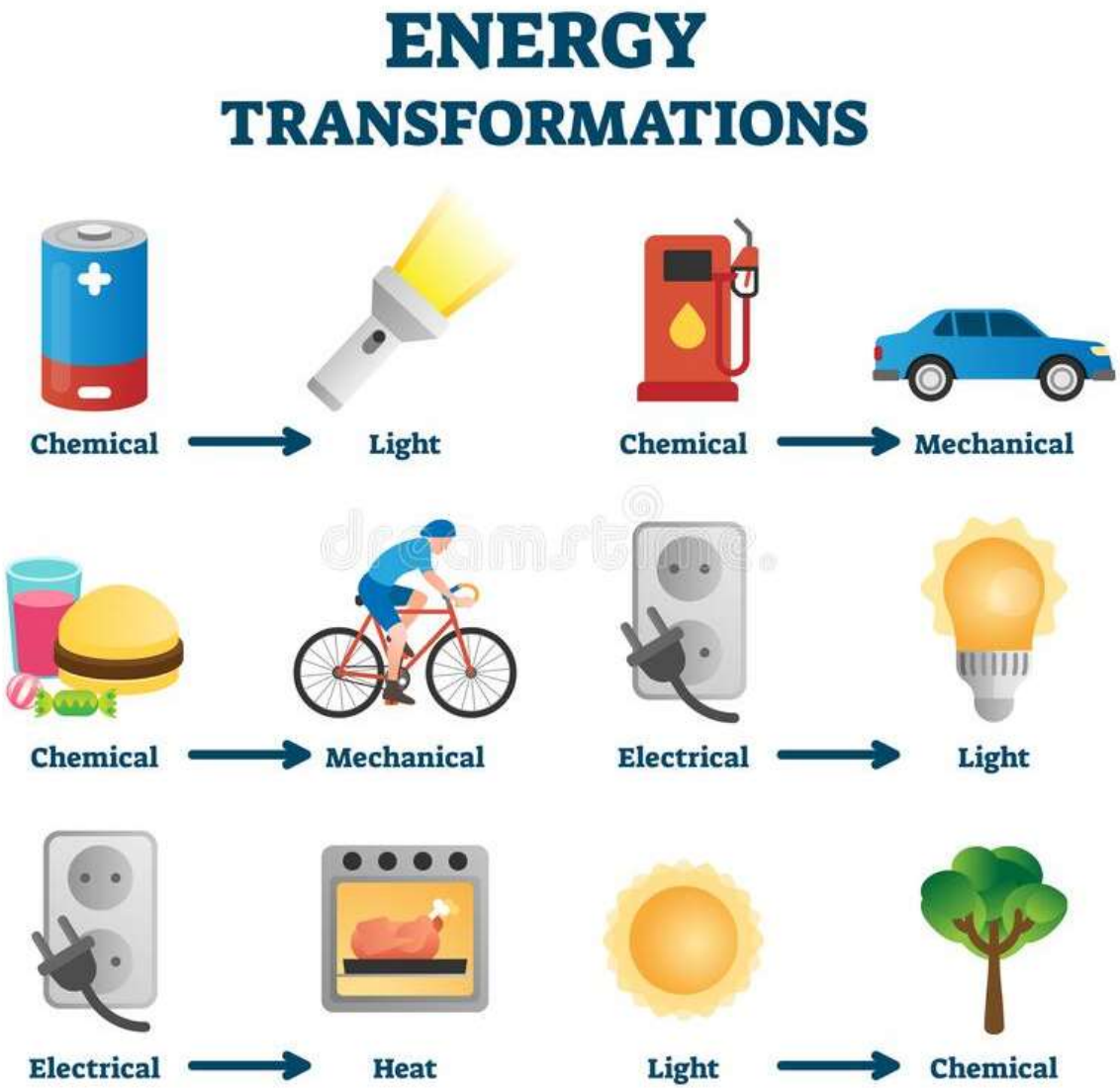
Laws of Matter and Energy

- What rule about **energy** should we follow when investigating biochemical reactions?

Law of Conservation of Energy

Energy can NOT be created or destroyed.

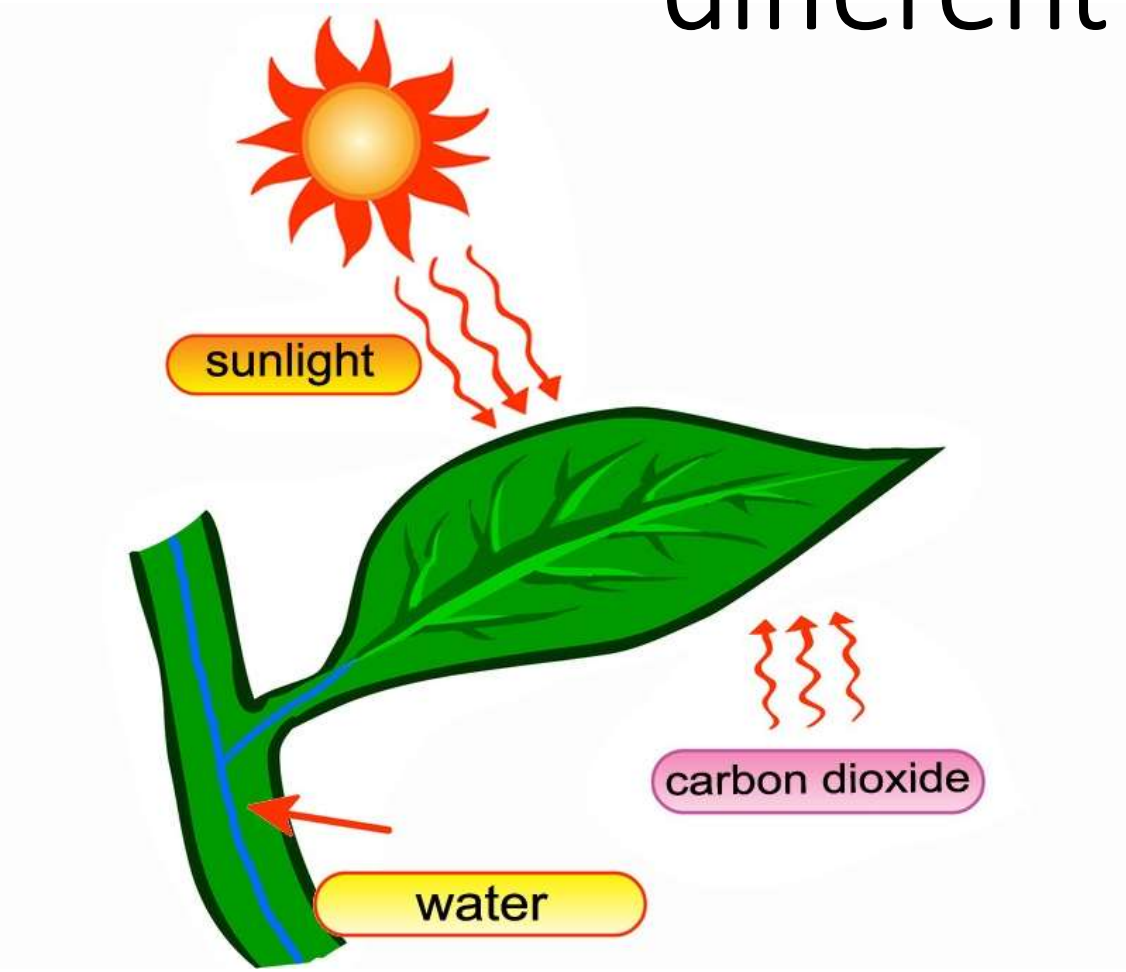
Energy CAN be transferred or change forms!



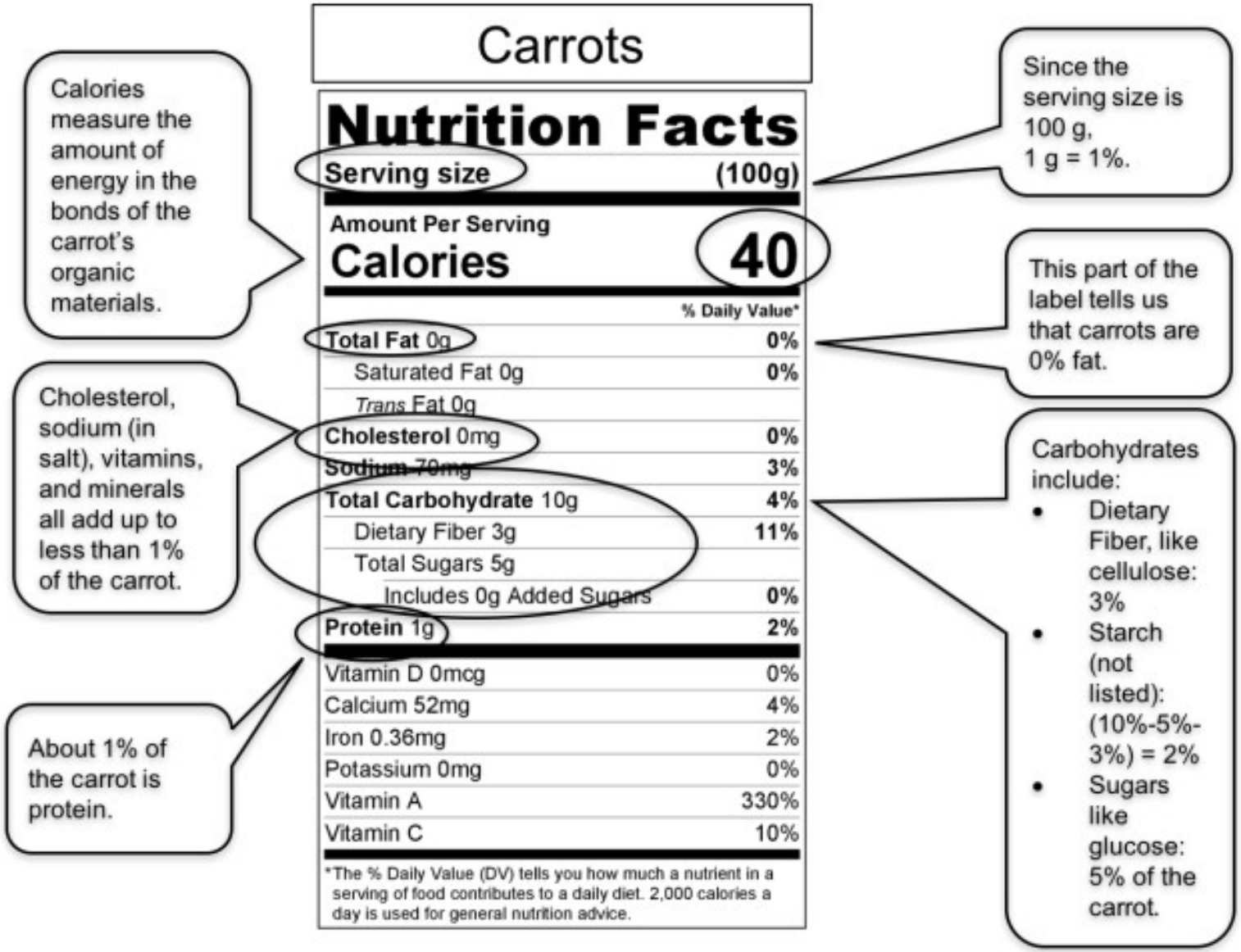
Energy exists in many <u>forms</u>. Some examples….

- <u>Light</u>
- <u>Chemical</u>
- <u>Mechanical</u> (motion)
- <u>Thermal</u> (heat)
- <u>Electrical</u>

How do living things obtain energy in different ways?



Reading Nutrition Labels



2.2 Food Label Cards

Beef (Animal Muscle)

Nutrition Facts

Serving size	**(100g)**
Amount Per Serving	
Calories	**250**
	% Daily Value*
Total Fat 21g	**27%**
Saturated Fat 7g	**35%**
Trans Fat 0g	
Cholesterol 70mg	**23%**
Sodium 70mg	**3%**
Total Carbohydrate 0g	**0%**
Dietary Fiber 0g	**0%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 18g	**36%**
Vitamin D 0mcg	0%
Calcium 52mg	4%
Iron 1.8mg	10%
Potassium 0mg	0%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Carrots (Plant Roots)

Nutrition Facts

Serving size	**(100g)**
Amount Per Serving	
Calories	**40**
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 70mg	**3%**
Total Carbohydrate 10g	**4%**
Dietary Fiber 3g	**11%**
Total Sugars 5g	
Includes 0g Added Sugars	**0%**
Protein 1g	**2%**
Vitamin D 0mcg	0%
Calcium 52mg	4%
Iron 0.36mg	2%
Potassium 0mg	0%
Vitamin A	330%
Vitamin C	10%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Celery (Plant Leaf/Stems)

Nutrition Facts

Serving size	**(100g)**
Amount Per Serving	
Calories	**15**
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 80mg	**3%**
Total Carbohydrate 3g	**1%**
Dietary Fiber 1g	**4%**
Total Sugars 2g	
Includes 0g Added Sugars	**0%**
Protein 1g	**2%**
Vitamin D 0mcg	0%
Calcium 52mg	4%
Iron 0.36mg	2%
Potassium 0mg	0%
Vitamin A	8%
Vitamin C	6%

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2.2 Food Label Cards (continued)

Mushrooms (Decomposers)

Nutrition Facts

Serving size	(100g)
Amount Per Serving	
Calories	**40**
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 11g	**4%**
Dietary Fiber 5g	**18%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 2g	**4%**
Vitamin D 0mcg	0%
Calcium 104mg	8%
Iron 3.6mg	20%
Potassium 0mg	0%
Vitamin A	70%
Vitamin C	25%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Spinach (Plant Leaves)

Nutrition Facts

Serving size	(100g)
Amount Per Serving	
Calories	**35**
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Total Carbohydrate 8g	**3%**
Dietary Fiber 3g	**11%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 3g	**6%**
Vitamin D 0mcg	0%
Calcium 0mg	0%
Iron 1.08mg	6%
Potassium 0mg	0%
Vitamin A	0%
Vitamin C	0%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Peanuts (Plant Seeds)

Nutrition Facts

Serving size	(100g)
Amount Per Serving	
Calories	**590**
	% Daily Value*
Total Fat 50g	**64%**
Saturated Fat 8g	**40%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 15mg	**1%**
Total Carbohydrate 22g	**8%**
Dietary Fiber 8g	**29%**
Total Sugars 9g	
Includes 0g Added Sugars	**0%**
Protein 24g	**48%**
Vitamin D 0mcg	0%
Calcium 52mg	4%
Iron 1.8mg	10%
Potassium 0mg	0%
Vitamin A	0%
Vitamin C	0%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

All living things need energy that they obtain from chemical energy stored in the bonds of food molecules.

2.2: Food Labels Worksheet

Food labels can tell us a lot about the molecules in the cells of the organisms that they come from—especially large organic molecules. You can analyze different kinds of organisms by studying the handout 2.2 Food Label Cards. This handout shows how many grams of different materials are in 100 g of each food. Follow these steps to fill out the table below:

1. Fill in the kind of organism that the food comes from (animal, plant, or decomposer).
2. Find the mass in grams of main organic materials in the food: carbohydrates, fats, and proteins.
3. Remember that the total mass of vitamins and minerals is less than 1 gram.
4. Calculate the amount of water by subtracting the mass of the organic materials from the total mass (100 g).
5. Find the amount of chemical energy (calories) in that food.

	FOOD NAME	Kind of organism it comes from	Organic materials			Water (grams)	Chemical energy (calories)
			Fat (grams)	Carbohydrates (grams)	Protein (grams)		
1	beef						
2	carrots						
3	celery						
4	mushrooms						
5	spinach						
6	peanuts						

Compare the organic materials in beef (cow muscle) with the organic materials in carrots (plant roots), celery (plant leaf stems), and spinach (plant leaves). What are the differences in the kinds and amounts of organic materials in animals vs. plants?

_____

_____

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5. Find the amount of chemical energy (calories) in that food.

	FOOD NAME	Kind of organism it comes from	Organic materials			Water (grams)	Chemical energy (calories)
			Fat (grams)	Carbohydrates (grams)	Protein (grams)		
1	beef	animal	21g	0g	18g	61g	250
2	carrots	plant	0	10	1	89	40
3	celery	plant	0	3	1	96	15
4	mushrooms	decomposer	0	11	2	87	40
5	spinach	plant	0	8	3	89	35
6	peanuts	plant	50	22	24	4	590

Compare the organic materials in beef (cow muscle) with the organic materials in carrots (plant roots), celery (plant leaf stems), a spinach (plant leaves). What are the differences in the kinds and amounts of organic materials in animals vs. plants?

Animal foods (ex. Beef) contain more fat and protein than most plant foods. Plants contain more carbohydrates and water.

5.1: Tracing Atoms and Energy in Plants

Some things you may already know. One thing you already know is that *atoms last forever* in living systems. So all the atoms in a plant must have come from somewhere. Land plants need *water, air, sunlight,* and *soil nutrients* to live and grow. So those are the sources that the atoms and the energy in plants must come from.

You may not know what kinds of atoms plants are made of. Chemists can take a garden plant like a radish and analyze what kinds of atoms (what elements) it is made of. A lot of a growing plant is water, but if they take the water away and analyze the dry materials in a plant, the first column of the table below shows what they find. Where does each kind of atom in a plant come from?

Kinds of atoms in plants	*Where atoms come from*			*Your reasons for your ideas*
Carbon atoms make up about 45% of the dry mass of the plant.	Plants get some carbon atoms from **water.**	True	False	From CO_2 in air
	Plants get some carbon atoms from **air.**	True	False	
	Plants get some carbon atoms from **sunlight.**	True	False	
	Plants get some carbon atoms from **soil.**	True	False	
Oxygen atoms make up about 45% of the dry mass of the plant	Plants get some oxygen atoms from **water.**	True	False	H_2O, O_2, CO_2,
	Plants get some oxygen atoms from **air.**	True	False	
	Plants get some oxygen atoms from **sunlight.**	True	False	
	Plants get some oxygen atoms from **soil.**	True	False	
Hydrogen atoms make up about 6% of the dry mass of the plant	Plants get some hydrogen atoms from **water.**	True	False	H_2O
	Plants get some hydrogen atoms from **air.**	True	False	
	Plants get some hydrogen atoms from **sunlight.**	True	False	
	Plants get some hydrogen atoms from **soil.**	True	False	
All other elements (mostly nitrogen, potassium, calcium, magnesium, and phosphorous) make up about 4% of the dry mass of the plant	Plants get some other atoms from **water.**	True	False	soil contains minerals → nitrogen
	Plants get some other atoms from **air.**	True	False	
	Plants get some other atoms from **sunlight.**	True	False	
	Plants get some other atoms from **soil.**	True	False	

You already know is that *energy lasts forever* in living systems. When dry plants burn, they release chemical energy. So that energy must have come from somewhere. Use the table below to show where the chemical energy comes from.

Kinds of energy in plants	*Where energy comes from*			*Your reasons for your ideas*
Where does the *chemical energy* in a plant come from?	Plants get some energy from **water.**	True	False	chlorophyll absorbs light
	Plants get some energy from **air.**	True	False	
	Plants get some energy from **sunlight.**	True	False	
	Plants get some energy from **soil.**	True	False	

5.1: Tracing Atoms and Energy in Animals

Some things you may already know. One thing you already know is that *atoms last forever* in living systems. So all the atoms in an animal must have come from somewhere. Animals need *water*, *air*, and *food* to live and grow. So those are the sources that the atoms and the energy in animals must come from.

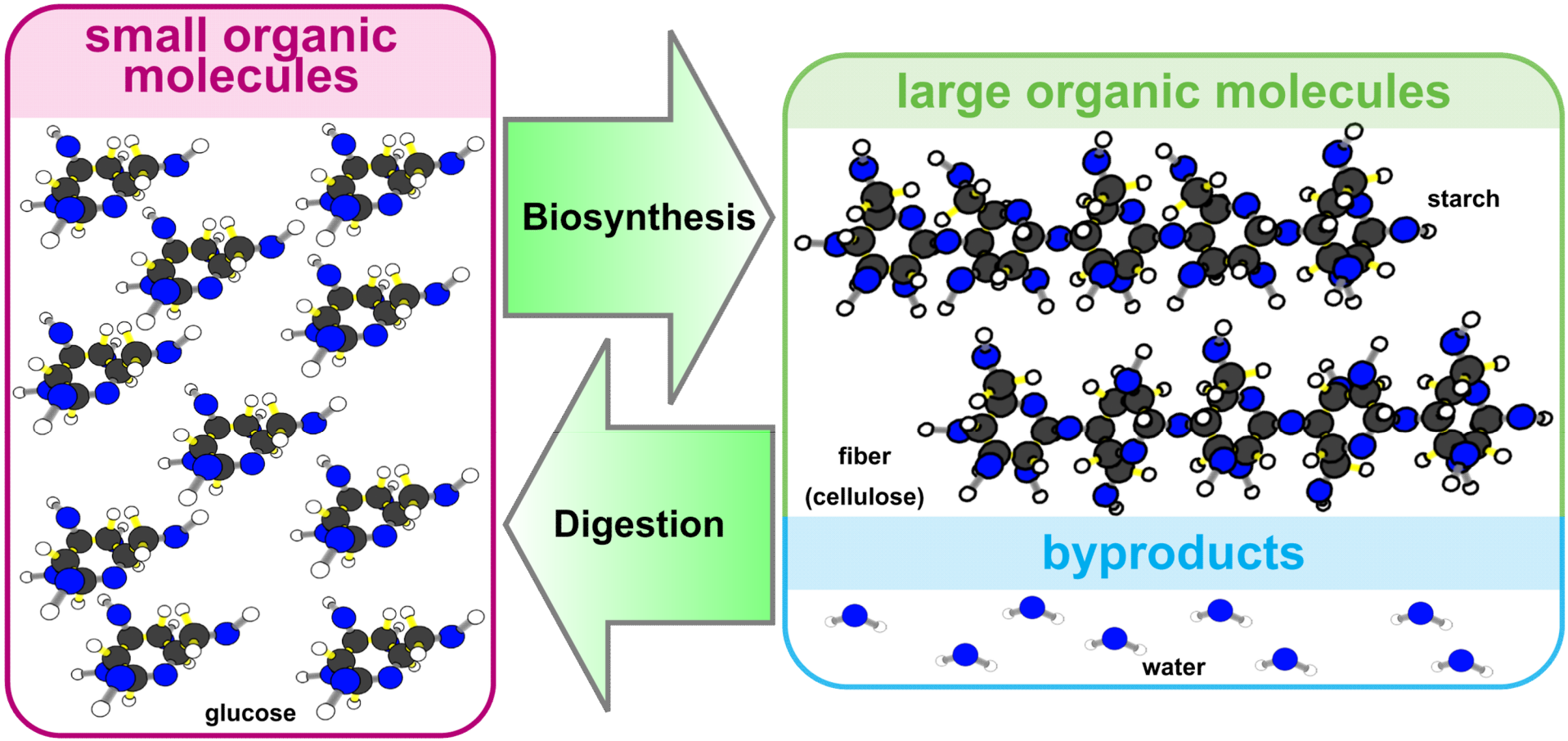
You may not know what kinds of atoms animals are made of. Chemists can take an animal and analyze what kinds of atoms (what elements) it is made of. The first column of the table below shows what they find. Where does each kind of atom in an animal come from?

Kinds of atoms in animals	***Where atoms come from***			***Your reasons for your ideas***
Carbon atoms make up about 19% of the mass of animals.	Animals' bodies get some carbon atoms from **water.**	True	False	$C_6H_{12}O_6$ (glucose)
	Animals' bodies get some carbon atoms from **air.**	True	False	
	Animals' bodies get some carbon atoms from **food.**	True	False	
Oxygen atoms make up about 65% of the mass of animals.	Animals' bodies get some oxygen atoms from **water.**	True	False	**H_2O / O_2 / $C_6H_{12}O_6$**
	Animals' bodies get some oxygen atoms from **air.**	True	False	
	Animals' bodies get some oxygen atoms from **food.**	True	False	
Hydrogen atoms make up about 10% of the mass of animals.	Animals' bodies get some hydrogen atoms from **water.**	True	False	H_2O / $C_6H_{12}O_6$
	Animals' bodies get some hydrogen atoms from **air.**	True	False	
	Animals' bodies get some hydrogen atoms from **food.**	True	False	
All other elements (mostly nitrogen, potassium, calcium, magnesium, and phosphorous) make up about 6% of the mass of animals.	Animals' bodies get some other atoms from **water.**	True	False	Proteins: nitrogen
	Animals' bodies get some other atoms from **air.**	True	False	
	Animals' bodies get some other atoms from **food.**	True	False	veggies: minerals

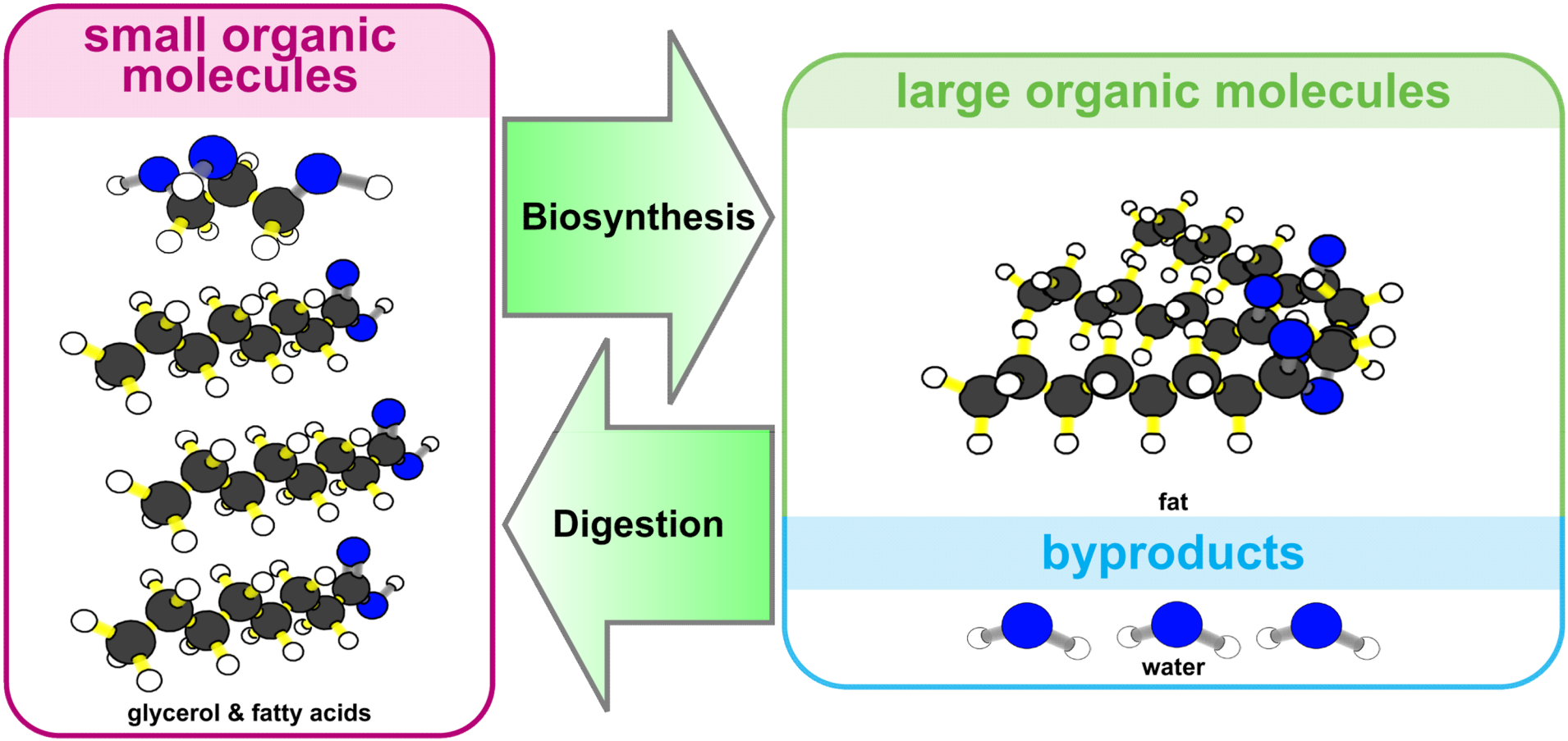
You already know is that *energy lasts forever* in living systems. The energy in animals must come from somewhere. Use the table below to show where the chemical energy comes from.

Kinds of energy in animals	***Where energy comes from***			***Your reasons for your ideas***
Where does the *chemical energy* in an animal come from?	Animals' bodies get some energy from **water.**	True	False	Food molecules:
	Animals' bodies get some energy from **air.**	True	False	
	Animals' bodies get some energy from **food.**	True	False	energy rich bonds

Digestion and Biosynthesis of Carbohydrates



Digestion and Biosynthesis of Fat



Digestion and Biosynthesis of Protein