
## Gotta Love Those Frosted Flakes[i]

No doubt there is better food to have for breakfast, but let's face it—sometimes a sugar craving hits and there's just no satisfying it without a great big bowl of Kellogg's Frosted Flakes® covered in ice cold milk. There's nothing quite like it, really. Of course, we might as well call them something like "Sugar Coated Endocrine System Complex-Carbohydrate Belly Bombs." Although foods are broken down in the digestive system in the same fashion whether a small salad and a one-ounce serving of farm fresh grilled organic chicken (hold the growth hormone) or a bowl of Sugar Frosted Flakes®, the bowl of flakes does introduce a great amount of complex carbohydrates all at once. Recall from unit two that foods are broken down during the digestive process from carbohydrates, proteins, and fats into simpler substances for use in the body—monosaccharides (simple sugars), amino acids, and fatty acids/glycerol, respectively. The bowl of flakes and will introduce a boat-load of carbohydrates into the system, which will be broken down into monosaccharides.[1] Without the Endocrine System and its feedback mechanisms, we would go positively loopy with this much simple sugar in our bloodstream all at once—blood sugar typically increases after eating (and will certainly do so with this cereal), and it must be regulated.

The flow chart in figure 1 depicts the general workings and the affects of feedback related to a blood glucose level that has risen above the normal range (somewhere in the neighborhood of 45-95mg/100ml).

[1] There is a small amount of protein and fats from the corn (and more from the milk), but here we will address the sugar-frosted part of the cereal, lactose in the milk, and the abundance of complex carbohydrates in the corn itself. See endnotes for USDA nutritional breakdown of this "Not-So-Good-For-You-But-Irresistible Snack."

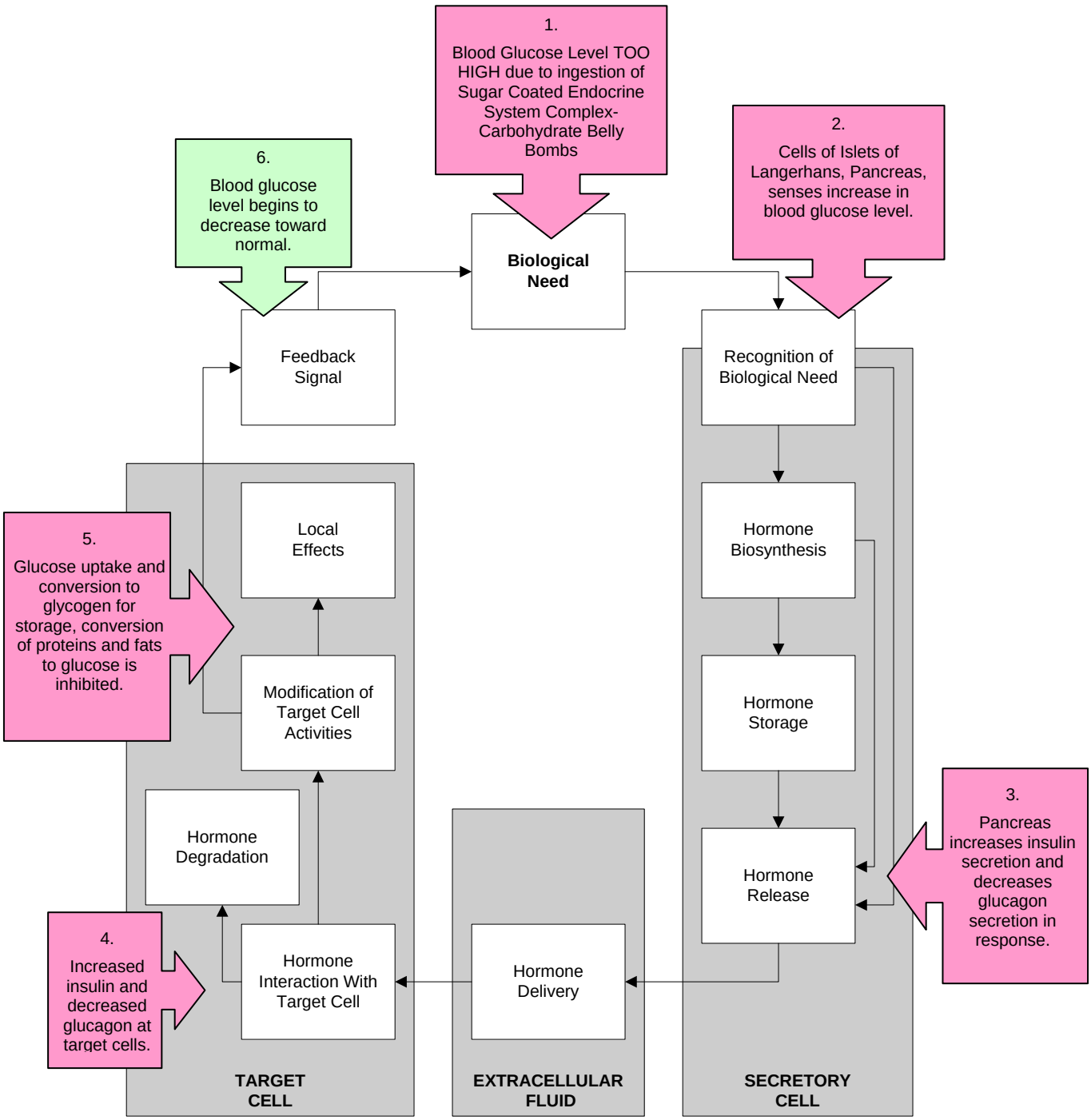


**Figure 1: Blood Glucose Level Feedback Mechanism[2]**

Figure 2 is a basic illustration of the blood-glucose negative feedback mechanism.

[2] Although the Pancreas is generally considered part of the digestive system, the Isle of Langerhans secretes two very important hormones that control blood glucose levels: Insulin (stimulating glucose uptake) and Glucagon (stimulating Glucose release). This diagram modified from Unit Three, Feedback Mechanisms.

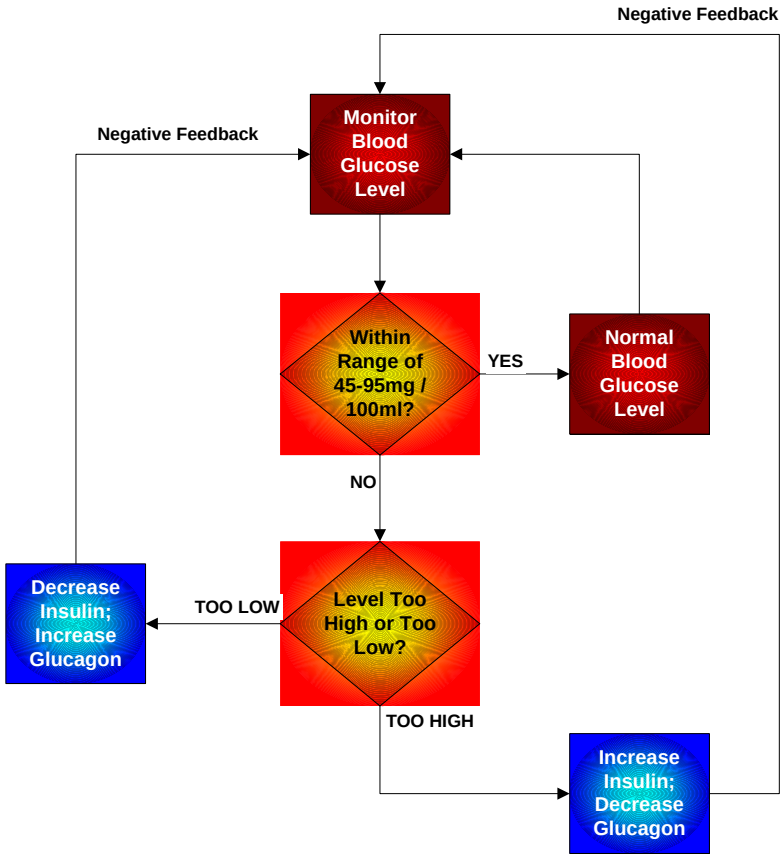


**Figure 2: Blood Glucose Level Regulation**

Continually monitored and controlled by cells of the Islets of Langerhans within the pancreas, blood glucose levels are managed through a negative feedback system. Insulin acts to control the levels of absorbed nutrients in the blood when they rise too high, and the following changes occur (insulin's specific target tissues are the liver, muscles (heart, skeletal, and smooth), and fat (adipose tissue)):

- Uptake and use of glucose is stimulated. When insulin binds with receptors in the target cell membrane, this triggers additional glucose transporters to fuse in the membrane, increasing the cell's ability to take up glucose.

- Glycogenesis increases (conversion of glucose to glycogen for storage in the liver and skeletal muscles). Unless we break into vigorous exercise after the bowl of cereal, the extra glucose is converted to glycogen.
- Glycogenolysis decreases or is inhibited (conversion of glycogen to glucose)
- Breakdown of protein and fat prevented, thus inhibiting gluconeogenesis (formation of new sugars).
- Glucose entrance into fat cells is also promoted by insulin; it is metabolized to form glycerol which is used to form triglycerides (storage as body fat). Too many flakes and not enough running for the train (or other cardio-type activities), and it is likely that obesity will result.

Somatostatin, a third hormone acting locally within the pancreas, provides control over insulin and glucagon secretions (runaway insulin levels causing low blood sugar can result in hypoglycemia, and if not corrected can lead to impaired brain function if serious enough, death). It is believed that insulin release occurs in two separate phases: an initial spurt or spike lasting a few minutes (which may then be controlled and regulated by somatostatin), and a slower response that may last for a couple of hours until blood sugar levels return to normal (carbohydrates take approximately 2 hours for digestion).

In addition to pancreatic monitoring and control of blood sugar, the hypothalamus plays a role in the regulation of blood sugar. Glucostat neurons in the hypothalamus sense high glucose levels and their signals inhibit our appetite (so we should be able to feel satisfied with a small bowl of cereal). As the cereal hits our stomach and digestion begins, the hormone CCK is released and also acts on the hypothalamus to trigger satiety. Leptin, a fat tissue hormone, provides longer-term feedback that similarly suppresses hunger.

## Bibliography

Kapit, Macey, Meisami. The Physiology Coloring Book. San Francisco: Benjamin/Cummings Science Publishing, 2000.

Lippincott Williams & Wilkins. Anatomy and Physiology. Second Edition. New York: Lippincott Williams & Wilkins, 2002.

Waugh, Anne. Ross and Wilson: Anatomy and Physiology in Health and Illness. Spain: Elsevier Health, 2004.

[i] Cereals ready-to-eat, KELLOGG, KELLOGG'S FROSTED FLAKES

| Nutrient | Units | Value per 100 grams | Number of Data Points | Std. Error |
|---|---|---|---|---|
| **Proximates** | | | | |
| Water | g | 3.00 | 0 | 0 |
| Energy | kcal | 367 | 0 | 0 |
| Energy | kj | 1536 | 0 | 0 |
| Protein | g | 3.30 | 0 | 0 |
| Total lipid (fat) | g | 0.52 | 0 | 0 |
| Ash | g | 2.88 | 0 | 0 |
| Carbohydrate, by difference | g | 90.30 | 0 | 0 |
| Fiber, total dietary | g | 3.2 | 0 | 0 |
| Sugars, total | g | 38.00 | 0 | 0 |
| **Minerals** | | | | |
| Calcium, Ca | mg | 5 | 0 | 0 |
| Iron, Fe | mg | 14.50 | 0 | 0 |
| Magnesium, Mg | mg | 8 | 0 | 0 |
| Phosphorus, P | mg | 34 | 0 | 0 |
| Potassium, K | mg | 73 | 0 | 0 |
| Sodium, Na | mg | 479 | 0 | 0 |
| Zinc, Zn | mg | 0.18 | 0 | 0 |
| Copper, Cu | mg | 0.040 | 0 | 0 |
| Manganese, Mn | mg | 0.245 | 0 | 0 |
| Selenium, Se | mcg | 4.4 | 9 | 1.29 |
| **Vitamins** | | | | |
| Vitamin C, total ascorbic acid | mg | 20.0 | 0 | 0 |
| Thiamin | mg | 1.200 | 0 | 0 |
| Riboflavin | mg | 1.500 | 0 | 0 |
| Niacin | mg | 16.200 | 0 | 0 |
| Pantothenic acid | mg | 0.341 | 0 | 0 |
| Vitamin B-6 | mg | 1.600 | 0 | 0 |
| Folate, total | mcg | 327 | 0 | 0 |
| Folic acid | mcg | 308 | 0 | 0 |
| Folate, food | mcg | 19 | 0 | 0 |
| Folate, DFE | mcg_DFE | 543 | 0 | 0 |
| Vitamin B-12 | mcg | 5.00 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Vitamin B-12, added | mcg | 5.00 | 0 | 0 |
| Vitamin A, IU | IU | 1720 | 0 | 0 |
| Vitamin A, RAE | mcg_RAE | 517 | 0 | 0 |
| Retinol | mcg | 517 | 0 | 0 |
| Vitamin E (alpha-tocopherol) | mg | 0.09 | 0 | 0 |
| Vitamin E, added | mg | 0.00 | 0 | 0 |
| Vitamin D | IU | 129 | 0 | 0 |
| Vitamin K (phylloquinone) | mcg | 0.2 | 0 | 0 |
| **Lipids** | | | | |
| Fatty acids, total saturated | g | 0.170 | 0 | 0 |
| 4:0 | g | 0.000 | 0 | 0 |
| 6:0 | g | 0.000 | 0 | 0 |
| 8:0 | g | 0.000 | 0 | 0 |
| 10:0 | g | 0.000 | 0 | 0 |
| 12:0 | g | 0.001 | 0 | 0 |
| 14:0 | g | 0.001 | 0 | 0 |
| 16:0 | g | 0.139 | 0 | 0 |
| 18:0 | g | 0.025 | 0 | 0 |
| Fatty acids, total monounsaturated | g | 0.090 | 0 | 0 |
| 16:1 undifferentiated | g | 0.001 | 0 | 0 |
| 18:1 undifferentiated | g | 0.090 | 0 | 0 |
| 20:1 | g | 0.000 | 0 | 0 |
| 22:1 undifferentiated | g | 0.000 | 0 | 0 |
| Fatty acids, total polyunsaturated | g | 0.300 | 0 | 0 |
| 18:2 undifferentiated | g | 0.291 | 0 | 0 |
| 18:3 undifferentiated | g | 0.009 | 0 | 0 |
| 18:4 | g | 0.000 | 0 | 0 |
| 20:4 undifferentiated | g | 0.000 | 0 | 0 |
| 20:5 n-3 | g | 0.000 | 0 | 0 |
| 22:5 n-3 | g | 0.000 | 0 | 0 |
| 22:6 n-3 | g | 0.000 | 0 | 0 |
| Fatty acids, total trans | g | 0.000 | 0 | 0 |
| Cholesterol | mg | 0 | 0 | 0 |
| **Other** | | | | |
| Alcohol, ethyl | g | 0.0 | 0 | 0 |
| Caffeine | mg | 0 | 0 | 0 |
| Theobromine | mg | 0 | 0 | 0 |
| Carotene, beta | mcg | 0 | 0 | 0 |
| Carotene, alpha | mcg | 0 | 0 | 0 |
| Cryptoxanthin, beta | mcg | 0 | 0 | 0 |
| Lycopene | mcg | 0 | 0 | 0 |
| Lutein + zeaxanthin | mcg | 0 | 0 | 0 |

## USDA National Nutrient Database for Standard Reference, Release 18 (2005)

**NDB No:** 08069 (Nutrient values and weights are for edible portion)

http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl