asgn4o -- "Biological" Motivations: Early Models of Hunger

**Biological drives or motives** are the motivating processes that directly affect an individual's ability to survive. They are associated with homeostatic processes ranging from maintaining CO₂ (carbon dioxide) and O₂ (Oxygen) levels, which must be adjusted in seconds, to hunger, which can remain unsatisfied for weeks. Sexual motivation is often included as a biological drive. It is absolutely necessary for reproduction, but not survival, because it can be postponed indefinitely.

"Biological" motives are often contrasted with "psychological" and "social" motives, which are not necessary for survival. Some early models proposed that "psychological" and "social" motives are derived from "biological" motives by association with them. They are much better thought of as parallel, interacting motivating processes. Each kind affects the others, but they do not depend on each other. There are at least two reasons to adopt this idea.

**Q1.** Compared to biological motives, social and psychological motives are
A. secondary  
B. derived from biological motives by association with them  
C. independent but parallel motives, which can modify the action of other kinds of motivating processes  
D. also adaptive for survival  
E. A & B are both correct  
F. C & D are both correct

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**Hunger**

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<th>Three reasons motivate research interest on hunger:</th>
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<td>1. Hunger can be controlled, varied, and operationally measured quite easily. Because of these features, hunger was something of a model system for motivation in general.</td>
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<td>2. At first, hunger seemed simple: the problem was to find THE signal that makes people and animals start eating and THE signal that makes them stop.</td>
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<td>3. Eating problems, such as obesity, anorexia (not eating enough), and bulimia (bouts of overeating followed by purging by vomiting or laxatives) are important medical/psychological problems in developed countries.</td>
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**Amount of food in the stomach.** The first model for signaling hunger and satiety (~fullness) was the amount of food in the stomach. This "stomach rumble" model states that an empty stomach triggers eating; a full stomach stops eating. In some species this appears to be an adequate description. The blowfly extends its mouthparts when it detects sweet and sucks in food until neurons sensing gut distension (fullness) signal the brain to stop (Dethier, 1967). But in mammals in general and omnivores (animals that eat both meat and plants) humans in particular, hunger has turned out to be a far more complex process than the early researchers could have imagined.

In simple animals, this is accurate. As described above, blowflies drink sweetened water until the gut is full. When the gut empties, drinking sweetened water starts again.

To test this model in humans, Cannon and Washburn (1912) used a swallowed balloon to measure an observer's stomach contractions and compared them with his reports of hunger pains. They reported that two responses, stomach contractions and hunger reports, correlated closely. However, surgically removing the stomach for medical reasons has little effect on the ability to maintain normal body weight (Wangensteen & Carlson, 1931). The same thing has been found experimentally in rats. The only thing that
changes is the pattern of eating: many small meals instead of a few larger ones. Furthermore, the stomach contractions Cannon measured were more likely induced by the balloon used to measure them than hunger pangs, and subjects failed to detect them reliably even when the did occur (Davis et al., 1959). The current view states that signals from the stomach primarily regulate the time between meals.

Several other lines of research support this idea.
1. The time between meals depends on the size of the preceding meal. The larger the meal, the longer time till the next meal (Le Magnen, 1985).
2. Preventing food from moving from a rat's stomach to its intestines does not affect the size of its meal.

Match the following with their probable effect on the interval between meals
1. make the time between meals longer
2. make the time between meals shorter
Q2A. surgically remove the stomach
Q2B. eating plain raw vegetables (as opposed to donuts) for a meal
Q2C. putting a small amount of sugar into the stomach every 20 minutes
Q2D. injecting insulin into the body (NOT the brain)

Brain Areas in Hunger.

Research on brain systems in hunger has focused on the hypothalamus. In the 1920’s W. R. Hess had shown that the hypothalamus plays an essential role in regulating body processes, including eating and drinking. (Hess won the Nobel prize in 1949 for his pioneering work. Link to his prize lecture) The current view states that the hypothalamus is the major site for detecting signals of nutritional state and organizing hunger-related behavior. It gets information about the body's need for food through neural connections and hormones from the gut, and it controls food-related responses, partly through the autonomic nervous system and the pituitary gland (see asgn2c). A long winding route led to this view.

Early research showed that damage in the hypothalamus severely disrupts normal eating and regulation of body weight. Damage to the lateral (~side) hypothalamus greatly depresses eating, (Teitelbaum & Epstein, 1962). After lesions in the lateral hypothalamus, rats usually ignore food completely. They will starve to death in the midst of food. They must be force-fed for up to several weeks before they start eating again. Eventually they recover enough to maintain their body weight with tasty, easily eaten food, but they keep their body weight well below normal. After regaining normal body weight by force-feeding, they eat less, until they return to the low weight at which they had stabilized after the brain lesion.

In contrast, damage to the ventromedial hypothalamus (ventro- = ~bottom or belly side; medial = [toward the] middle) greatly increases eating. A rat with such a lesion can overeat enough to more than double its normal body weight with fat. Figure 1-4o shows the location of this area, and figure 2-4o illustrates the change in body weight following damage to these areas.

The upper left-hand part of Figure 1-4p shows the location of the rat’s hypothalamus on the ventral (underneath, stomach side) surface of the front end of the brain stem. The lower right-hand side of Figure 1-4o shows the location of the lateral hypothalamus on a slice through the brain at about the level of the ears.

Figure 1-4p. location of lateral hypothalamus (LH) and ventromedial hypothalamus (VMH) in the rat brain.

![Figure 1-4p](image)

Figure 2-4p. Silhouettes of rats with damage in the lateral hypothalamus (LH) (center) and ventromedial hypothalamus (VMH) (right).

![Figure 2-4p](image)
Electrical stimulation of these areas in the hypothalamus often has an effect on eating that is opposite to that of lesions. Stimulating the lateral hypothalamus can trigger voracious eating in a rat that has just finished eating. Repeated stimulation in this area for weeks makes the rat overeat so much that it becomes very obese (Steinbaum & Miller, 1965). In contrast, stimulating the ventromedial hypothalamus can block eating in a hungry rat.

Match the following with their probable effect on the interval between meals

1. lateral hypothalamus (LH)  2. ventromedial hypothalamus (VMH)

Q3A. damage here depresses eating  Q3B. stimulation here depresses eating  Q3C. damage here depresses eating  Q3D. stimulation here depresses eating

These findings suggested a model of hunger in which the lateral hypothalamus is a hunger "center," and the ventromedial hypothalamus is a satiety (~fullness) "center." According to this model, illustrated in Figure 3-4o, the lateral hypothalamus detects food deficiency, react to food related stimuli with increased food-directed behavior. At the same time, it inhibits the satiety "center" in the ventromedial hypothalamus. The ventromedial hypothalamus does the opposite. It detects food surplus, inhibits food-directed behavior in response to food-related stimuli, and inhibits the lateral hypothalamus.

Q4. According to the hunger-satiety center model, ___.
A. the lateral hypothalamus (LH) is where you feel hunger, whereas the ventromedial hypothalamus (VMH) is where you feel being full.
B. LH detects low food level in the body and activates eating, whereas VMH detects high food level in the body and stops eating
C. When it is active, LH inhibits VMH, and when it is active, VMH inhibits LH
D. B & C are both correct  E. A, B, & C are all correct

This model has been discarded because the early studies gave an incomplete picture of the effects of hypothalamic functioning. In addition, the model as described also fails to indicate how we know when to start and stop eating. What are the signals we use?

More complete information shows that damage in these systems produces under- and overeating indirectly. **Damage to the lateral hypothalamus turns out to depress responsiveness to all kinds of external stimuli,** not just food related ones. These rats simply sit and do nothing, as if completely unmotivated. Oddly, if tasty food is put into the mouth, these rats chew and eat it actively. They appear to like the food, but they don't do anything to get it. They don't because the dopaminergic (dopamine-using) "wanting system" (Berridge & Robinson, 1995) passes through the lateral hypothalamus is damaged.

Damage to ventromedial hypothalamus produces over-eating and obesity by making gut reflexes work faster. This speeds up digestion and remove food faster (Keesey & Powley, 1975). Therefore, the next meal comes much sooner than normal, which produces overeating and obesity. Link to a summary of some evidence about the functions of the lateral and ventromedial areas of the hypothalamus.

Mark the food related processes with the part of the hypothalamus to which it is more closely related:

1. ventromedial hypothalamus  2. lateral hypothalamus

Q6A. damage here produces unresponsiveness to all kinds of stimuli  Q6B. damage here exaggerates reactions to food tastes  Q6C. controls how fast the gut digests food  Q6D. damage here exaggerates the effect of work needed to get food
A modern view of hunger also makes the hypothalamus crucial for starting and stopping eating and for long-term regulation of body weight. But the story is a lot more complex than the balance between a "start-eating center" and a "stop eating center." The hypothalamus contains a network of interconnected areas involved in hunger and satiety. This system gets several different signals about the body's nutritional state. It is also affected by signals from the rest of the brain, which are essential for the psychological and social influences on eating.

Neural and hormonal signals of the body's energy balance come from the gut and from fat storage cells in many parts of the body. Two kinds of signals from the gut reach the hypothalamus: hormones and neural signals. The main hormones are insulin, which controls the level of blood glucose ("blood sugar"), and leptin, which fat cells release when they are filled. The neural signals come from receptors in the gut that detect stomach content and hormones the gut releases in response to food level. One of these is CCK, a hormone the gut releases when it is filled with food. The neural signals get to the central nervous system mainly over the vagus nerve in the parasympathetic division of the autonomic nervous system. This large nerve connects the insides of the body to the brain stem.

Figure 4-40 summarizes the overall organization of the system that detects food level and turns eating on and off. Leptin, insulin, and blood glucose level regulate food intake in the short-term (hours). Leptin is also important in long-term regulation of body weight, because it reflects calories stored in fat cells.

Q1. The body uses ____ as signals to measure the amount of food in the body.
A. the lateral and ventromedial areas of the hypothalamus  B. leptin level  C. insulin level  D. neural signals triggered by food in gut and gut hormones  E. B, C, & D are all correct

Figure 5-40 summarizes the way insulin and leptin control of the body's use of energy and of eating. Low levels of insulin and of leptin both signal that the body is in negative energy balance (using more energy then it is getting). To counteract this condition, these signals depress unnecessary body activity to conserve energy and activate eating. High levels of insulin and of leptin both signal that the body is in positive energy balance (getting more energy than it is using). In this condition, these signals increase body activity to burn energy and inhibit eating. In summary, insulin and leptin levels generate negative feedback to counteract both low and high levels of food, to keep the body within homeostatic limits.

Q2. A low level of leptin produces ___. A high level of insulin produces ___.
A. decreased activity; increased activity  B. increased activity; increased activity
C. increased eating; decreased eating  D. increased eating; increased eating
E. A & C are both correct  F. B & D are both correct
The basic physiological core that regulates eating does not operate in isolation. Many psychological, social, and cultural processes modify eating. These processes include associative learning, food variety, food palatability (tastiness), visual appearance, social setting for eating, and cultural effects.

Learning

Signals that predict food in the gut also trigger insulin release by Pavlovian conditioning. This conditioned release of insulin and the fall in blood glucose it triggers is one reason why you start to feel hungry as the lunch hour approaches or when you see your favorite restaurant (Woods, 1991). Laboratory animals and animals in zoos are usually fed at about the same time every day. As that time approaches, these animals become increasingly active until food arrives. If food is delayed from its usual time, the animals become less active and usually eat less than normal when it does arrive.

This conditioned response has an important adaptive function. Removing extra sugar from the blood quickly prevents a large rise in blood glucose during and after a meal, which can have damaging effects in the body (Woods, 1991). If a lot of insulin is secreted quickly, the extra blood glucose from the food leaves the blood quickly, and eating starts again sooner.

Classical conditioning of hunger also shows up in other ways. People and rats can learn the association between a flavor and caloric density. In one study, people who got a flavored high-calorie milkshake to drink before eating lunch ate less lunch that did people who got a low-calorie milkshake. One day, the caloric densities of the milkshakes (but NOT the flavors) were switched between these two groups: The people who had had the high-calorie shakes during learning still ate less than did the people who had had the low-calorie shakes during learning (Shaffer & Tepper, 1994; Arbour & Wilkie, 1988).

Q3. We learn
A. how much blood sugar is needed in the blood stream  B. when to expect to eat and get hungry
C. to associate time of day (and other signals) with opportunity to eat  D. what smells good
E. what kinds of food are appropriate to eat  F. B, C, and E are all correct

Food Variety

Variety is the spice of eating as well as life. Although rats (and people) avoid new foods, they prefer variety in familiar foods. If given a single food to eat, they stop eating sooner than if the food changes within a meal (Le Magnen, 1985). This effect is called sensory-specific satiety.

In one demonstration of sensory-specific satiety, rats got the same diet with one of four different odors added until they ate about equal amounts of the four diets. Then they were tested daily with one 2-hour meal divided into four 30-minute periods. On some days the diet remained the same for all four periods; on others each period had a different diet. When the odor of the diet did not change, the rats ate very little after the first 30-minute period. When the diet changed, the rats ate about five times as much on each of the last three periods as they did if the diet did not change.

Humans also show sensory specific satiety. Overweight people can cut calorie intake and lose weight if they eat as much as they want of a single bland tasting nutritionally complete artificial diet and nothing else. From your own experience, you probably notice that you eat more when you can have many different foods at a meal or at a party than if you have only a few. This effect was demonstrated very clearly a few years ago in a camp where refugees had been living for many months eating the same monotonous, but nutritionally complete diet. They started trading for local food which was less nutritious than the food they had (B. Rolls et al., 1981).

Q4. Evidence for sensory-specific satiety comes from the fact that
A. sugar stops hunger faster than anything else  B. having several different foods in a meal results in more eating than does having only one
C. animals (including people) prefer some tastes to others  D. there are specific sensory cues from gut and blood that stop eating
E. A and B are both correct  F. C and D are both correct

The appearance of the food has a strong effect on eating. People prefer food that looks good, even if its taste and nutritional value is no better than food that doesn't look as good. The appearance of raw food affects how positively it is evaluated even after it has been cooked (Hurling & Shepherd, 2003).
Social and Cultural Factors

The more people with you when you eat, the more you are likely to eat (deCastro, 1991). Eating diaries show that people eat more when they are with other people. This may reflect social facilitation and inattention to how much one eats.

Social factors that affect eating: As noted above, religious and cultural convention strongly affects what foods people think is acceptable as food. This is especially true for meats and other animal-derived foods. Hebrew and Islamic law forbids eating pork, whereas Hindus avoid beef and some avoid animal products of any kind. Social convention also tells us that we eat at certain times, whether we are hungry or not. A trip to the canteen during work breaks is often almost a social obligation. Social demands disrupt our normal eating patterns. People eat at a party even though they have just had a large meal. Party foods are usually sweet, fatty, or both, which people (and rats) overeat much more easily than foods served at normal meals.

Marie goes to the canteen with her co-workers when they have their midmorning break. Match each behavior with the process that contributes to her weight problem

1. eating more than you notice you are eating
2. eating more because you are with other people
3. eating for flavor

Q5A. She eats a donut even though she is not hungry, because other people are eating
Q5B. She automatically eats without noticing, because her attention is fixed on the pleasant conversation with an attractive co-worker
Q5C. She likes the texture and sweet taste of donuts a lot

Social factors also affect what people eat and when they eat. Dietary rules vary a lot among cultures and social groups. Most Americans enjoy eating pork and beef, but pork is strictly forbidden and seen as disgusting among Muslims and traditional Jews, as is beef for Hindus. Most Americans cannot imagine eating dog meat, but in some cultures it is considered a great delicacy. Many Americans like fish, but only the more adventurous ones try sushi, Japanese dishes made from raw fish and other kinds of ocean animals, like octopus.

Rats also learn what to eat. Mother's milk can be flavored by adding flavors to the food the mother eats. Rat pups born to rat mothers that ate a flavored food grew up preferring that flavor. Young rats also learn what to eat by smelling the breath of older rats that have returned to the nest after eating.

Culture also affects people's attitudes to food and how they eat. French people take their food seriously, eat much slower, and have smaller portions than do Americans, even in prepared food servings they buy. These differences in eating may be an important reason why the French are much less affected by the worldwide increase in obesity (Rozin et al, 2003).

Obesity (being really overweight) is mostly a modern problem (Hill & Peters, 1998). Only in the past 200 years could many people count on a steady supply of good food. Only in the past 100 years have machines replaced muscle power for most jobs. So, until recently, food supply was uncertain, and hard physical labor rapidly burned calories. Under such conditions, people with a very efficient metabolism (low energy use) were more likely to survive periods of poor harvest. They got along with less food and stored food as fat in times of plenty for times when food was scarce.

With a steady supply of good tasting food and little need for hard physical labor, people with efficient (low) metabolism have weight problems. A fuel-efficient car is one that needs less gas to go a given distance than does a fuel inefficient car. An efficient (low) metabolism requires less food to do the same work than does an inefficient metabolism, so it is easier to eat more than necessary and gain weight.
Q1. An efficient metabolism is helpful when ___. It can be harmful when ___
A. you need to eat fast; you can eat slowly
B. you don't know whether you will have enough food for a while; your pantry is full of good food
C. plenty of tasty food is always available; food supply is irregular
D. A and B are both correct
E. B and C are both correct

Factors Affecting Body Weight

Many processes contribute to human obesity. They range from genetic and biochemical factors to learning and social facilitation of eating. People differ a lot in how much each process affects their weight problems. So no single method of weight control is likely to be effective for everyone with a weight problem, and some people are “designed” to be “overweight.”

Genetic Factors: Twin and adoption studies (see asgn1q and r) provide the strongest evidence for a genetic factor in obesity. Adopted children resemble their birth parents more than their adoptive parents in body shape and composition. Monozygotic (identical) twins are more similar in body weight than are dizygotic (fraternal) twins. However, environmental effects can produce large differences even in monozygotic twins. Figure 1-4q shows monozygotic twins who were adopted into different families. They have strikingly different body shapes despite having the same genes (Gottleib, 2000).

Metabolic efficiency is at least partly under genetic control, so it will contribute to genetic effects on body weight. (This is another example of the fact that genes that help in one situation [irregular food supply] can harm in another [lots of tasty food always available].) Genetic effects on body composition include genetic differences in the activity of hormone and neurotransmitter systems involved in eating.

Neurotransmitters: The brain’s circuits for controlling eating use chemical neurotransmitters from a family of chemicals called neuropeptides (small protein molecules that act as neurotransmitters). One of these is galanin. Some strains of genetically obese rats have high levels of this neuropeptide, and injecting it into normal-weight rats increases their preference for fatty food. An overactive galanin system may contribute to obesity in humans. Neuropeptide Y also plays a major role in controlling eating and body weight. Unlike galanin, its main effect is on consumption and metabolism of carbohydrates. (Leibowitz, 1995).

Many psychologically active drugs and medications, including some anti-schizophrenic and anti-depressant medications, also lead to increased body weight. Because these chemicals affect chemical neurotransmitter systems (dopamine, serotonin, and noradrenalin, in particular) in the brain, one or more of these neurotransmitters probably affect eating. The most likely is a serotonin system (Wurtman & Wurtman, 1989).

Hormones also play a major role in hunger and obesity. Recent reports have described leptin, a hormone that is released by fat cells. Although leptin is absent in a strain of genetically obese mice, it is not absent in obese humans (Gura, 1997). Insulin is another hormone that plays a major role in regulating food intake. Insulin is best known as the hormone that is deficient in many forms of diabetes mellitus. Its role in controlling blood sugar levels has important effects on hunger and eating. Elevated secretion of insulin lowers the blood sugar level, which starts hunger and eating.

Developmental variables also influence adult weight. Having too little or too much to eat early in development appears to affect adult weight. Maternal starvation during pregnancy affects children’s adult body weight. In 1944 during World War II, the retreating German armies virtually isolated a part of the Netherlands (Holland), resulting in a severe famine that winter. When the young men born there in the spring of 1945 were drafted 18 years later, they were more likely to be overweight than were young men from other parts of the Netherlands (Ravelli et al., 1976; Stein et al., 1975).
Having too much to eat as a baby can also lead to increased adult body weight. People who were fed too much as babies are more likely to be overweight as adults, apparently because the early overfeeding makes the developing body produce extra fat cells, which need to be filled.

Breast feeding may reduce the chance of developing obesity. A recent study reported that the longer a child had been breast-fed, the lower his/her chance of becoming obese at age 5 to 6 (von Kries et al., 1999). However, this is a correlational study, so breast feeding may be confounded with other variables, such as socioeconomic status, which also correlates with obesity. For more information about some recent approaches to understanding obesity, click HERE.

Some people have the opposite problem. They eat too little (anorexia nervosa), or induce vomiting after a binge of eating too much (bulimia). Curiously, eating disorders are much more common in adolescent and postadolescent women. Furthermore, social factors, probably extremely thin role-models, have a very strong influence. Fifty years ago anorexia and bulimia were almost unheard of. For more information about these disorders, click HERE. For another website on eating disorders with many links to other aspects of eating, click HERE.

**Q2**

Match the evidence below with the process they indicate contributes to obesity

1. genetic factors
2. environmental factors during early development
3. chemical communication systems in brain and body

Q2A. Identical twins are more similar in body weight than are same-sexed fraternal twins

Q2B. Babies who get too little or too much food tend to become overweight as adults

Q2C. Some obese (very overweight) people may have abnormal metabolic processes, chemical neurotransmitters, and/or hormones.

Q2D. The body weight of a sample of adopted children correlates more highly with biological parents' weight than with adoptive parents' weight.

**Activity level affects body weight.** Before the introduction of electric power and the gasoline engine, muscle power did most of the work. People were much more active and burned off lots of calories. So the meals they ate were enormous by modern standards. In modern “post-industrial” society, many people seek out some of the exercise that used to come naturally from everyday activities. They join health clubs, work out at home, or jog.

In many parts of the world, human muscle power is still the major source of work. In these places, the bosses who don’t work physically may eat as many calories as do people who work hard physically, so naturally they likely to be overweight. Interestingly, the people who eat the least have intermediate activity levels.

**Exercise has three main effects on caloric balance:**
1. It burns calories
2. It can increase metabolism, so calories are burned faster; however, this effect seems to operate only after extended, vigorous exercise
3. It can increase food intake to make up for the extra calories used up. This happens only for lean people. Obese people do not increase food intake much after exercise (Pi-Sunyer, 1987).

Several recent studies emphasize the importance of physical activity. Overweight, sedentary (inactive) women lost an average of 7.4 Kg over 18 month when they did several short bouts of exercise using home exercise equipment. Simply fidgeting burns off calories. Volunteers were overfed for several weeks and their weight gain was measured. Although many gained weight, some gained very little. These people turned out to be “fidgeters.” They moved around a lot even when they weren't doing anything that required physical activity. Apparently they increased this “background” physical activity enough to burn off the extra calories. Even the simple activity of chewing gum burns up some calories, about 11/hour (Levine et al., 1999). Exercise has an additional benefit unrelated to weight control: It increases brain function and neuronal growth (van Praag et al., 1999).

**Q5.** Vigorous exercise helps overweight people lose weight because it

A. depresses their appetite
B. burns up calories
C. does not produce much compensatory increase in eating
D. increases body’s metabolic rate
E. A, B, and D are all correct
F. B, C, and D are all correct
Losing weight and keeping it off is not an easy task. **Successful weight loss requires increased expenditure of calories, decreased intake of calories, or preferably both.** Increasing activity is especially useful, because it burns up calories, which obese individuals do not make up by eating more. Cutting down caloric intake is often quite difficult. The many good-tasting foods people can get and the many pressures that encourage overeating. Furthermore, when people eat less, the body responds by making metabolism more efficient, so they need less food. Finally, as described above, some people have genetic predispositions and/or environmental experiences that bias them toward a heavier body weight.

A fundamental change in eating habits is required for **lasting weight loss.** A successful diet does not require self-starvation. It does require eating less fats and simple carbohydrates (like sugar) and eating more food with low caloric density (vegetables, fruits) and with complex carbohydrates (bread, pasta). (Dr. Atkins' popular diet plan recommends exactly the opposite: high fat, high protein, low carbohydrate. However, this diet has never been tested. Few, if any of the other popular plans have either.)

Other effective steps are:
- Eat only under specific conditions, so that fewer situations are signals to eat;
- Eat smaller portions;
- Stop eating when you feel satisfied (not stuffed).

Unfortunately, some overweight people are not sensitive to their internal conditions and are more reactive to external cues. They need to monitor carefully how much they actually eat. In addition, some overreact to taste. They eat more of tasty foods than do normal weight people and less of less tasty foods.

Monitoring food intake is important for another reason. Many overweight people claim that they cannot lose weight even when they reduce their food intake. **Careful observation shows that they dramatically underestimate how much they really eat, if they don't keep a careful record.**

Crash diets take off some pounds, but those pounds come right back unless people make permanent changes in their eating habits. More important, repeated dieting and regaining weight has two negative consequences.

1. The decreased metabolism from decreased food intake occurs more quickly each time a person diets.
2. Repeated weight loss and gain appears to increase chances for heart disease.

Surgery that reduces the size of the stomach is used to help people with severe weight problems lose weight. The idea is to reduce the amount of food the stomach can hold and limit the number of small meals the patient receives. Recently this technique has been improved to that it is usually very successful. Patients report that they feel very full after a small meal, though the sense of hunger may take several weeks to fade. This approach to weight control is a last resort, when other methods have not succeeded and the patient's health is threatened by his/her weight.

**Mark EACH item True (T) or False (F)**

Q6A. metabolism becomes more efficient when caloric intake is reduced.  
T F

Q6B. they underestimate how much they eat.  
T F

Q6C. crash diets, which are the most efficient, are hard to start.  
T F

Q6D. they react to good tastes by overeating.  
T F

Q6E. they have a lower threshold for tasting sweet than do normal weight people.  
T F

Link to an article about the effects of restricting calories in what you eat.  
Links to websites with information about obesity and weight control, click Doctor's Guide; Mayo Clinic.

Link to a series of recent authoritative articles in Nature about obesity and weight control.

"**Specific**" Hungrers. We usually think of hunger as need for calories. However, the body needs more than calories. It needs protein, vitamins, and minerals as well. For many species of animals, getting adequate protein, vitamins, and minerals is automatic. These animals are ones that eat a narrow range of food. Part of their adaptation to this narrow range of food is adjustment of body needs to fit what is in their normal food supply. For example, carnivores (carne = meat; vore ~ eaters) like cats and dogs get everything they need automatically from the meat they naturally eat. Some herbivores (herb ~ plant) eat a very restricted range of plants (for example, koalas that eat only eucalyptus leaves and pandas that eat only bamboo shoots), which must contain everything they need.
Omnivores (omni = all; vore = eat, as in devour) like rats, pigs, bears, and humans eat almost anything. They must have a mechanism to select an adequate diet. They do so by developing preference for flavors associated with the relief of symptoms of malnutrition. Such preferences are called specific hungers.

Specific hungers let rats and people self select a balanced diet. This process works well only when it is not overwhelmed by very tasty, but nutritionally inadequate foods ("junk" foods). Normally rats avoid new foods (neophobia). However, if rats are maintained on a diet that is missing some specific nutrient, say thiamin (a B vitamin), they begin to eat and even prefer new foods. If one of these new foods contains the thiamin they need, they quickly develop a preference for that flavor. The rats learn to prefer food flavors associated with relief from symptoms of the deficiency. This process is like taste aversion learning (see asgn3b), except that it is opposite in direction: learned taste preference.

Q7. People and rats can select a balanced diet, if lots of tasty (but non-nutritious) foods are not available because

A. food flavor that relieves diet deficiency is associated with feeling better
B. taste receptors are innately tuned to nutritious food
C. a good diet is instinctively recognized
D. each vitamin and mineral has its own taste
E. C and D are both correct