LECTURES 7 & 8 – CARBOHYDRATES

QUESTIONS TO TRY FOR PRACTICE

1) How do the α and β forms of glucose differ?
A) Their ring structures differ in the location of a hydroxyl group.
B) Their linear structures differ in the location of a hydroxyl group.
C) The α form can be involved in 1,4 and 1,6 glycosidic linkages; the β form can participate only in 1,4 linkages.
D) The oxygen atom inside the ring is located in a different position.

2) Which of the following linkages would you expect to find at a branch point in glycogen or amylopectin?
A) α-1,4-glycosidic linkage
B) β-1,4-glycosidic linkage
C) α-1,6-glycosidic linkage
D) β-1,6-glycosidic linkage

3) Which of the following can vary among monosaccharides?
A) the number of carbon atoms
B) the presence of a carbonyl group
C) the presence of hydroxyl groups
D) all of the above

4) What is the difference between an aldose sugar and a ketose sugar?
A) the number of carbons
B) the position of the hydroxyl groups
C) the position of the carbonyl group
D) one is a ring form, the other is a linear chain

5) Which of the following sugars might have the formula $C_6H_{12}O_6$?
A) triose
B) pentose
C) hexose
D) heptose

6) The term *carbohydrate* is appropriate because of which of the following characteristics of sugars?
A) They all have the general formula $(CH_2O)_n$.
B) They all have the general formula $(C_2H_2O_2)_n$.
C) They all have the general formula $(C_2HO)_n$.
D) They all have the general formula $(CHO_2)_n$.

7) Carbohydrates have been shown to form
A) only in biotic conditions (inside living cells).
B) in biotic and abiotic conditions, but only if nucleotides and RNA have already formed.
C) in biotic and abiotic conditions, including outer space.
D) only in biotic conditions, when enough free energy is available to allow their formation.

8) Given that individuals with phenylketonuria are unable to metabolize phenylalanine, which of the following is most likely to be true in terms of what food items they should avoid?
A) all food with phenylalanine
B) all foods containing aspartame because it is artificial
C) all foods containing any artificial sweeteners because they are not natural

9) Why do artificial sweeteners have less calories than sucrose and fructose, but still taste sweet?
A) They bind to specific taste receptor, but are quickly metabolized by the body.
B) They do not bind to any receptors and are quickly eliminated from the body.
C) They bind to a specific taste receptor, but do not have any ATP.
D) They bind to ATP, which then binds to the taste receptor.

10) You like to add sugar to your coffee. Why would you need 1 teaspoon of table sugar to make it as sweet as only 1/8 of a teaspoon of an artificial sweetener?
A) Artificial sweeteners bind to a wider variety of receptors that detect sweetness, whereas table sugar only binds to one.
B) Artificial sweeteners have a greater affinity for the receptor that detects sweetness relative to table sugar.
C) Artificial sweeteners expand in the body once they encounter certain enzymes.

11) Synthesis of larger sugars has allowed us to study them more in depth. Which of the following are potential benefits/reasons why we would want to study oligosaccharides in detail?
A) Oligosaccharides are present on cell surfaces and are part of cell identity mechanisms.
B) Oligosaccharides are embedded in the cell membrane and help transport molecules across the membrane.
C) Oligosaccharides are one of the information molecules of the cell.
D) Oligosaccharides form the part of the membrane bilayer that controls membrane permeability.

12) Which of the following carbohydrates contains a peptide bond?
A) Carbohydrates don't contain peptide bonds; only proteins do.
B) cellulose
C) chitin
D) peptidoglycan
E) glycogen

13) Scientists believe polysaccharides played little role, if any, in chemical evolution. Which of the following is not true of polysaccharides, leading scientists to discount them as the first life-forms?
A) They are incapable of catalyzing chemical reactions.
B) Because there is no complementary pairing between monosaccharides, they cannot provide the information for copying themselves.
C) The formation of glycosidic linkages between monosaccharides has been observed only with complex enzymes that would have come after chemical evolution—during biological evolution.
D) Polysaccharides are polymers, meaning they contain many monomer subunits. Polymers have never been observed to form, in any type of molecule, under laboratory conditions.

14) What is the major structural difference between starch and glycogen?
A) the types of monosaccharide subunits in the molecules
B) the type of glycosidic linkages in the molecule
C) whether glucose is in the α or β form
D) the amount of branching that occurs in the molecule

15) Which of the following do starch and cellulose have in common?
A) the type of glycosidic linkage used
B) the size of their monosaccharide subunits
C) the amount of hydrogen bonding that occurs between parallel strands
D) their main function in plants

16) Which of the following structural features is common to cellulose, chitin, and peptidoglycan?
A) They are all composed of glucose in either the α or β form.
B) They all contain peptide bonds.
C) They can all form bonds between polymer chains that create parallel strands.
D) They all form highly branched fibers.

17) A glycosidic linkage is analogous to which of the following in proteins?
A) an amino group
B) a peptide bond
C) a disulfide bond
D) a β-pleated sheet

18) Which of these best reflects the following relationship: monosaccharide versus polysaccharide?
A) glucose versus glycogen
B) glucose versus fructose
C) 1,4-glycosidic linkage versus 1,6-glycosidic linkage
D) α-linkage versus β-linkage

19) Enzymes that readily break starch apart cannot hydrolyze the glycosidic linkages found in cellulose. Why is this logical?
A) The geometry of the bonds is different, and the shapes of enzyme active sites are highly specific.
B) Starch is held together by hydrogen bonding, not covalent bonding.
C) Cellulose molecules are highly branched, and enzymes are too bulky to fit.
D) Starch is held together by peptide bonds, not glycosidic linkages.

20) Peptidoglycan forms sheets that stiffen the cell walls of bacteria. How is the formation of sheets possible?
A) The polysaccharides in peptidoglycan are highly branched and form a network.
B) The glycosidic linkages between monosaccharides in peptidoglycan are extraordinarily strong.
C) Individual strands are joined by peptide bonds—a type of covalent bond.
D) The polysaccharides in peptidoglycan form helical structures, as in cellulose.

21) Lactose, a sugar in milk, is composed of one glucose molecule joined by a glycosidic linkage to one galactose molecule. How is lactose classified?
A) as a pentose
B) as a hexose
C) as a monosaccharide
D) as a disaccharide
E) as a polysaccharide

22) Which polysaccharide is an important component in the structure of many animals and fungi?
A) chitin
B) cellulose
C) peptidoglycan
D) amylose

23) Glucose ($C_6H_{12}O_6$) has a single carbonyl group (-C=O) in its linear form. Based on the number of oxygen atoms in glucose, how many hydroxyl groups (-OH) would you expect glucose to have?
A) 6
B) 5
C) 3
D) 1

C) 3
D) 1

24) Compare the molecular formula of a carbohydrate $(CH_2O)_n$ with that of carbon dioxide (CO_2). What does the presence of hydrogen atoms in carbohydrates indicate?
A) Carbohydrates are more reduced than carbon dioxide.
B) Carbohydrates are more oxidized than carbon dioxide.
C) Every carbon atom in a carbohydrate is bonded to four different atoms.
D) Carbohydrates contain a carbonyl functional group.

25) Which of the following enzymes catalyzes the hydrolysis of α-glycosidic linkages in glycogen?
A) amylase
B) phosphorylase
C) glycolase

26) Why do endurance athletes practice "carbohydrate loading," meaning to eat massive amounts of starch in the days leading up to a long race?
A) Starch is used as a building block for the synthesis of many other molecules.
B) Starch provides dietary fiber or "roughage" that aids digestion.
C) Carbohydrates are reduced molecules that can provide the chemical energy required during exercise.
D) Starch can be used to synthesize cellulose and build up the cell walls of muscles.

27) Which of the following enzymes catalyzes the hydrolysis of α-glycosidic linkages in starch?
A) amylase
B) phosphorylase
C) glycolase

28) Which of the following polysaccharides is made up of parallel strands joined together by peptide bonds?
A) glycogen
B) starch
C) cellulose
D) peptidoglycan

29) Which of the following polysaccharides is made up of parallel strands joined together by hydrogen bonds?
A) glycogen
B) starch
C) chitin
D) peptidoglycan
Answer: C

30) Which of the following best explains why "carbs" (carbohydrates) are advertised by manufacturers of candy bars and sports drinks as a "quick energy boost"?
A) The energy in them can be stored as fat, which has high energy per unit weight.

30) Which of the following best explains why "carbs" (carbohydrates) are advertised by manufacturers of candy bars and sports drinks as a "quick energy boost"?
A) The energy in them can be stored as fat, which has high energy per unit weight.
B) The carbons in carbs are rich in energy because they are highly oxidized.
C) Carbs are reduced molecules that have high-energy electrons.
D) This is an advertising gimmick that has no scientific evidence to support it.

31) Which of the following molecules would you expect to have the most free energy per gram?
A) one with carbon and hydrogen atoms only
B) one with carbon, hydrogen, and oxygen atoms only
C) one with a variety of atoms that are found in cells
D) one with hydrogen and oxygen atoms only

32) Which of the following polysaccharides is made up of highly branched helices?
A) glycogen
B) chitin
C) cellulose
D) peptidoglycan

33) Why do plants require sunlight?
A) Sunlight helps plants break down their food products so they can extract the energy stored in them.
B) Sunlight energy can be used by plants to reduce the carbon atoms in carbon dioxide.
C) Sunlight oxidizes carbon dioxide and water to form glucose.
D) Sunlight can be used directly by plants to perform a number of physiological processes.

35) When an insect is crushed, it creates a crunching sound. What carbohydrate is the most likely source of this sound?
A) glycogen
B) chitin
C) peptidoglycan
D) cellulose
E) starch

36) If you were going to develop a new antibiotic, you would probably need to become an expert on which of these carbohydrates?
A) glycogen
B) chitin
C) peptidoglycan
D) cellulose
E) starch

37) Cell walls are used by many different organisms for protection from their environment and structural support. These cell walls must obviously be insoluble in water, otherwise, they would dissolve the first time the o[redacted]g carbohydrates would you expect to be the most soluble in water?

37) Cell walls are used by many different organisms for protection from their environment and structural support. These cell walls must obviously be insoluble in water, otherwise, they would dissolve the first time the organism got wet. Which of the following carbohydrates would you expect to be the most soluble in water?

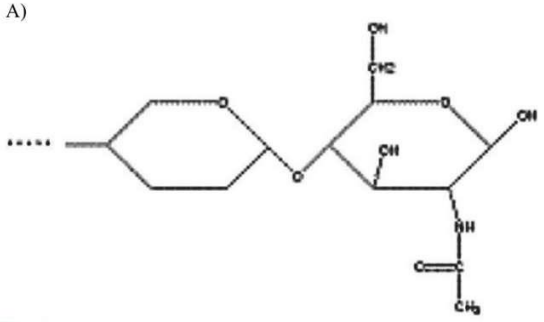
A) starch
B) peptidoglycan
C) cellulose
D) chitin

Use the following paragraph to answer to the corresponding question(s).

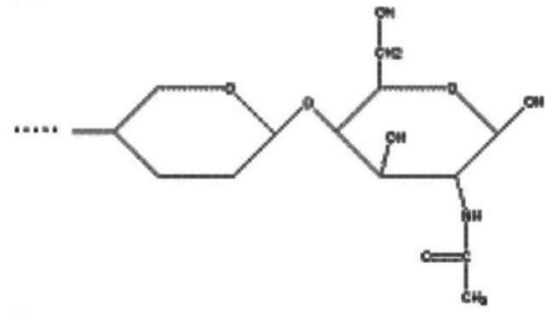
Masatomo Kawakubo et al. reported in *Science* in August 2004 that the human stomach contains a natural, carbohydrate-based antibiotic that probably protects a large portion of the population from various diseases caused by the bacterium *Helicobacter pylori*. This bacterium has been linked to peptic ulcers, gastritis, and stomach cancer. This naturally occurring antibiotic is described by Kawakubo as having a terminal α1,4-linked N-acetylglucosamine (NAG), and it acts by inhibiting the biosynthesis of a major component of the cell wall in H. pylori. [: M. Kawakubo et al., *Science* 305 (2004): 1003.]

38) Which of the following structures is most consistent with Kawakubo's description of this antibiotic?

A)



B)



39) Kawakubo's group created a glycoprotein with a terminal NAG (i.e., a protein with NAG attached to its end). Their hypothesis is that the terminal NAG—and not the protein component—is responsible for the damage to the cell wall in *H. pylori*. What would be the most appropriate control for testing this hypothesis?
A) Grow *H. pylori* in a test tube (in vitro) with no glycoprotein.
B) Destroy the *H. pylori* by exposing them to a hypotonic solution. Then add the glycoprotein and observe.
C) Expose other species of bacteria to the glycoprotein.
D) Grow *H. pylori* in a test tube with glycoprotein that has its terminal NAG removed.

40) In animals, the role of carbohydrate polymers is primarily
A) body protection.
B) information storage.
C) energy storage.
D) enzymes.

41) Which of the following categories includes all others in the list?
A) monosaccharide
B) disaccharide
C) starch
D) carbohydrate
E) polysaccharide

42) You isolate an organic molecule that contains C, H, O, N, and S. This molecule
A) is a disaccharide.
B) could be a glycoprotein.
C) is a nucleic acid.
D) could be cellulose.
E) could be glycogen.

43) How do carbohydrates contain and/or display information for cells?
A) Carbohydrates store information in the nucleus.
B) Carbohydrates contain and display information at the cell surface.
C) Carbohydrates display information used by mitochondria to bond to substrates and catalyze reactions.
D) Carbohydrates display information by moving throughout the cell.
E) Carbohydrates have no role in containing or displaying information for cells.