Question 1:

1. Maize plants are C4 plants undergoing C4 photosynthesis and carbon dioxide fixation occurs by this pathway. Phosphoenolpyruvate (PEP) carboxylase is used to fix carbon dioxide from the atmosphere for maize plants to avoid photorespiration. In C4 plants, PEP is the primary acceptor of CO2 and after it accepts the CO2 (as CO2 enters into the mesophyll cells of maize leaves), it is converted to a four-carbon compound oxaloacetate (OAA). OAA is the transported to the chloroplast produce malate, and it can also produce aspartate in the cytosol of mesophyll cells. Therefore, after about 1 second of illumination, most of all radioactivity incorporated in leaves is found at C4 of both malate AND oxaloacetate (and aspartate in addition).
2. As mentioned, the malate produced in the chloroplast of mesophyll cells is then transported from there to chloroplast of bundle sheath cells for conversion to pyruvate. The released 14CO2 then undergoes the Calvin Cycle – as it combines with RuBP (ribulose-1,5-biphosphate) – where the production of 3-phosphoglycerate occurs. This is why after 60 seconds, the 14C radioactivity appears in 3-phosphoglycerate.

Question 2:

1. The decreased coenzymes NADH and NADPH differ by only one phosphate, but NADH provides catabolism power reduction in the cell, whereas NADPH is used in biosynthetic pathways. Enzymes almost always differentiate between coenzymes, but the functionally dual specificity of glucose 6-phosphate dehydrogenase (G6PD) from Leuconostoc mesenteroides is unusual. The structures of NADP(+)- and NAD(+)-complexed L are in order to elucidate the coenzyme selectivity. Including data at 2.2 and 2.5 A resolution respectively, and compared to unliganded G6PD crystallized in the same space groups, G6PD mesenteroids were determined. Coenzyme binding is also contrasted with that in a mutant ternary complex where Asp177 has been mutated at the active site to asparagine. Among the complexes, there are no gross structural differences. The enzyme interdomain hinge angle has opened up in both binary complexes. NADP(+) binds to the furthest open form; only Arg46 moves from the residues in the coenzyme domain, interacting with 2’-phosphate and adenine. In the binding site, NAD(+) is less well defined; smaller hinge openings are seen, but larger local changes are seen: Arg46 is displaced, Thr14 binds the 3’-hydroxyl and Gln47 bonds the 2’-hydroxyl. The hinge angle has closed in the ternary complex; only the adenine nucleotide is ordered at the binding site. Again, most binding interactions are given by Arg46.
2. Major flux of carbon starting with glucose: Cellular respiration (the oxidation of glucose to produce pyruvate in glycolysis), Glycogenesis (formation of glycogen – polysaccharide of glucose)
3. 1) Gluconeogenesis and glycolysis are not identical pathways running in opposite directions. Although they do share several steps, 7 of the 10 enzymatic reactions of gluconeogenesis are the reverse of glycolytic reactions. These 7 reactions are reversible and so catalyzed by their respective enzyme in both biochemical pathways. The 7 glycolytic reactions have a delta G near zero.

2) 3 reaction of glycolysis is irreversible because these three reactions are characterized by a large negative free-energy change. In gluconeogenesis, the three irreversible steps are bypassed by a separate set of enzymes, catalyzing reactions that are sufficiently exergonic to be effectively irreversible in the direction of glucose synthesis. Thus, both glycolysis and gluconeogenesis are irreversible processes in cells.

Question 3:

1. Muscle cells are different from brain in having a large storage of glycogen (1200 kcal, or 5000 kJ). In fact, about three-fourths of all the glycogen in the body is stored in muscle cells. This amount glycogen is readily converted into glucose 6-phosphate for use within muscle cells. Muscle cells, like the brain, lack glucose 6-phosphatase, so it does not export glucose. Rather, muscle retains glucose – its preferred fuel for bursts of activity.
2. Glycogen phosphorylase is regulated by phosphorylation, binding of allosteric effectors and by the catalytic mechanism, phosphorylation takes glycogen phosphorylase from a disordered state to an ordered one, allosteric effector provides changes in the structure of the enzyme. Regulation occurs on the enzyme’s glycogen phosphorylase and glycogen synthase and involves allosterism, covalent modification of enzymes and ultimately hormonal control. The regulatory enzyme phosphorylase kinase catalyzes this covalent modification. Increased level of epinephrine and the electrical stimulation of muscle result in phosphorylation of the enzyme to the phosphorylase a form.