B.Sc. Part III Zoology (Hons)

Paper V, Grp-I.

Metabolism of Carbohydrate: glycogenesis

Part II

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Contd. from Part I -

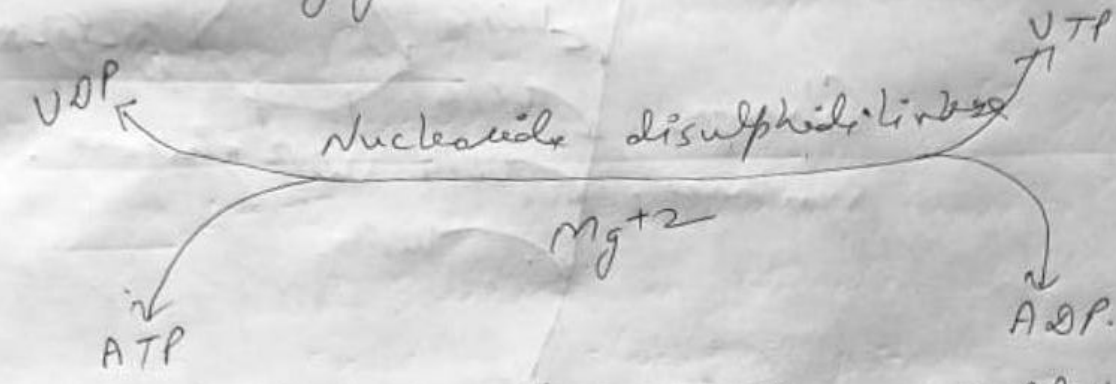
4. Transfer of glucose from UDP-glucose to glycogen primer :- In this step, glucose moiety of UDP-glucose is transferred to an already existing glycogen primer molecule. This primer is present as a conjugate to a protein molecule named glycogenin, a polypeptide of 332 amino acids. Carbon-1 of the first glucose of the glycogen primer forms a covalent bond with -OH of tyrosine of the protein glycogenin. The enzyme, glycogen synthase, brings about cleavage of the phosphoester bond between C-1 of glucose and α-P of UDP and leaves glucose with oxonium ion as intermediate. This immediately reacts with -OH of the C-4 of terminal glucose of glycogen primer forming α(1-4) glycosidic bond. Glycogenin acts as a self-glycosylating enzyme and brings about its own glycosylation by

introducing glucose from UDP-glucose to -OH of its own tyrosine. The free energy change of the reaction is highly negative ($\Delta G^\circ = -13.3$ KJ per mol). UDP liberated is converted back to UTP by the enzyme nucleoside diphosphate kinase, which brings about transfer of energy-rich phosphate from ATP to UDP.

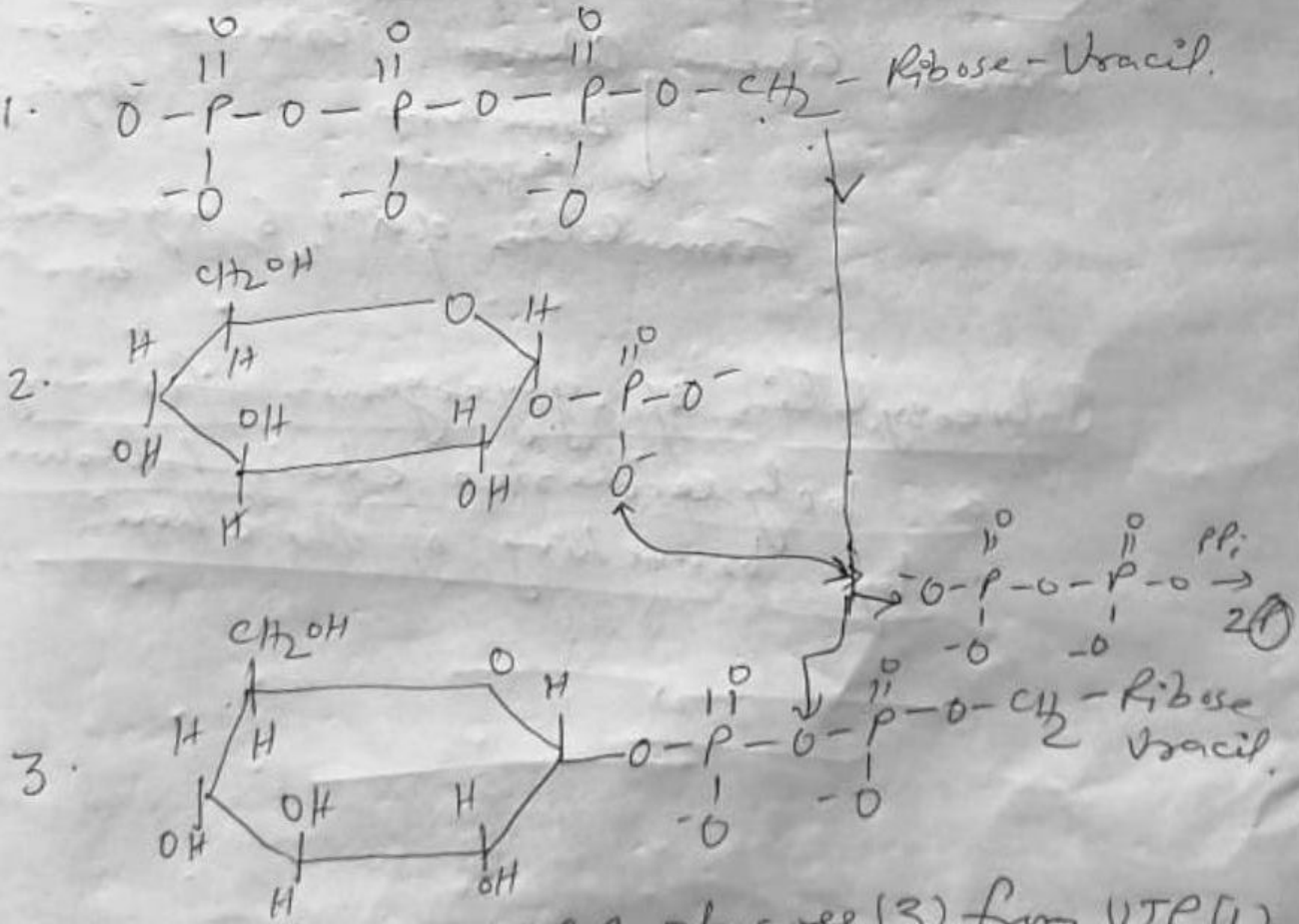
Similarly, fresh UDP-glucose molecules are generated through reactions 1-3 and the glucose unit are transferred to the non-reducing end of the glycogen primer, one after other and the glycogen goes on increasing in linear length by addition of glucose unit by 1→4 glycosidic bond.

(5) Branching of the linear polymer: After repeated actions of different enzymes in succession, through step 1 to step 4, different branches of glycogen primer increase linearly away from its glycogenin. Once a linear chain has elongated by 11 glucose residues. Another enzyme, a branching enzyme, amylo (1,4→1,6) transglycosylase brings about transfer of an oligosaccharide piece of 6 to 7 glucose unit from the growing chain to an adjacent chain by forming a branch point of α-1,6, glycosidic

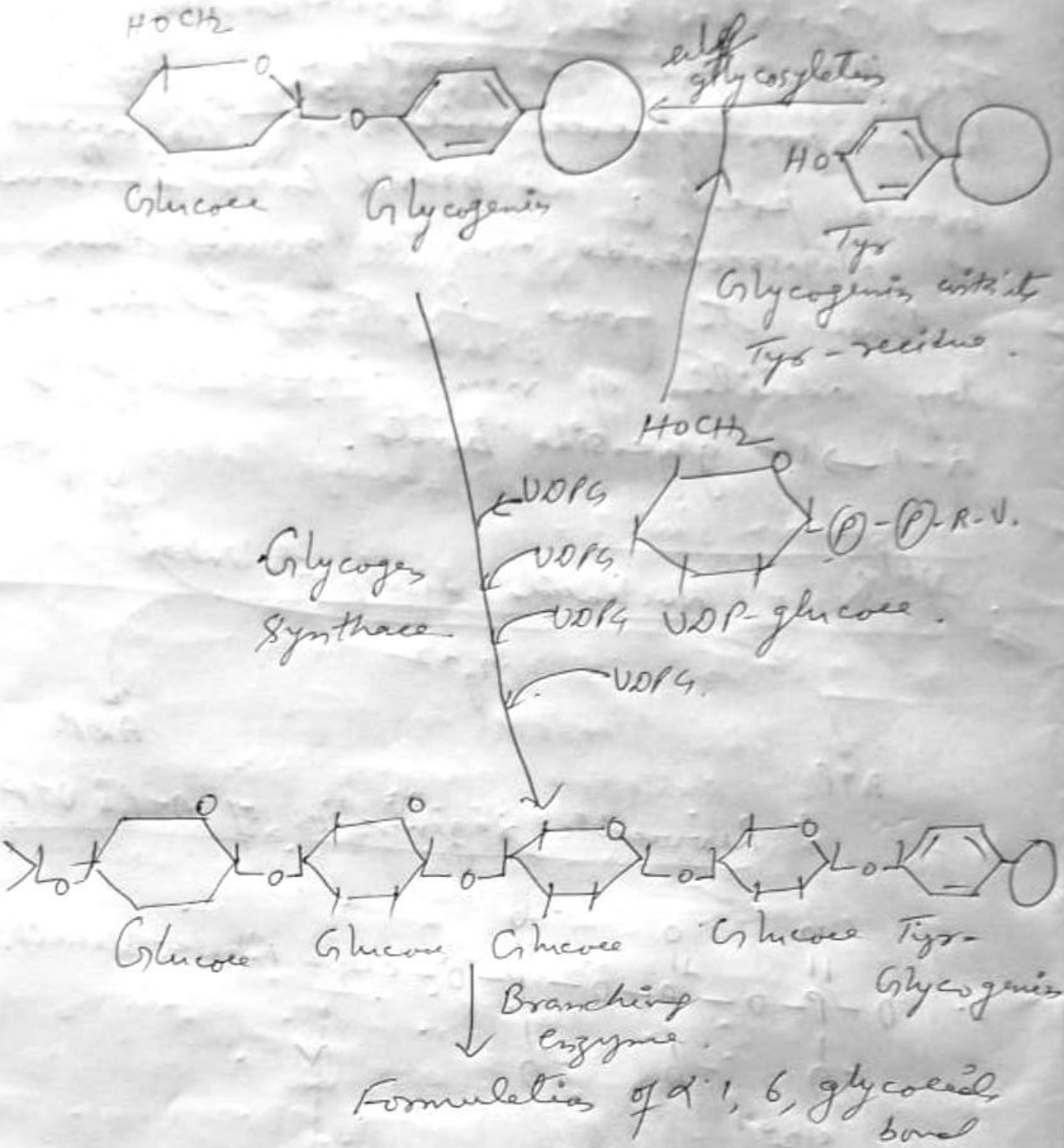
bond between Carbon-6 of the adjacent chain and Carbon-1 of the oligosaccharide piece. This branch point is mostly away by at least four glucose unit from the nearest branch point. This branch point is formed of oligosaccharide and the growing chain continues to grow further and further by addition of new glucose unit by α-1 → 4 glycoside bonds.



Reversible regeneration of ATP & UTP



Formation of UDP-glucose (3) from UTP (1) & glucose-1-P_4 (2).



Glycosylation of glycogenin forming a polysaccharide chain, followed by branching of the chain.