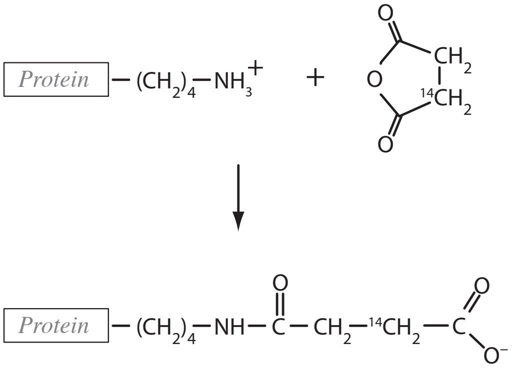
Carboxylic Acid Derivatives Practice Items

1. What type of linkage is a peptide bond?

A. ester
B. amino
C. anhydride
D. amide

2. A method was devised to quantify free ε-amino groups of proteins using [^{14}C]succinic anhydride for measurement in scintillation counting.



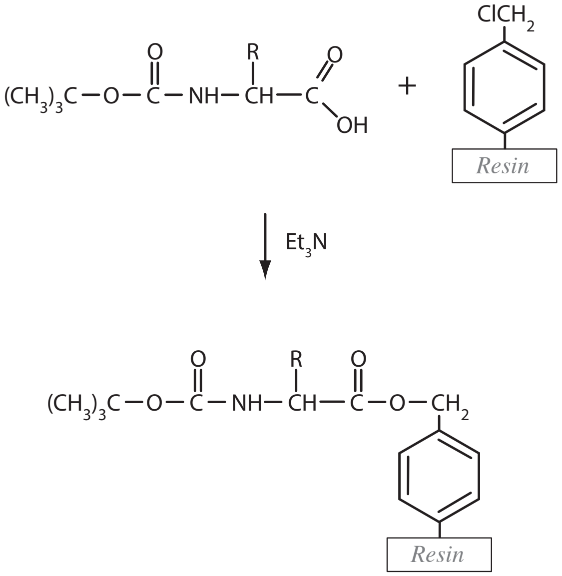
In the depiction above, what type of reaction mechanism has occurred between [^{14}C]succinic anhydride and the lysine side chain?

A. SN2 substitution
B. imine formation
C. nucleophilic acyl substitution
D. cyanohydrin formation

3. Which of the following general class of carboxylic acid derivatives is most reactive towards nucleophiles in acyl substitution?

A. amides
B. thioesters
C. carboxylates
D. carboxylic acids

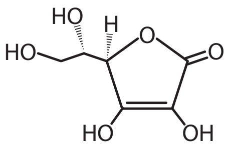
4. A technique for solid phase polypeptide synthesis begins with anchoring a chemically protected C-terminal amino acid to a chloromethyl substituted polystyrene resin.



What type of reaction is depicted in the above figure?

A. SN2 substitution
B. Michael addition
C. nucleophilic acyl substitution
D. oxidation

5. Vitamin C (ascorbate) functions as a cofactor in many enzymatic reactions in humans.

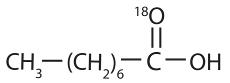


Ascorbate

Vitamin C is a . . .

A. β-lactone
B. γ-lactone
C. β-lactam
D. δ-lactone

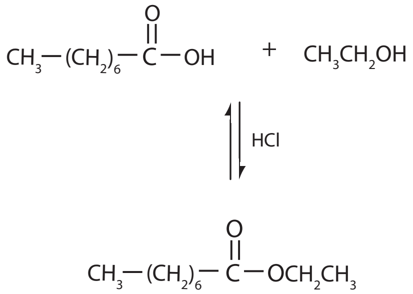
6. To form ethyl caprylate, Fischer esterification was carried out upon ^{18}O labeled caprylic acid, a medium-chain saturated fatty acid.



$$CH_3-(CH_2)_6-\overset{\overset{^{18}O}{\|}}{C}-OH$$

^{18}O labeled caprylic acid

Caprylic acid is sparingly soluble in water. The reaction was carried out with excess ethanol in aqueous solution.



$$CH_3-(CH_2)_6-\overset{\overset{O}{\|}}{C}-OH + CH_3CH_2OH \underset{}{\overset{HCl}{\rightleftharpoons}} CH_3-(CH_2)_6-\overset{\overset{O}{\|}}{C}-OCH_2CH_3$$

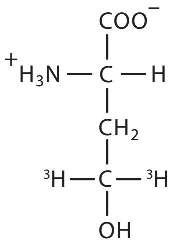
Upon completion of the reaction the supernatant was evaporated and the ethyl caprylate and unreacted caprylic acid were recovered as precipitates. The supernatant was separately recovered by means of a condensing column.

The various components were subsequently analyzed to confirm the presence of the ^{18}O label. In which of the following reaction components were ^{18}O labeled molecules confirmed to be present?

I. ethyl caprylate
II. caprylic acid
III. water
IV. ethanol

A. I and II
B. II and III
C. I, II and III
D. III and IV

7. A method for characterization of phosphorylated aspartate residues on enzymes involves cleavage of the acyl phosphate bond with sodium [^{3}H]borohydride. Analysis of the acid hydrolysate of the reacted protein of will show labeled homoserine if phosphorylated aspartate residues had been present.

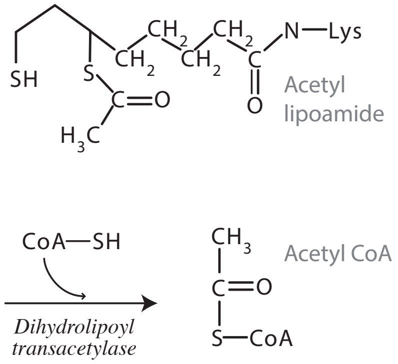


Labeled Homoserine

This technique is possible only because

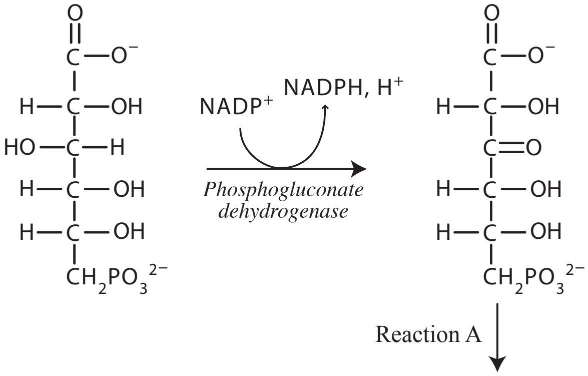
A. $NaBH_4$ is a strong acid.
B. $NaBH_4$ does not reduce carboxylic acids.
C. Acyl phosphates are strong oxidizers.
D. Tritide is more nucleophilic than hydride.

8. The figure below depicts a step in the mechanism of dihydrolypoyl transcetylase, a component of the pyruvate dehydrogenase complex. Which of the following describes this reaction?



A. transthioesterification
B. transsulfuration
C. transthiolation
D. transcarboxylation

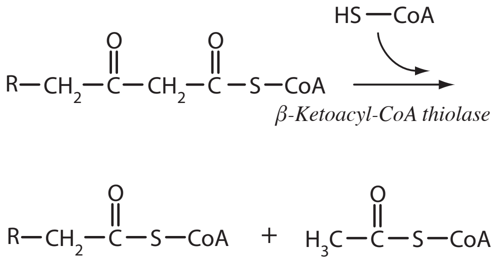
9. 6-Phosphogluconate dehydrogenase is an enzyme in the pentose phosphate pathway. The enzyme converts 6-phospho-D-gluconate into the intermediate 6-phospho-2-dehydro-D-gluconate. Still bound to the enzyme, 6-phospho-2-dehydro-D-gluconate then undergoes Reaction A to form Compound 1. What is reaction A?



Compound **1**

A. oxidation
B. reduction
C. decarboxylation
D. esterificaiton

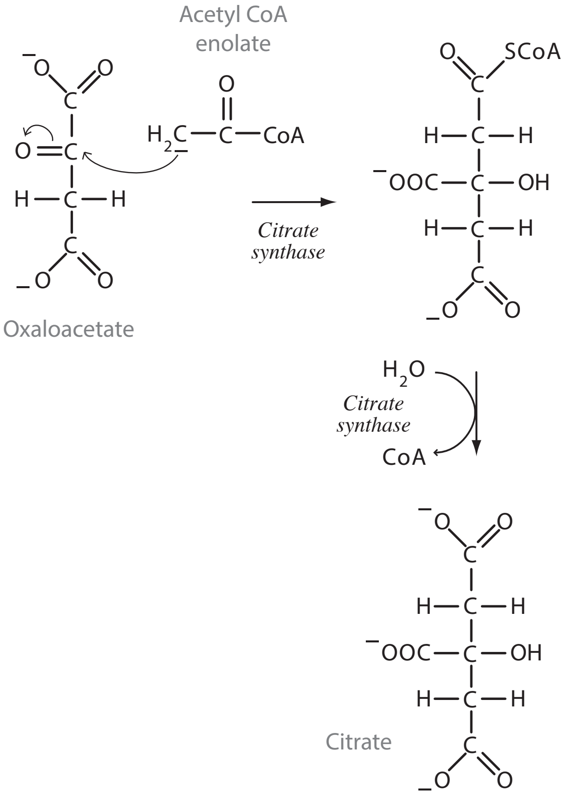
10. β-Ketoacyl-CoA thiolase catalyzes the final step of fatty acid oxidation in which acetyl-CoA is released and the CoA ester of a fatty acid two carbons shorter is formed.



What is the best description of the mechanism of this reaction?

A. retro-Claisen condensation
B. SN2 substitution
C. aldol cleavage
D. thioesterificaiton

11. Citrate synthase catalyzes the first reaction of the citric acid cycle: the condensation of acetyl-CoA and oxaloacetate to form citrate.

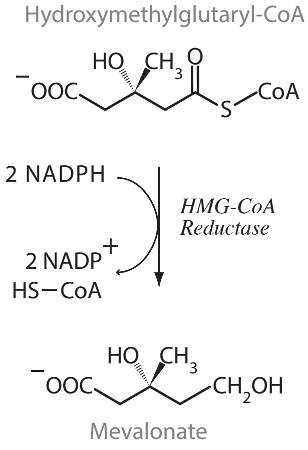


The standard free energy change (ΔG°) for the citrate synthase reaction is -31.5kJ/mol, and the enzyme functions far from equilibrium under physiological conditions.

What is the primary factor determining the negatative standard free energy change of the citrate synthase reaction?

A. hydration of the tri-carboxylate citrate product
B. resonance stabilization of the acetyl Coa enolate
C. hydrolysis of the thioester
D. electrostatic repulsion between the carboxylate groups of oxaloacetate

12. HMG-CoA reductase catalyses the conversion of HMG-CoA to mevalonate, a necessary step in the biosynthesis of cholesterol and other isoprenoid lipids.



What change has occurred to the oxidation state of the thioester carbon of HMG-CoA as a result of this reaction?

A. −3 → +1
B. +2 → 0
C. +2 → −1
D. +3 → −1

13. Glutamine synthetase (GS) catalyzes the ATP-dependent condensation of glutamate with ammonia to yield glutamine. The hydrolysis of ATP drives the first step of a two-part mechanism. In the first step (Step 1), ATP phosphorylates glutamate to form γ-glutamyl phosphate. In the second step (Step 2), γ-glutamyl phosphate reacts with ammonia, forming glutamine and inorganic phosphate.

Which of the two respective steps in the glutamine synthetase mechanism described above has a negative standard free energy change ($\Delta G°$)?

A. Step 1
B. Step 2
C. neither Step 1 nor Step 2
D. both Step 1 and Step 2

14. In polypeptide synthesis, the C-terminal residue of the growing polypeptide is sequentially esterified to the 3' hydroxyl of a t-RNA adenosine ribose (peptidyl-tRNA). In chain termination, a release factor binds to the stop codon leading to hydrolysis of peptidyl-tRNA by the peptidyl transferase ribozyme forming polypeptide and free tRNA. If an experiment were conducted with ^{18}O labeled water ($H_2{}^{18}O$) employed for hydrolysis, after liberation of the free polypeptide, ^{18}O label would be located on

A. the polypeptide
B. the tRNA
C. neither the polypeptide nor the tRNA
D. both the polypeptide and the tRNA