1. The following questions may have occurred to you: (i) do carbocations occur in living systems? (ii) Can an olefin (a Lewis base) react with a carbocation (a Lewis acid)? To address these questions, consider the following. At this very moment, certain enzymes in your liver are producing cholesterol and related steroids. These enzymes take up an endogenous olefinic compound called squalene and convert it into a carbocation that may be represented with structure A below. The enzymes also keep this carbocation in the rigidly defined conformation shown, protecting it from the action of external nucleophiles and promoting or disfavoring various chemical reactions, including rearrangements. Under such conditions, A is rapidly transformed into lanosterol, which is the precursor of cholesterol and of all other steroids.

Answer the above questions by writing a detailed mechanism for the conversion of A into lanosterol.

2. Predict the structure of the major product of each of the following reactions and write a detailed mechanism (curved arrows) for its formation.
3. Draw a clear skeletal structure of:

(a) an olefin that produces the same alcohol when treated with either H₂SO₄ / H₂O or BH₃ followed by H₂O₂ / NaOH

(b) an olefin that produces one alcohol when treated with H₂SO₄ / H₂O, but an isomeric alcohol when treated with BH₃ followed by H₂O₂ / NaOH

4. Provide all the reagents / catalysts, in the correct order, that are needed to convert vinylcyclopentane (structure below) into compounds a. - h. If a compound appears to be unavailable as the major product of any reaction known to you, answer "inaccessible".

![Vinylcyclopentane structure]

4. Propose a method for the preparation of compounds a. – h. below starting from appropriate alkenes. Draw a clear structure of your proposed starting olefin and list all reagents / catalysts, in the correct order, that are required to induce the desired transformation. Your method must be a good one, i.e., the desired compound must be the major product of your reaction(s). Note: it is understood that chiral compounds will be obtained as racemic mixtures.

![Compounds a. – h. structures]