Structure of Estrone (Oestrone)

i. The molecular formula of estrone is $C_{18}H_{22}O_2$

ii. Since it contains two oxygen atom, what is the nature of these two oxygen are ?

(a) On reaction with 2,4,DNP and hydroxylamine, estrone forms 2,4-dinitrophenyl hydrazone and oxime respectively. Indicating the presence of one oxygen as carbonyl group. This carbonyl group was found to be ketonic as it gives silver mirror test with silver nitrate.

(b) On reaction with acetic anhydride, estrone forms mono acetate. Indicating the presence of one hydroxyl group. This hydroxyl group was found to be phenolic in nature as estrone forms coloured complex with $FeCl_3$ and it also couples with diazonium salt in alkaline medium.

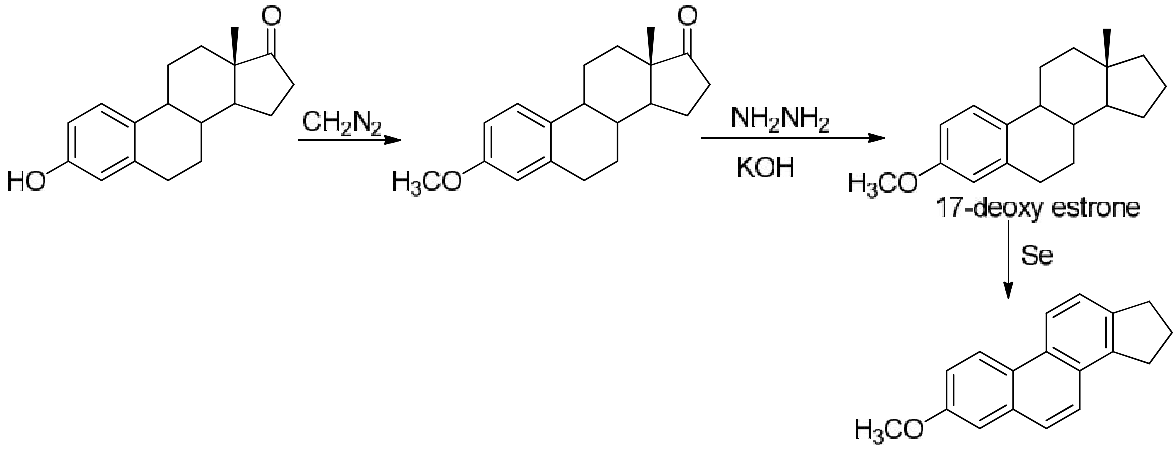
iii. On catalytic hydrogenation estrone absorbs four moles of hydrogen forming Octahydroestrone $C_{18}H_{30}O_2$. This compound contains two hydroxyl groups. One mole of hydrogen was used for converting keto to secondary hydroxyl group while three mole of hydrogen are use for saturation of three double bond. If the three double bonds are in one ring i.e benzenoid ring is present then only the phenolic group can be accounted. The presence of benzene ring was confirmed by UV which showed λ_{max} at 280 nm.

iv. Double bond equivalent of estrone $C_{18}H_{22}O_2$

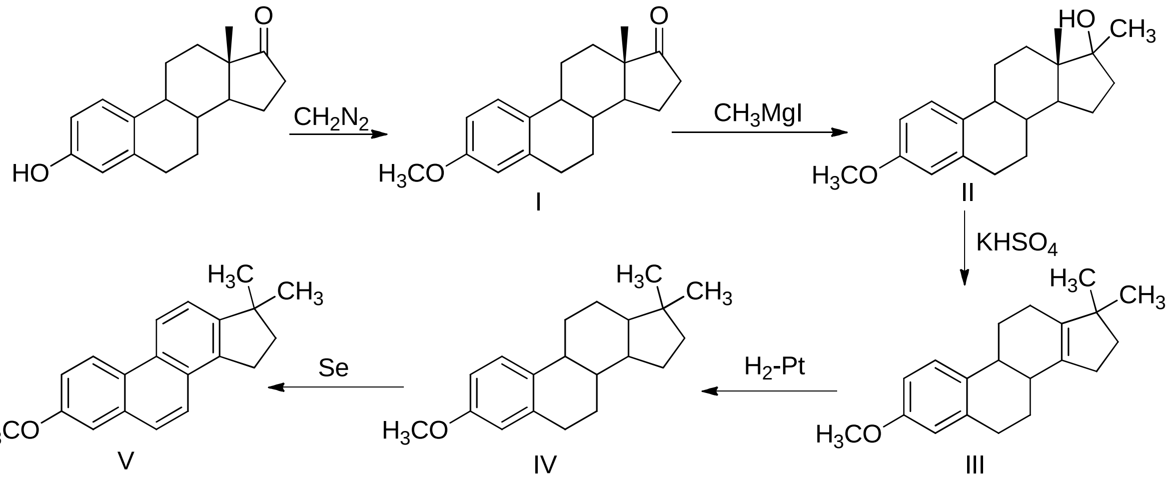
$$\text{D.B.E} = C - \frac{H}{2} + 1 = 18 - \frac{2}{2} + 1 = 8$$

One unit is for keto group, three units for the three double bonds and four for the rings. Thus estrone is tetracyclic in nature.

v. When monomethyl ether of estrone is subjected to Wolf-Kishner reduction it yields a product, which on distillation with selenium yields 7-methoxy 1,2-cyclopenteno-phenanthrene. Formation of 7-methoxy 1,2-cyclopentenophenanthrene suggests that estrone contains a steroid nucleus and position 7 in terms of steroids is position 3. Thus hydroxyl group is present at position 3, which is in ring A. Thus ring A is aromatic



vi. When monomethyl ether of estrone is condensed with methyl magnesium iodide it forms tertiary alcohol (II) which on dehydration with potassium hydrogen sulphate gives an ethylenic compound (lll), which is catalytically reduced to compound (IV). Compound (IV) on distillation with selenium yields 7-methoxy,3,3' dimethyl-1,2-cyclopentenophenanthrene. Position 7 and 3' in terms of steroid structure are 3 and 17. Thus hydroxyl group is present at C-3 and keto group at C-17



vii. The structure is further proved by its synthesis

Testosterone

i. The molecular formula of testosterone is $C_{19}H_{28}O_2$

ii. Since it contains two oxygen atom, what is the nature of these two oxygen are ?

(a) On reaction with 2,4,DNP and hydroxylamine, testosterone forms 2,4-dinitrophenyl hydrazone and oxime respectively. Indicating the presence of one oxygen as carbonyl group. This carbonyl group was found to be ketonic as it gives silver mirror test with silver nitrate.

(b) On reaction with acetic anhydride, testosterone forms mono acetate. Indicating the presence of one hydroxyl group. This hydroxyl group was found to be secondary alcoholic in nature as testosterone on oxidation forms diketo compound without any loss of carbon atom. Further proving that hydroxyl group is directly bonded to ring.

(c) On bromination it forms dibromo derivative indicating that one double bond is present in the ring.

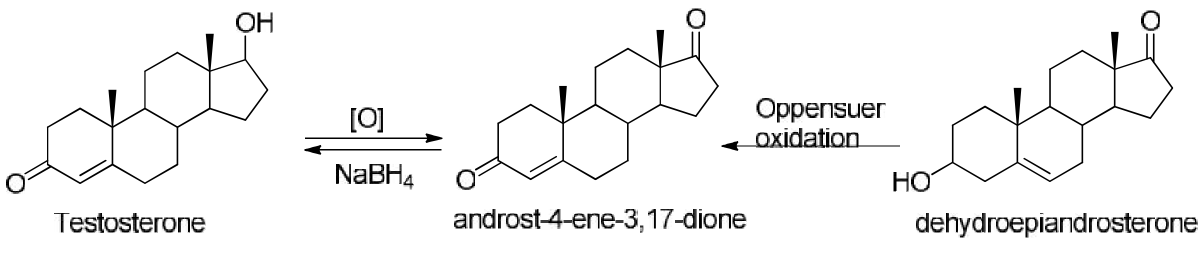
iii. Double bond equivalent of testosterone $C_{19}H_{28}O_2$

$$D.B.E = C - \frac{H}{2} + 1 = 19 - \frac{2}{2} + 1 = 6$$

One unit is for keto group, one unit for double bond. Thus testosterone is tetracyclic in nature.

iv. Testosterone is very sensitive to alkali, suggesting it might contain α,β-unsaturated group. The presence of this group was confirmed by UV which showed λ_{max} at 240 nm.

v. Testosterone on oxidation gives androst-4-en-3,17-dione a compound with known structure. This compound is also obtained by appenauer oxidation of dehydroepiandrosterone. The formation of this diketone could be explained only if I is the structure of testosterone



Androst-4-en-3,17-dione on reduction with NaBH4 gives testosterone thereby proving that keto group is at 3 and hydroxyl group is at 17 and double bond at 4,5 position in testosterone.

vi. The structure has further been proved by synthesis.

Progesterone

i. The molecular formula of progesterone is $C_{21}H_{30}O_2$

ii. Since it contains two oxygen atom, what is the nature of these two oxygen are ?

(a) On reaction with 2,4,DNP and hydroxylamine, testosterone forms 2,4-dinitrophenyl hydrazone and oxime respectively. Indicating the presence of oxygen as carbonyl group. This carbonyl group was found to be ketonic as it gives silver mirror test with silver nitrate. Since it forms dioxime hence there are two ketonic group.

(b) On bromination it forms dibromo derivative indicating that one double bond is present in the ring.

iii. On catalytic hydrogenation progesterone absorbs three moles of hydrogen to form a dialcohol derivative with molecular formula $C_{21}H_{30}O_2$. Two moles of hydrogen are used for converting keto group to secondary alcoholic group while the third mole adds across the double bond.

iv. Double bond equivalent of progesterone $C_{21}H_{30}O_2$

$$D.B.E = C - \frac{H}{2} + 1 = 21 - \frac{3}{2} + 1 = 7$$

two units are for keto group, one unit for double bond. Thus progesterone is tetracyclic in nature. Hence a steroid skeleton.

v. Progesterone is very sensitive to alkali, suggesting it might contain α,β-unsaturated group. The presence of this group was confirmed by UV which showed λ_{max} at 240 nm.

vi. Pregesterone on reaction with halogens in alkaline medium it yields haloform. This reaction proves that progesterone contains CH_3-CO group.

vii. X-ray analysis confirmed the structure of progesterone

vii. The structure was proved by synthesis.