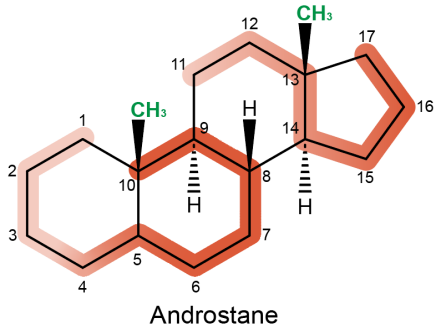
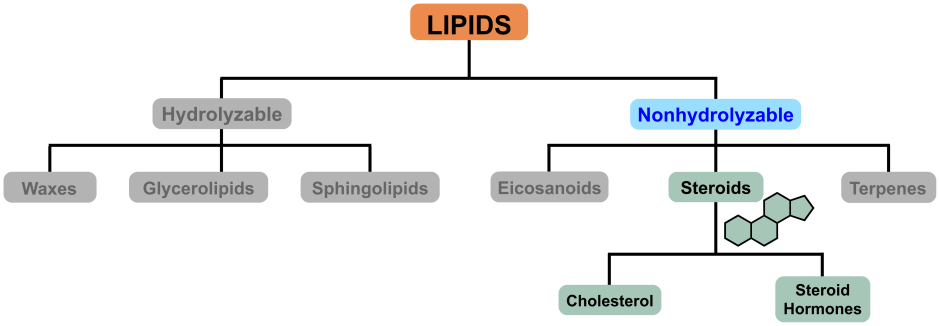
CONCEPT: STEROIDS

- Steroids are nonhydrolyzable lipids based on the _____ structure.
  - □ **Androstane:** Tetracyclic molecule with 3 cyclo_____ane rings, 1 cyclo_____ane ring, and 2 **–CH_3** groups.



Androstane



- Rings are designated **A, B, C,** and **D** and numbered in _____ order.
  - □ The two **–CH_3** groups at C13 and C10 are numbered ____ and ____, respectively.

EXAMPLE: Explain why cholesterol is a lipid but does not undergo saponification with aqueous base.

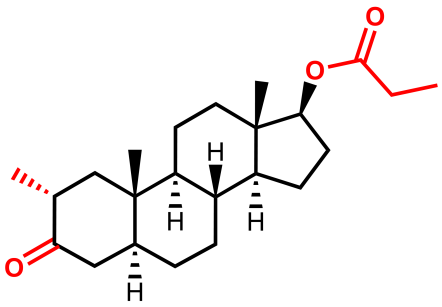
a) Cholesterol molecule is decomposed under strong basic conditions.

b) Cholesterol can only be hydrolyzed under acidic conditions.

c) The side chain on the steroid skeleton is very stable and does not undergo hydrolysis.

d) Cholesterol is not a fatty acid ester that can undergo hydrolysis.

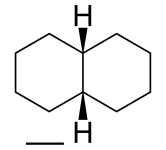
PRACTICE: Drostanolone propionate is a synthetic androgen that has been used to treat breast cancer. Number the carbon atoms with groups in red.



CONCEPT: STEROIDS

Review of Decalins

- **Recall:** Fused ring systems can have either _____ or _____ junctions.
  - □ *trans*-fused rings are _____ and more _____ than *cis*-fused rings.
    - cannot undergo ring flipping.
  - □ **Stereodescriptors:** β = ____ and α = _____.



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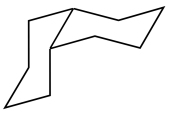
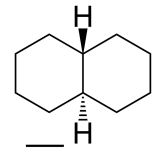


cis-decalin



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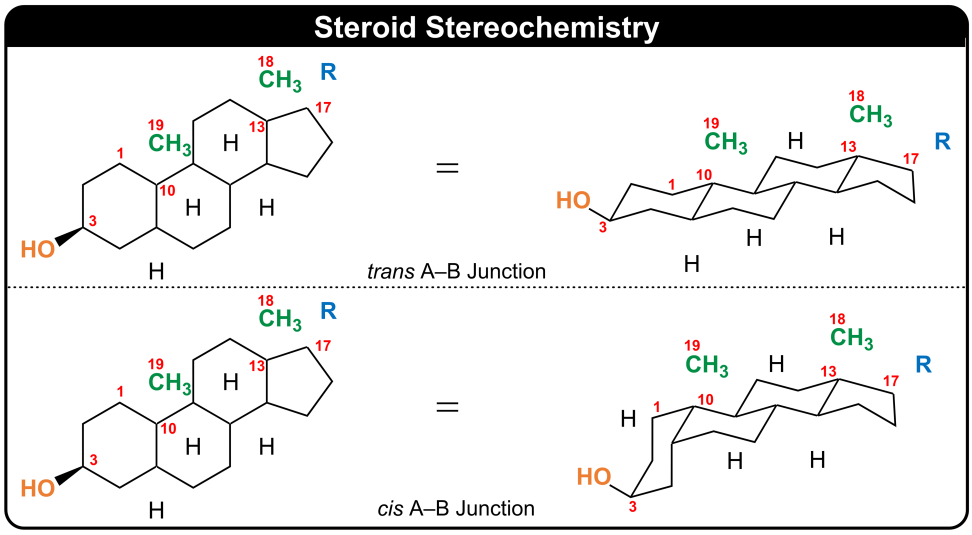
trans-decalin

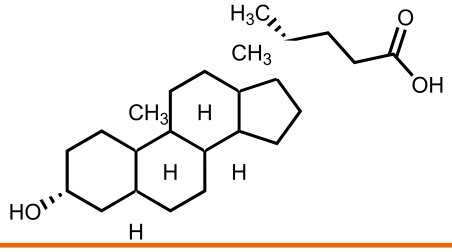
Steroid Stereochemistry

- Steroids have some characteristic stereochemical features.
  - □ **A–B** ring junction is usually _____.
  - □ **B–C** and **C–D** are almost always _____.
  - □ **Angular Methyl Groups:** The two –CH_3 groups at C13 and C10 are β (____) and _____.
  - □ C3 –OH group (if present) can be α or β.
  - □ C17 alkyl side chain (if present) is β (____) and _____.



- All ring junctions in cholesterol have _____ configuration.
  - □ The rigidity of cholesterol helps maintain the _____ of the cellular membranes.

EXAMPLE: Based on the general stereochemical characteristics of steroids, complete the following structure. (Hint: The A-B ring junction is *cis*.)



CONCEPT: STEROIDS

Drawing Steroids

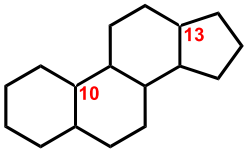
● Drawing a steroid requires knowledge of _____ stereochemical features along with given information.

EXAMPLE: Draw the structure of testosterone using the information given below:

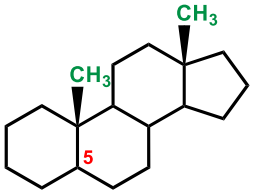
1) A carbonyl group at C3, 2) a double bond between C4 and C5, and 3) a *β*-hydroxyl group at C17.

Step 1: Start by drawing the steroid skeleton (___ cyclohexane rings and __ cyclopentane ring) and number all carbons.

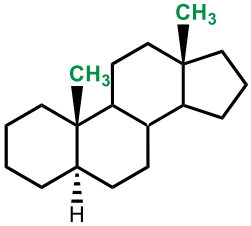
Step 2: Draw the two **–CH_3** groups at C13 and C10 using wedges (___ configuration).



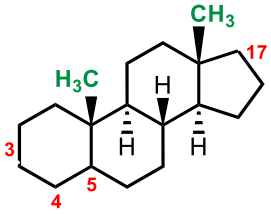
Step 3: Draw the C5 H using dashes (*trans* A–B junction), unless otherwise stated.



Step 4: Move right from C10 **–CH_3** group (↑) and draw H atoms on the junctions as *α* (___), *β* (___), *α* (___).



Step 5: Fill in all of the given information to complete the structure.



CONCEPT: STEROIDS

PRACTICE: Which one of the structures given below fulfills the given criteria?

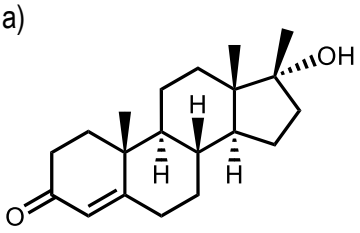
1) Ketone at C3

2) Double bond between C4 and C5.

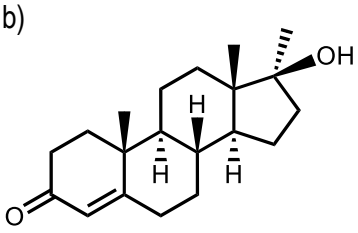
3) An –OH group at C17 in β configuration

4) A $-CH_3$ group at C17 in α configuration.

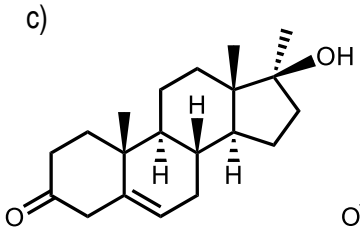
a)



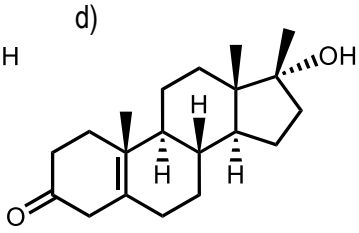
b)



c)



d)



PRACTICE: Draw the structure of metenolone from the information given below:

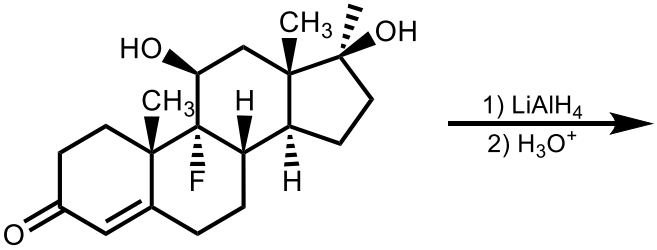
1) A $-CH_3$ group at C1

2) A double bond between C1 and C2

3) A ketone at C3

4) An acetate group at C17 in β configuration.

PRACTICE: Draw the structure of the product formed when fluoxymesterone undergoes reduction with $LiAlH_4$.



CONCEPT: STEROIDS

Steroid Hormones

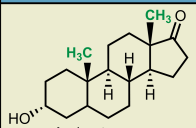
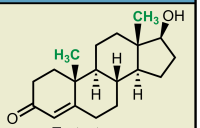
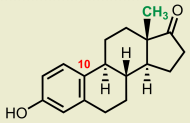
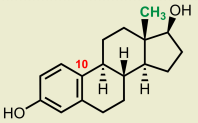
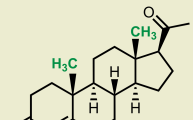
● **Hormones:** Chemical _____ that help one part of a body communicate with the other.

□ Can be broadly classified into _____ groups: 1) Sex hormones 2) Adrenocortical hormones.

1) Sex Hormones: control sexual characteristics and regulate _____ growth.

- **Male Sex Hormones:** _____ogens - **Female Sex Hormones:** _____ogens and Progestins

Sex Hormones

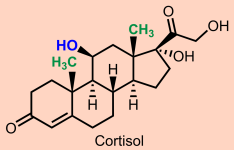
Hormone	Produced in	Function	Example
Androgens	● Testes	● Control sexual development in _____. ● Control muscle growth.	 Androsterone  Testosterone
Estrogens	● Ovaries	● Control sexual development in _____.	 Estrone  Estradiol
Progestins	● Ovaries	● Control the menstrual cycle & _____ in females.	 Progesterone

● Estrogens are characterized by an aromatic ring **A** and a missing **–CH_3** group at _____.

MEMORY TOOL 1: _____ers h__ve aroma.

2) Adrenocortical Hormones: Regulate a wide range of physiological functions.

Adrenocortical Steroids

Hormone	Produced in	Function	Example
Glucocorticoids	● Adrenal glands	● Regulate _____ metabolism. ● Reduce _____.	 Cortisol
Mineralocorticoids	● Adrenal glands	● Regulate the balance of ____ and ____ ions in cells and body fluids.	 Aldosterone

● All adrenocortical steroids have an **–OH** group at _____.

MEMORY TOOL 2: ____iana _____ates 11 times.

CONCEPT: STEROIDS

EXAMPLE: Which one of the following statements is correct about steroid hormones?

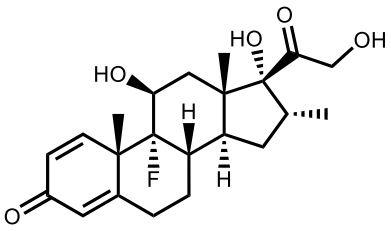
a) Testosterone molecule does not have the C19 methyl group.

b) All adrenocortical hormones have an –OH group at C10.

c) The methyl group at C10 is not present in estrogens due to the aromatic ring A.

d) The ring A in progesterone is aromatic like estrone.

PRACTICE: Classify dexamethasone into one of the steroid hormone classes.



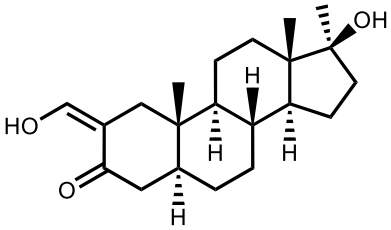
a) Androgen

b) Estrogen

c) Progestin

d) Adrenocortical hormone

PRACTICE: Oxymetholone is used to treat anemia and to promote weight gain and muscle growth. Based on this information, classify oxymetholone into one of the three classes of sex hormones.



a) Androgens

b) Estrogens

c) Progestins