PLUTUS IAS
UPSC/ PCS

Zoology optional

Development Biology

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Total Marks: 50 **Date: 07-Sep-2024**

Mains Answer Writing Guidance Programme	
Name	Shery Soren
Medium	English
Date	
Subject and Test Number	Zoology

Instructions:
1. Please scan your answers and form single pdf and share within 48 hours.
2. Writing in the margins leads to rejection of copy.
3. Kindly take due appointment with coordination team to discuss the answer copy with respective mentor.
4. Copies will be evaluated within 7 days of submission.

Evaluated	Reviewed

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Criteria/Parameters	Exellent	Very Good	Good	Average	Poor
Language and Articulation			✓		
Content and Conceptual Clarity			✓		
Number of Questions Attempted			✓		
Structure and Presentation				✓	
Coherence and Structuration			✓		

Examiner's Feedback

1) when write answer just try if there is need to Draw Diagram

→ Just Draw it.

1

Write in petri is three phases of oogenesis in females with the help of suitable diagram (15 Marks)

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The process of formation of mature ovum from oogonia in females is called oogenesis. It occurs in the outer-most layer of the ovaries. Oogenesis is initiated during the embryonic development stage and completes when the secondary oocyte is fertilised by sperm. In females this process ceases at menopause around 50 years of age because the ovaries no longer release ovum after menopause.

Oogenesis can be broadly classified into three stages:

(i) Embryonic development stage / Before birth

During this stage million of oogonia undergoes mitosis and forms primary oocyte. The primary oocyte further undergoes meiosis-I and get temporarily arrested at diplotene stage of prophase I. At this arrested time primary oocyte grows big in size. The primary ~~ooco~~ oocyte gets surrounded by a layer of follicular cells called primary follicles. A large number of these follicles gets degenerated during the phase from birth to puberty due to apoptosis. Therefore, at puberty only dominant primary follicles get surrounded by more layers of follicles.

(ii) Puberty

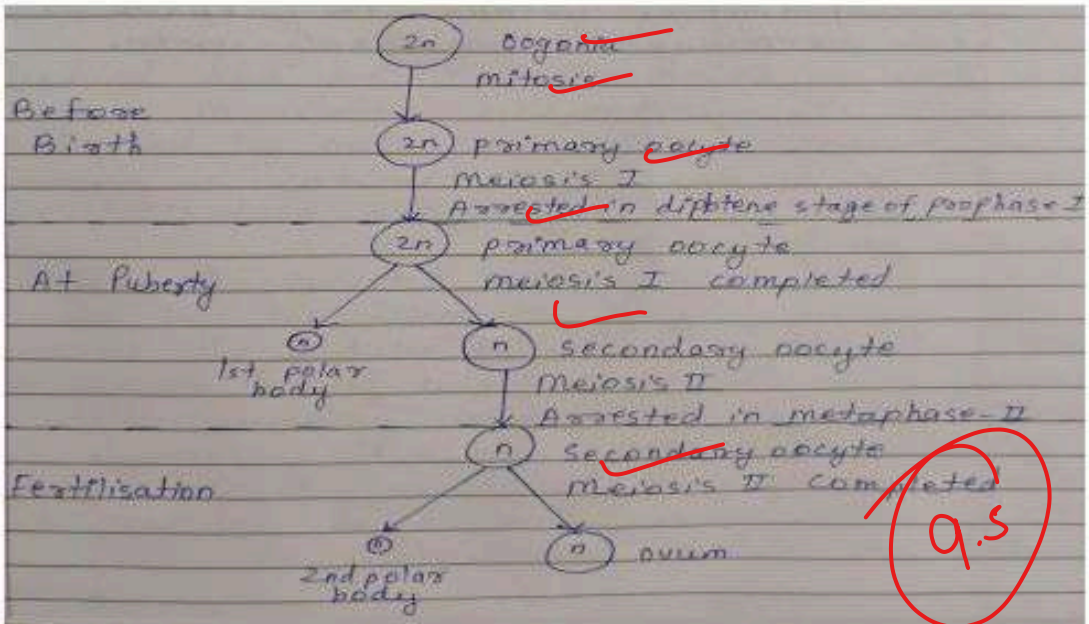
At puberty more layers of follicles is surrounded around primary oocyte called

as secondary follicle and theca is formed. Further, primary oocyte is surrounded by tertiary follicle and a fluid filled cavity antrum is formed. The theca layer is also organised into inner theca interna and outer theca externa. The tertiary follicle grows in size and becomes mature called as ~~graaff~~ graafian follicle. The primary oocyte within the graafian follicle completes its meiosis-I which results in an unequal division and leads to the formation of haploid secondary oocyte and tiny first polar body.

The secondary oocyte forms a new membrane called zona pellucida around it which undergoes meiosis-II and gets arrested at metaphase-II stage if fertilisation does not happen. The graafian follicle now ruptures to release secondary oocyte from the ovary by the process called ovulation.

(iii) Fertilisation

Oogenesis is completed by fertilisation when the secondary oocyte is fertilised by sperm. The arrested meiosis-II is also completed which results in the formation of ovum and second polar body.



9.5

During oogenesis many hormonal regulation occurs in female which is started at puberty.

Hormone	Site of production	Function
• Follicle Stimulating hormone (FSH)	Hypothalamus pituitary ovarian axis of anterior pituitary.	• Growth of immature oocytes into mature follicles. • Stimulates the release of estrogen.
• Luteinising hormone (LH)	Hypothalamus pituitary ovarian axis of anterior pituitary	• Controls the ovarian cycle by conversion of ruptured graafian follicle into corpus luteum and induces ovulation. • Stimulates the release of progesterone.
• Estrogen	Ovaries	• Growth of follicles. • Maintain ovulation
• Progesterone	Ovaries	• Prepare the uterine tissue for blastocyst implantation by the growth of uterine wall and blood vessels.

Also show the development of follicle Diagram.

Introduction	
Body	
Presentation/Structuration	
Conclusion	
Final Marks	

Q. No.

2

Explain the structure of placenta with the help of suitable diagram and also mention it's type.

(15 Marks)

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Placenta is the structural and functional unit jointly formed between foetus and maternal body. It is formed after implantation and develops in uterus during pregnancy. The embryo with 8 to 16 blastomeres morula continues to divide and transforms into blastocyst as it moves further in uterus. The blastocyst are arranged into outer layer trophoblast and inner group of cells attached to trophoblast called inner cell mass. The trophoblast gets implanted into endometrium of uterus and inner cell mass gets differentiated as the embryo and leads to pregnancy. After implantation, finger-like projection appear on trophoblast called chorionic villi are surrounded by uterine tissue and maternal blood which leads to the formation of placenta. The placenta develops gradually over the first three months of pregnancy and continues to grow alongside the uterus after that in the junction of posterior wall of foetus and body of uterus.

The placenta facilitate the supply of oxygen and nutrients to the foetus and also removal of carbon dioxide and waste materials produced by the foetus. The placenta is connected to the foetus by an umbilical cord which helps in the transport of substances to and from foetus. Plac-

enta also acts as an endocrine tissue and produces several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogen, progesterone, etc. hCG stimulates the corpus luteum to produce progesterone to maintain pregnancy. hPL regulates metabolism to make sure that foetus gets enough nutrients. It also prepares the body for breastfeeding. Estrogen helps the growth of uterus and maintains uterine lining.

Placenta can be classified into two categories:

(i) On the involvement of foetal part –
There are three types of placenta on this basis

- Chorionic placenta – Placenta formed from chorionic layer. e.g. Human.
- Chorio-allantoic placenta – Placenta formed from the allantois and chorionic layer. e.g. eutherian mammals.
- Yolk-sac placenta – Placenta formed from the yolk sac. e.g. Kangaroo

(ii) Fate of uterine wall –
There are three types of placenta on this basis

- Non-decidual placenta – No part of uterine tissue is shed during the time of delivery. e.g. Horse.
- Decidual placenta – Some part of uterine tissue is released as decidua. eg. Human.

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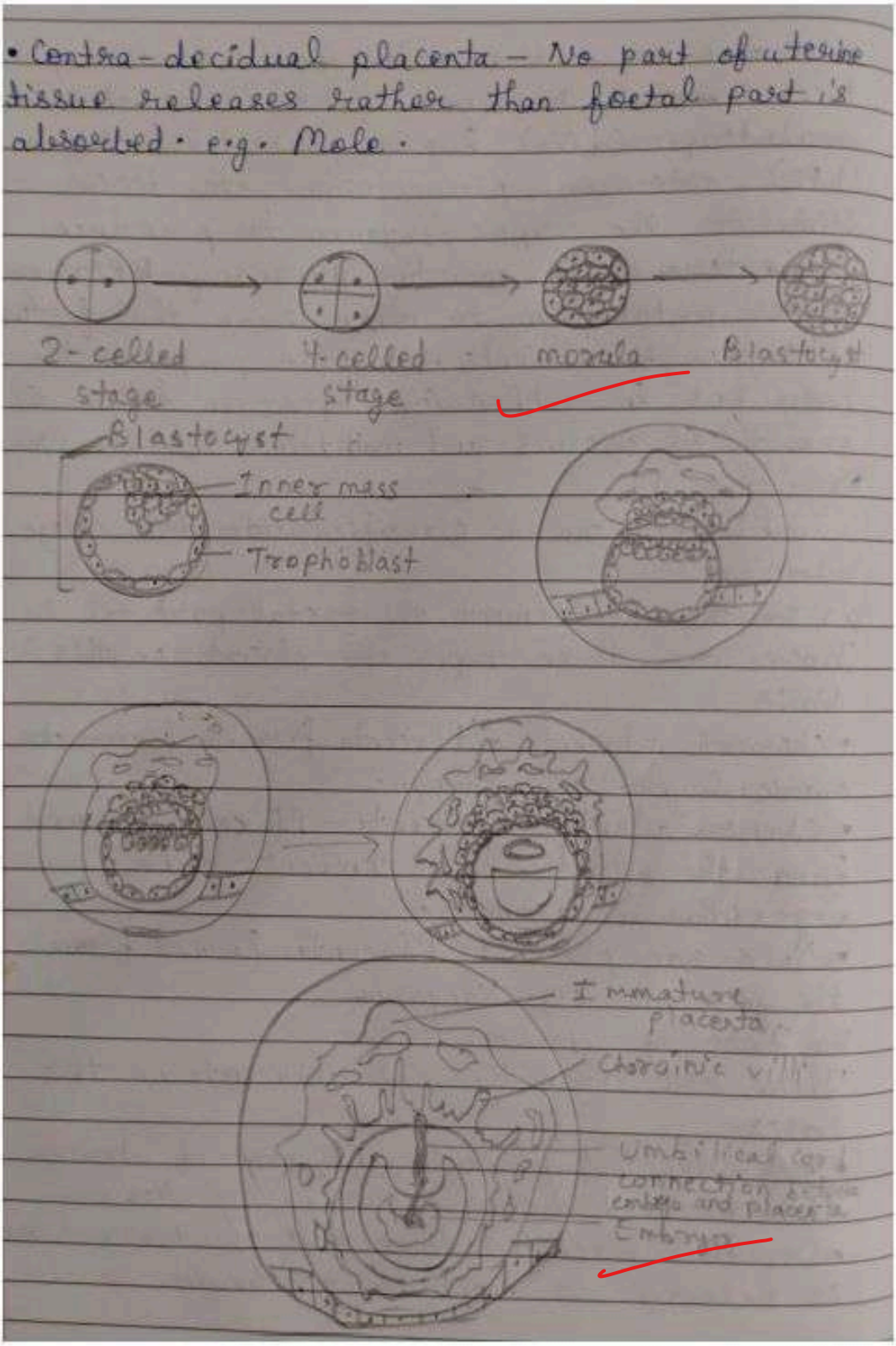
• Contra-decidual placenta – No part of uterine tissue releases rather than foetal part is absorbed. e.g. Mole.



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Q. No.

3

a) What is Homeotic gene & explain it's working mechanism

(10 Marks)

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Homeotic genes are a group of genes that regulate the development of anatomical structures in organisms like insects, mammals and plants. They are master regulatory gene.

Homeotic genes control the pattern of body formation during early embryonic development. They encode proteins called transcription factors that contains a region called hox gene and direct cells to form various parts of the body. Mutations in homeotic genes can cause displacement of body parts in organisms and this process is known as homeosis.

Examples

in Drosophila (fruit fly)

- Artennapedia gene — Responsible for 3 pairs of leg formation in thorax region but due to mutation legs are developed at different region. In gain of function mutation extra legs is developed in head. In loss of function mutation one pair of leg is displaced from thorax region and comes out from antennae sprout region.
- Ultrabithorax gene — Responsible for segmentation identities of abdomen by the formation of wings at mesothorax and halters at metathorax. In gain of function of mutation two pairs of wings and four halters are formed in meso and metathorax. In loss of function

5

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mutation this case only happens but due to absence of this gene in that area and this gene forms different part of organ at that area.

• Proboscipedia gene – Responsible for proper specification of adult mouth parts. Due to mutation the labial palp of mouth are transformed into legs.

(ii) Human

• Body polarity is formed by homeotic gene or by its product.

• Realistor gene controls the final organ development.

e.g. Myo D gene is responsible for muscle development.

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Detection of gene

3 b) How many Homeotic gene present in chick & their function. (10 Marks)

Number ?

4

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Transformation of egg into chick is highly complex process. This complexity development is controlled by different homeotic gene at different stages. There are total ten homeotic gene in chicken.

Some of them are listed below:

- OTX2 – They are expressed in primitive stalk and primitive node which forms the forebrain, midbrain and branchial arch.
- Goosecoid (GSC) – They are expressed in posterior blastoderm around Koller's sickle which forms neural plate and pre-chordal plate.
- VG1 and Wnt 8C – They help in gastrulation.
- Bone morphogenetic protein (BMP) – Ventral development of chick.
- Chicken 2 – Helps in proper neuralation.
- LAMA 3 – Helps in dermal differentiation.
- Transforming growth factor (TGF) – Development of epidermis.
- Thine-man – Heart development

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4 Explain the capacitation process of Mammalian sperm

(10 Marks)

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Capacitation is a series of biochemical and physiological changes that mammalian sperm undergo before fertilising the oocyte. It occurs in the uterus and oviducts after ejaculation of semen in female genital tract. Capacitated sperms show no morphological change but are more active. Completion of capacitation permits acrosome reaction to occur.

Initially capacitation is started by removal of decapacitation factors like cholesterol and inhibitory factors which prevents the release of acrosome enzyme from sperm and decrease its motility. When sperm comes in contact with fluid in female genital tract cholesterol and ~~f~~ inhibitory factors are washed away. The uterine cavity increase the permeability of calcium due to which mobility of sperm increases and also weakens the membrane of acrosome. After capacitation of sperm there is loosening of membrane, increase motility of sperm and release of enzyme from acrosome which results in acrosome reaction. This reaction is between the acrosome of sperm and receptor of zona pellucida of ovum. Various enzymes are responsible for this reaction like hyaluronidase that depolymerise hyaluronic acid that hold the granulosa cells together in an ovum, proteolytic enzyme digest proteins in structural

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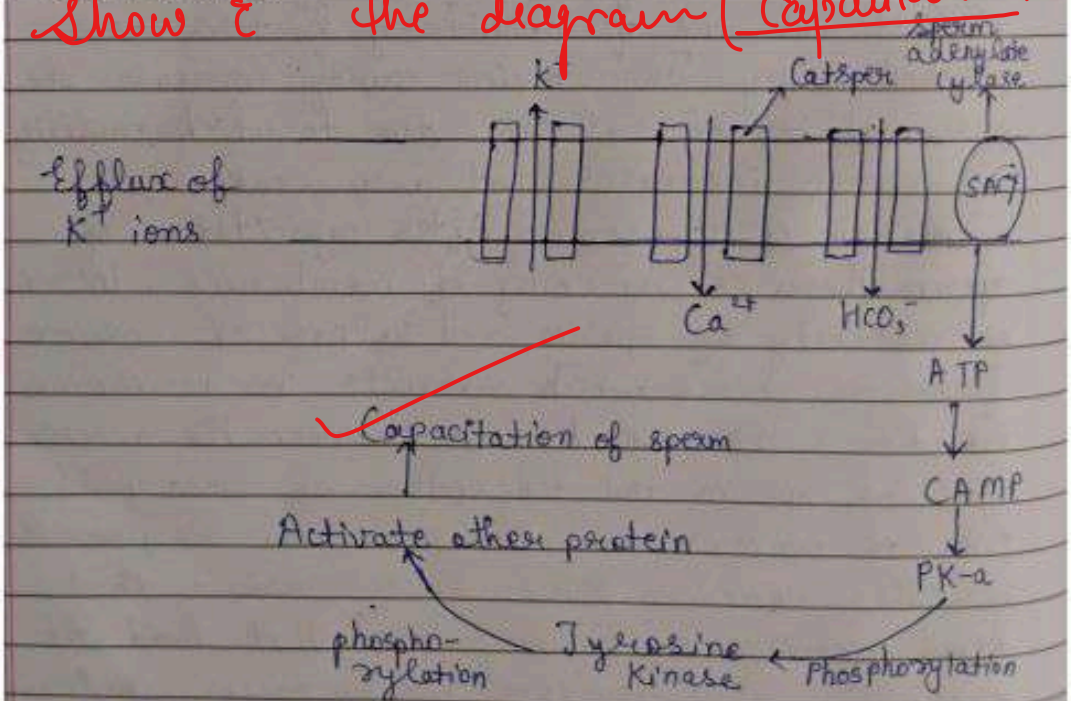
element of tissue cell adhere to ovum, corona penetrating enzyme helps the sperm penetrate inside ovum, acrosin forms the penetrating path-way in zona pellucida. There is increase of calcium inside the cell. Further cortical reaction occurs to prevent the further entry of sperm after the entry of one sperm. In this reaction calcium fuses with cortical granules and alters the nature of zona pellucida due to which lysosome is stimulated and cortical granules is released by exocytosis. This prevents the entry of other sperm as it get shocked after the entry of first sperm by depolarisation.

4.5

Show the diagram (capacitation)



Molecular basis of sperm capacitation

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Final Marks	