Module name	**Developmental biology**
Module code	B-BM.074Eng
ISCED code	0511: Biology *(zostaje bez zmiany)*
Study cycle	*I°*
Semester	winter
Responsible for this module	Imię i Nazwisko dr hab. Monika Hułas-Stasiak Department: Functional Anatomy and Cytobiology email: monika.hulas-stasiak@poczta.umcs.lublin.pl
Language of instruction	English
Website	
Prerequisites	Knowledge of zoology, anatomy and physiology of a high school program
ECTS	2
ECTS points hour equivalents	Contact hours (work with an academic teacher) – 30 - lectures: 15 - labs: 15 Non-contact hours (students' own work): 25 - preparation for the exam: 15 - preparation for labs: 10 **Total number of ECTS points for the module - 2**
Learning outcomes verification methods	Laboratory: written partial tests oral presentation /activity during classes Lecture: final test participation in lectures
Course full description	**Lectures:** 1. Types and importance of animal reproduction (asexual and sexual reproduction). Sexual reproduction. Sexual selection. 2.The female and male reproductive system. Gametogenesis (oogenesis, spermatogenesis). 3. Hormonal regulation of the reproductive system (hypothalamic-pituitary-gonadal axis). 4. the first steps of embryo development: fertilization, cleavage, and gastrulation in various systematic groups (amphibians, birds, mammals). 5.The main mechanisms of embryonic development during gastrulation (germ layers: ectoderm, mesoderm, endoderm) and development of the primary organs. 6. Adaptation to embryonic life (transitional organs). 7. Morphogenetic processes in the later stages of ontogenesis. 8. In vitro fertilization and cloning. 9. Development of monozygotic twins **Laboratory:** 1. Female reproductive system 1 A. Ovary (structure, function) 1b. germ cells (origin, migration and colonization of genital ridge) 1c. oogenesis (mitosis, meiosis, oogonium, primary and secondary oocytes, ootid, polar bodies) 1d. ovary differentiation (gonadal/genital ridge consists of: coelomic epithelium, mesenchyme and primordial germ cells; primitive sex cords, secondary sex cords, egg nests, egg nest breakdown, medulla, cortex, type of follicles: primordial, primary, secondary, antral, preovulatory-Graafian follicle)

	1e. the structure of Graafian follicle: secondary oocyte, zona pellucida, granulosa layer (estogen production), basement membrane, theca layer (externa, interna-steroidogenic cells (androgen production), corona radiata, cumulus oophorus, antrum. Two gonadotrophins and two cells theory. 1f. Atresia (follicular atresia, atretic follicles, apoptosis, fragmentation and lysis of oocyte, detachment of granulosa layer from basement membrane, loss of granulosa cell junctions Massive loss of oocyte during prenatal and postnatal female life. Recruitment, selection and dominance 1g. Ovulation (spontaneous, induced) 1h. corpus luteum (CL) formation, structure, function, and luteolysis 1B. Fallopian tube (uterine tube) – structure (simple columnar and ciliated epithelium, mucosal layer, muscularis layer and serosa), function, origin (mesonephros, mesonephric duct (Wolffian), paramesonephric duct (Müllerian) 1C. Uterus – structure (morphological and histological, 3 layers- endometrium, myometrium and perimetrium, uterine glands, functonalis and basalis layers of endometrium) 1D. Menstrual cycle (proliferative phase, ovulation, luteal phase, menstruation), key hormones: FSH, LH, estrogens, progesterone (hormonal regulation of reproductive system- hypothalamus-pituitary-gonadal axis) 1E. Vagina (structure – stratified squamous epithelium, function), external genitalia (-only mention) 1F. Estrus cycle (proestrus, estrus, metestrus, diestrus, anestrus, the pattern of vaginal smears) – differences between menstrual and estrus cycle 1G. polyestrous, seasonally polyestrous (longer/shorter day breeders, diestrus, monoestrus animals, delayed fertilization and implantation. 2. Male reproductive system 2A. Testis (structure and function) 2b. Testis descent, cryptorchidism 2c. Testis lobules, seminiferous tubules 2d. The structure of seminiferous tubule (basement membrane, germ cells (spermatogonium, spermatocytes I, II, spermatids, spermatozoa, Sertoli cells) 2e. spermatogenesis (meiosis, spermatogonia Ad, Ap and B, spermatocytes I,II, spermatids, spermatozoa) 2f. spermiogenesis (spermatid – mature spermatozoa transformation) and spermatozoon structure (head, acrosomal cap, neck, middle piece, tail -flagellum) 2g. differences between oogenesis and spermatogenesis 2h. Sertoli and interstitial (Leydig) cells function 2i. testis differentiation (in fetus, SRY gen on Y chromosome- sex determination, TDF-testis determining factor, MIF- Müllerian inhibiting factor or anti-Müllerian hormone, Wolffian duct) 2j. Pathway of spermatozoa - Straight tubules - Rete testis

	- Efferent ductules - Epididymis (structure- stereocilia, sperm maturation) - Vas deferens (structure, function) - Ejaculatory duct - Urethra 2k. Accessory organs (structure and function) Seminal vesicles Prostate gland Bulbourethral glands Penis 2l. Hormonal regulation of the male reproductive system 3. Capacitation (Spermatozoa undergo the physiological changes to have the ability to fertilize an ovum). 4. Fertilization (acrosomal reaction, cortical reaction, polysperm block, fusion of male and female pronuclei - zygote) 5. Types of ova (alecithal, oligolecithal, mesolecithal, polylecithal, isolecithal and telolecithal, what is the yolk?) 6. Eggs or zygote polarity (animal, vegetal poles) 7. Cleavage (types, characteristic features, furrows: vertical, horizontal) 8. Blastula (structure, types: coeloblastula, discoblastula, stereoblastula, periblastula, blastocyst) 9. Gastrulation (definition, germ layers: ectoderm, mesoderm, endoderm, types of cell movement - invagination, involution, ingression, delamination, epiboly) 10. ecto, meso and endoderm differentiation into tissue 11. Zygotic induction or cytoplasmic inheritance as determinant of animal germ line 12. Embryonic induction (totipotent, pluripotent, multipotent stem cells, cell differentiation – gene activation and inhibition –acetylation, metylation) 13. Amphibian development - external or internal fertilization - frog egg organisation (animal, vegetal poles, cortex cytoplasm- dark, light and internal cytoplasm- grey, grey crescent - cleavage (holoblastic- complete cleavage, micromeres, macromeres) - structure of blastula (blastocoel, blastoderm) - gastrulation (blastopore, germ layers: ectoderm, mesoderm (grey crescent), endoderm), fate map of a frog embryo, way of gastrulation, gastrulation in detail (bottle cells, prechordal plate, chordamesoderm cells, notochord, ectoderm, endoderm, archenteron) - neurulation (neurula, ectoderm differentiation into: neural tube (in future brain and spinal cord), neural crest and epidermis) - mesoderm differentiation (paraxial mesoderm-somites, intermediate mesoderm- nephrotomes (gonads and urinary system), lateral mesoderm- splanchnic and somatic or vesceral and parietal mesoderm - organogenesis (primitive organs: notochord, neural tube, gut) - derivatives of germ layers 14. Bird development

	- chicken reproductive system - anatomy of an egg (polylecithal, telolecithal egg) - cleavage (meroblstic, discoidal, area pellucida, area opaca, blastodisc, blastoderm, epiblast, hipoblast, blastocoel, subgerminal space, Koller's sickle region) - gastrulation (primitive streak, primitive knot=Hensen's node, gastrulation in detail, germ cell layers, intraembrionic mesoderm, extraembrionic mesoderm) - ectoderm, mesoderm, endoderm differentiation (see amphibian development) - extraembrionic tissue (chorion, amnion, allantois, and yolk sac, function) - blood circulation in chicken embryo (three systems: vitelline- yolk sac, allantois and chicken circulation) 15. Mammals development -cleavage – the unique nature of mammalian cleavage - embryo compaction and cavitation (outer and inner cells) - blastula=blastocyst (embryoblast and trophoblast, blastocoel) - implantation (definition, phases) - placenta (trophoblast differentiation: syncytiotrophoblast, cytotrophoblast; placental formation, trophoblastic lacunae, primary, secondary and tertiary chorionic villi) - placenta structure and functions -umbilical cord - classification of placental types - gastrulation (germ disc, epiblast, hipoblast, primitive streak – see chicken development, amnioblast, amniotic cavity) - germ layer (ectoderm, mesoderm, endoderm differentiation – see amphibian development) - extraembryonic tissue, (chorion, amnion, allantois, and yolk sac, differences between chicken and human)
Bibliography	1. Sadler TW (2006) Langman's Medical Embryology, 10th edition. Wolters Kluwer/Lippincott Williams and Wilkins Company 2. Gilbert SF (2010) Developmental biology, 9th edition. Sinauer Associates.
Learning outcomes	**KNOWLEDGE** **Student:** 1. Understands the importance of sexual reproduction for biodiversity and evolutionary variability of organisms 2. Knows and understands the various stages of animal development - gametogenesis, fertilization, embryogenesis, organogenesis 3. Knows the mechanisms of reproduction, embryonic and fetal animal development **SKILLS** 1. Has an ability to use the light microscope 2. Exhibits understanding of recommended academic textbooks 3. Has an ability to prepare an oral presentation on specific developmental biology issues 4. Uses biological terminology in scientific discussions 5. Can make a proper selection of data sources, conduct a critical analysis, evaluation and synthesis of

	information to solve problems and perform specific tasks **SOCIAL COMPETENCES** 1. Adopts an active attitude towards acquisition, extension, and updating the acquired knowledge 2. Is ready to perform occupational roles responsibly, e.g. to comply with the principles of professional ethics and require such compliance from other team members
Practice	----------
Teaching methods	-Hybrid teaching -stationary teaching - on-line teaching (Teams platform, Virtual Campus) 1. microscopic observations, 2. demonstration of anatomical models, organs, amphibian eggs and placenta 3. didactic discussion 4. explanation 5. multimedia presentation, 6. worksheets