ZOOLOGY

BY RAY KUEFLER.

MAY 13-1941

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.THE END.

Name_____ Date_____

Forward!

Due to my disagreements with Instructor William Goldsmith and to the inadequate grading system which he uses, I have not applied myself this semester. Although my ranking at the end of last term was one of the best in the class, my grade of B was not altered, mainly because the Instructor was too busy to be disturbed by anything as insignificant, so incon-sequential as a student, me.

Grades should be given as an indication of work submitted, and the techniques applied in comparison with that of all the other members of the class. Your grade should be a definite incentive to study & to do as well as possible in a course.

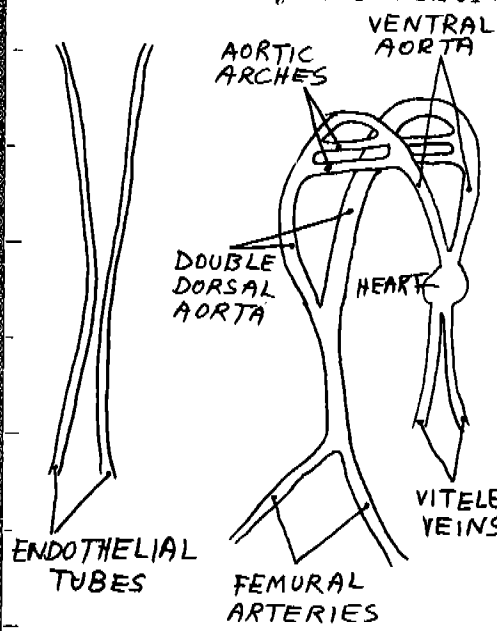
I feel that I am capable ~~or capable~~ of a better calibre of work but the grade which I may expect from Dr. Goldsmith is indicative to what I can get if I do not study, so.....

Ray Knepler

Name RAY KUEFLER. Date ONE

Lecture Notes:

Elimentary Circulation:



Tube forms on each side of animal and fuses to form the heart. It branches to run over the place where the shoulders of a human would be and there it forms the Aortic Arches. It comes together again on the back and branches again to form the Femural Arteries. See illustration for scientific names.

The Endothelial tubes are formed when the chick reaches 32 hour stage during incubation.

Oviporous-ova, an animal which rears its young from the egg.

Viviporous-live, an animal which rears its young through direct breeding and the young are born alive.

Blastoderm-absorbs food from the yolk.

Placenta-absorbs food from the blood of the mother by osmosis.

It is quite easy from the divitioulum and the budding of the different organs in the early organizms to see how "Ontogeny Recapitulates Phylogeny". All the systems are formed the same. Enlarging of a tube and the budding of that tube cause the formation of each and every one of our internal organs. The digestive system of a dog-fish shark is nothing more than a bunch of funnels, one in the other; this is explained by the fact that they take up less space and they have a greater absorbing surface.

Note:

DIGESTIVE CIRCULATION OF DOG-FISH SHARK.

Name RAY KUEFLER Date TWO.

Lecture Notes!

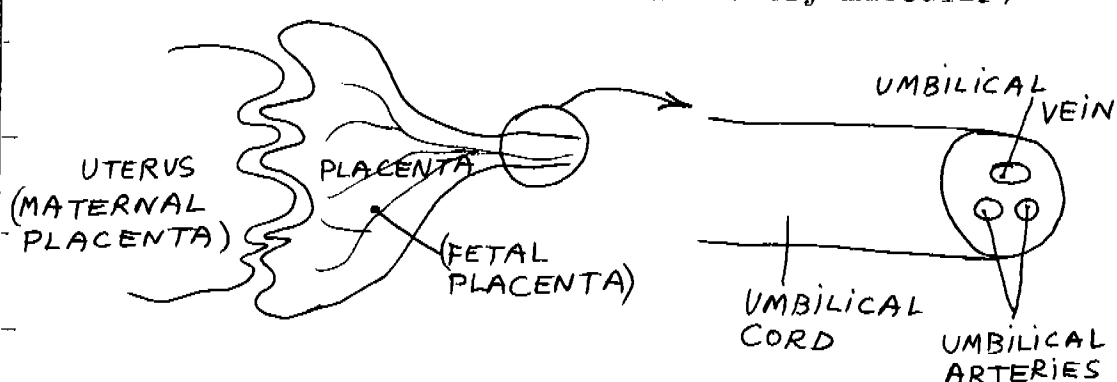
Know the Meaning of:

1. Placenta
2. Tubal Pregnancy
3. Uterus
4. Umbilical Cord
5. Amnionic Sac
6. Amnionic Fluid
7. Umbilical Arteries
8. Umbilical Vein
9. Chorionic or Fetal Villi

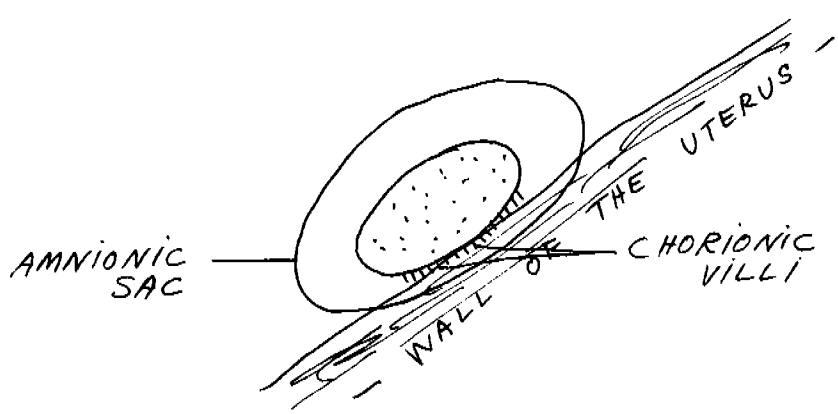
I. Human before birth
II. Sleep
III. Page 406-410 Hegners
IV. 1st ½ stem-root words

Part One.

5. Sac which encloses embryo before birth.
6. Sac includes viscous fluid known as (6).
1. Plate attached to the uterus (very muscular)



1. Vein conducts blood to liver.
2. Arteries get blood from iliacs of child.



Name RAY KUEFLER Date THREE

Lecture Notes!

Page 406 in Hegners.

Cell Theory-Schliden and Schwan.
Robert Holk also.

Morphology -Ideas based on basic principles and Structures.

Physiology -Fundementals based on functions of Physiological theories.

Cell Division-Prophase, metaphase, anaphase, telaphase.

Origin of Metazoa-Forms of animals over Protozoa.

Symmetry -Homogenius mixture
Bilaterally symmetrical.

Homology -Directly Corresponding.

Germ Layers -ecto, endo and mesoderm.
(hair)(blood) (intestines)

The Coelom -Body cavity of Embryo.

Organology -Science of Organs

Spontaneous Generation-insects and development in dew. Dead tissue and Maggots.

Sexual Reproduction-

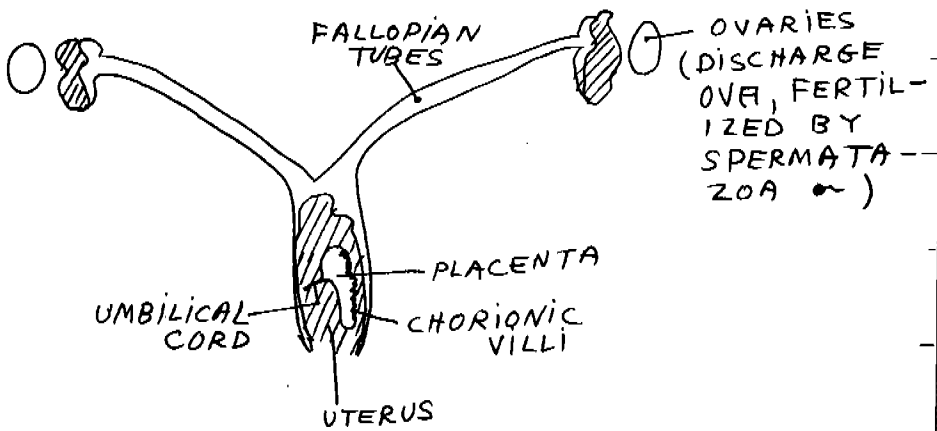
Name RAY KUEFLER. Date FOUR.

Lecture Notes!

Part Two.

Is Tubal Pregnancy a serious condition in life of mother and child.

No. The fertilized eggs are supposed to be implanted in the Fallopian tubes and therefore the condition is one of congruent pregnancy and not a dangerous one.

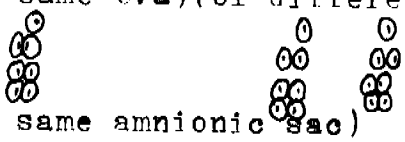


IMPLANTATION may occur in one of four places.
1. On the Body Wall
2. On the Ovary Wall
3. In the Fallopian Tubes (lower animals)
4. In the Uterus (human)

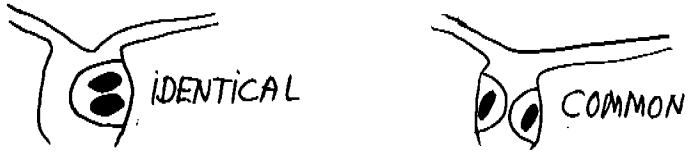
When Menstruation stops is that an indication of Pregnancy?

No. Disease contributes the same symptoms.

IDENTICAL AND COMMON TWINS.
(of same ova)(of different ova)



(in same amnionic sac) (in different amnionic sac)



External genitals prominent in three months.

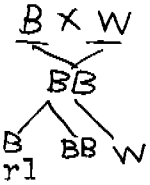
Name RAY KUEFLER. Date FIVE.

Lecture Notes!

1. Darwins theory of Pangenesis.

2. Weissman- Continuity of Germ Cell.

3. Castle (chicken)



Ray Pearl

Professor of Biostastics at the University of Minnesota he plotted the statistics on the world population. In the last ten years the United States gained 7% in population and in the 10 years prior to that some 20% more. Each decade population increase has decreased. In 1970 according to his calculations158 thousand (population) and at this time the race senescence will occur.

Hegners Page 411-416.

Report by Paul Ukena.
Library Material- March Issues.

American Scholar	American Naturalist
Blackwoods Magazine	Hygea
Journal of Heredity	National Geographic
The Nature Magazine	The Outdoorsman
Scientific American	Scientific Monthly
Yale Review	

Lamprey Eel.

The lamprey eel is a direct cousin to the Hagfish. It has a suction mouth and on the end of its tongue it has a row of teeth. These teeth are used to rip and lacerate the flesh of a host after theattachment has been made.

Digestive tract.

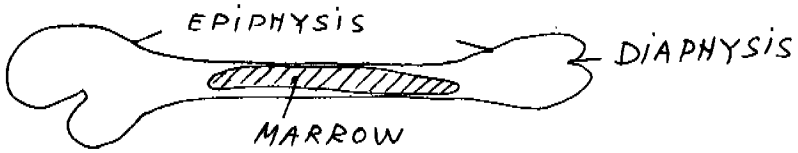
Food passes from the mouth to the buccal cavity. It has a Typhlosole digestive tract. It may be used as food although it is almost extinct now. Preserve-dry salt.

Reproduction very primitive.

Name RAY KUEFLER Date SIX.

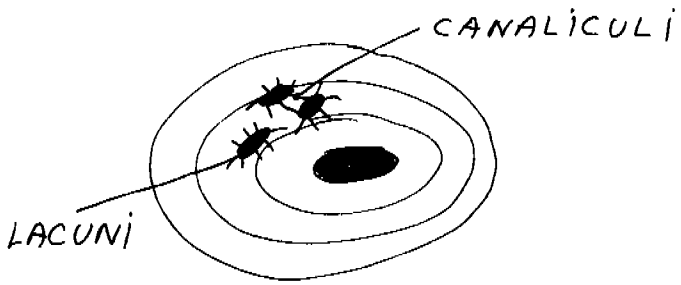
Lecture Notes!

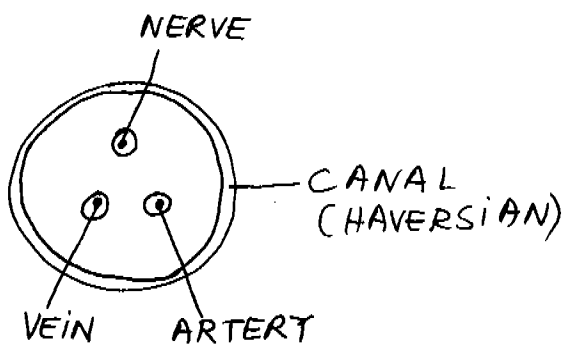
Bone Structure.



Occification similar to ice freezing.

Haversian system is system of blood circulation made up of haversian canal and:





C. AMPHIOXUS LANCEOLATUS

Phylum, Chordata: Subphylum, (Cephalochorda)

1. Study of the Whole Mount*-Place a specimen in a watch glass and examine with a hand lens and the low power of a microscope. If attainable, also study permanently prepared whole mounts.

The body wall of the amphioxus is divided into V-shaped muscle segments called myotomes, which are separated by thin partitions of the connective tissue, called myocommata. The myotomes on one side alternate with those on the other side. Count the myotomes. A cartilaginous, rod-like structure, the notochord (thus the name chordata) aids the myotomes in giving a certain amount of ridity to the body.

Note the elongated lance-like shape, (thus the name lanceolatus) especially of the posterior end. A primitive fin-like fold is practically continuous around the entire fish-like animal. Along the mid-dorsal line, this fold is called the dorsal fin. This broadens to form a lance in the region of the tail, where it is called the caudal fin. This same structure on the ventral side is divided by a gap which marks the atriopore. That part posterior to the atriopore, and anterior to the caudal fin, is the ventral fin, while anterior to this opening, the ventral structure is divided into two folds, matepleural folds, along either edge of the body wall.

The nondifferentiated head is marked by the presence of a comparatively large oral vestibule or hood, which is surrounded by oral cirri or buccal tentacles, which aid in the collection of food.

Since the amphioxus has no distinct stomach, the large sac-like pharynx which contains gills or gill-bars, separated by branchial clefts, along its sides, becomes continuous with the long tube-like intestine, which leads directly to the anus on the left side of the caudal fin. The liver is little more than a ventral anlage of the intestine.

As in the case of molgula, the pharynx is surrounded by the atrial chamber through which water passes to the atriopore. The notochord lies dorsal to the pharyngeal chamber, and extends the entire length of the animal. The dorsal nerve cord runs along the dorsal surface of the notochord. The anterior end of the nerve cord is slightly enlarged and is called the brain, on which may be located the olfactory pit and eye spot.

In certain mature specimens the paired gonads may be seen metamerically arranged along the ventral side. Count them, and note the graduation in size. In amphioxus the sexes are separate The gonads are found projecting into the atrial cavity. The germ cells are discharged into this cavity and reach the exterior by means of the atriopore.

EXERCISE III. Make a drawing 4 to 6 inches long, showing the entire animal as observed. Locate and label all parts studied.

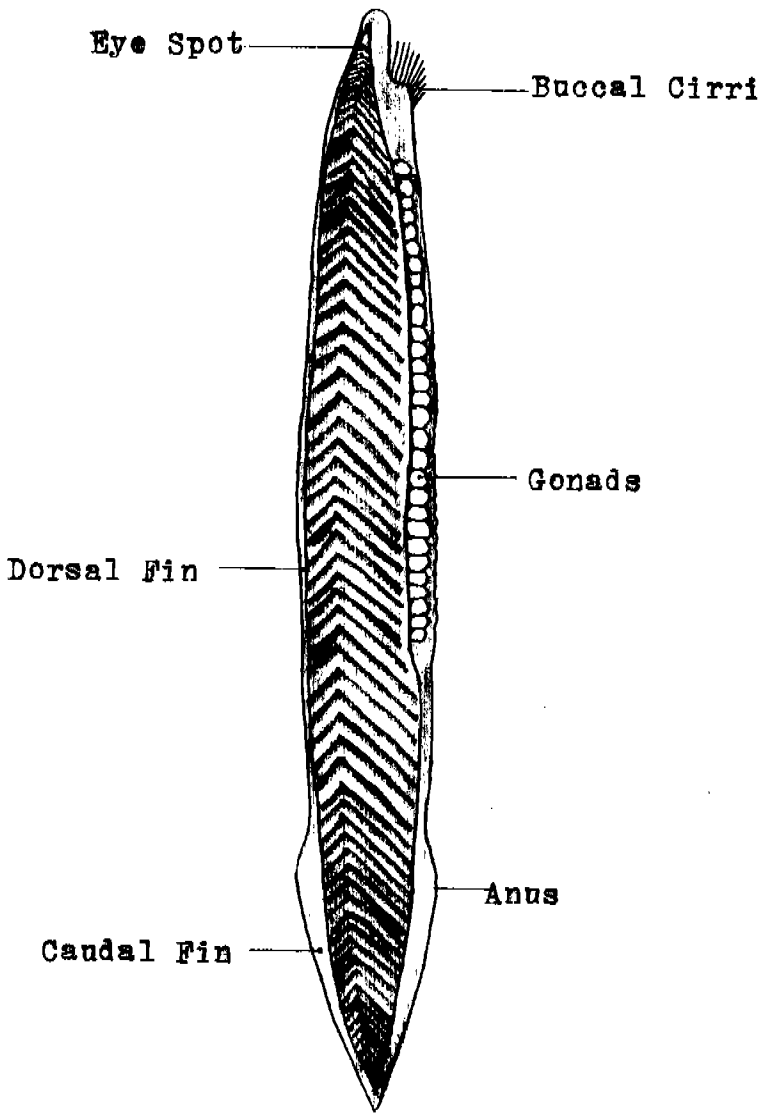
2. Cross-Section through the Pharyngeal Region of the Amphioxus--If the student has a clear conception of the general structure of the amphioxus, he should have no difficulty in identifying the following structures from the cross-section: Dorsal fin (note fin rays); Body wall: myotomes, (muscles); neural tube, (spinal nerve cord); notochord; pharynx; gonads; liver; atrial cavity; and the metapleural folds containing lymph sacs.

Certain sections may show dorsal and ventral roots of the spinal nerves, branching off from the spinal cord. The noticeable grooves in the dorsal and ventral angles of the pharynx are the hyper-pharyngeal (epibranchial), and the hypopharyngeal grooves (endostyle) respectively. On either side of the hyperpharyngeal groove may be seen a dorsal aorta. The amphioxus has no heart. The single ventral aorta is located,in the subendostyler coelom, beneath endos.

Name_____ Date_____

8

Amphioxus!

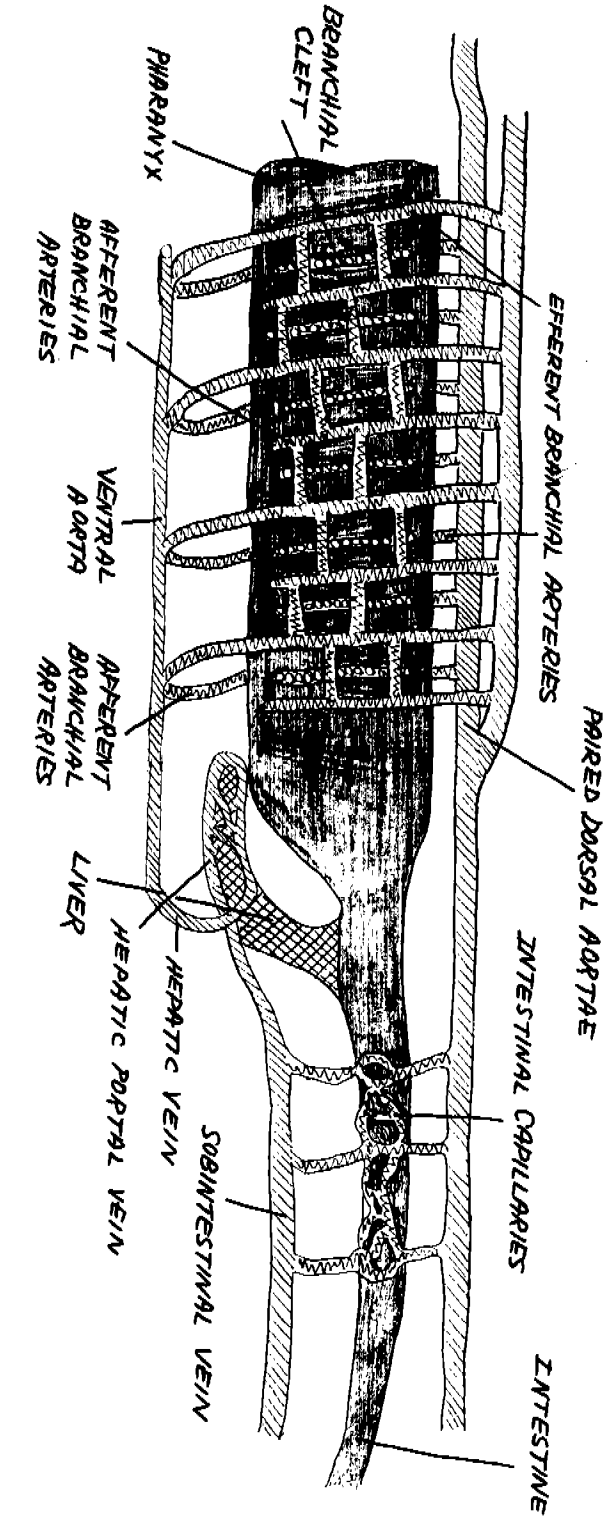


LAB. SPECIMAN

10

Name_____ Date_____

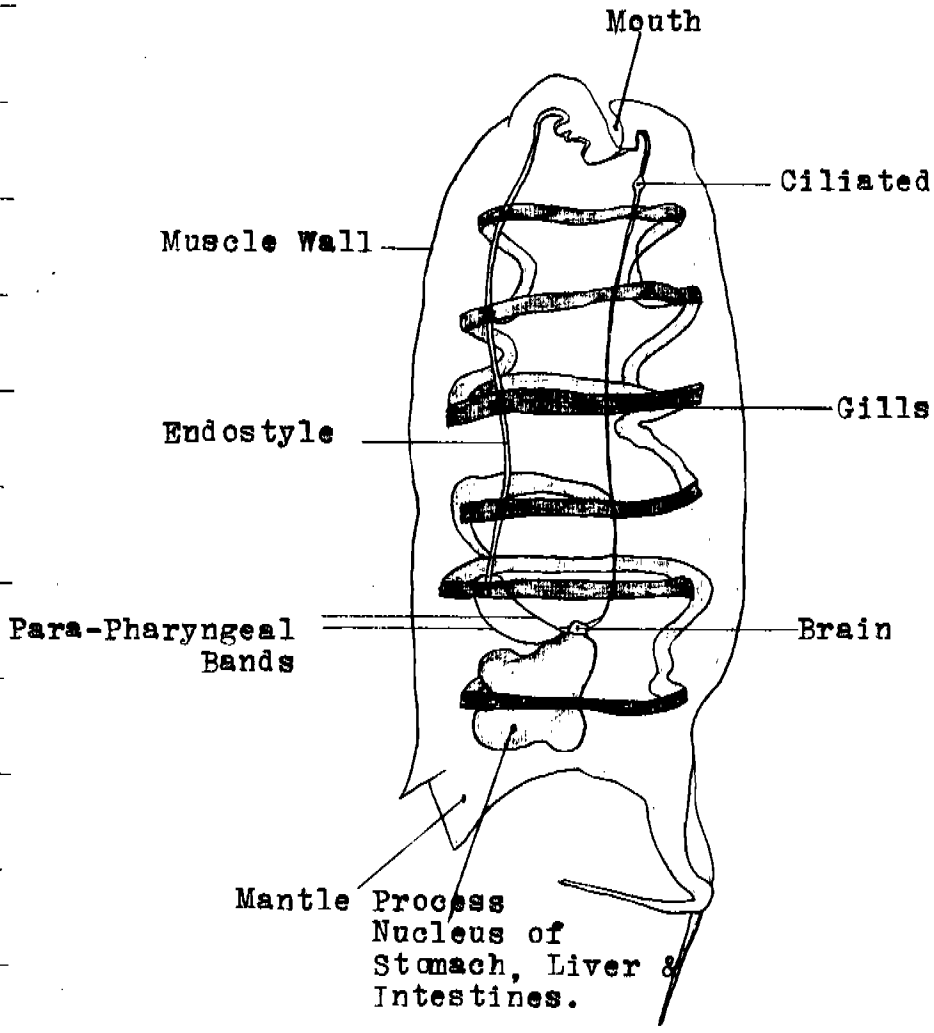
VASCULAR SYSTEM OF AMPHIOXUS



Name_____ Date_____

B

The Salpa!



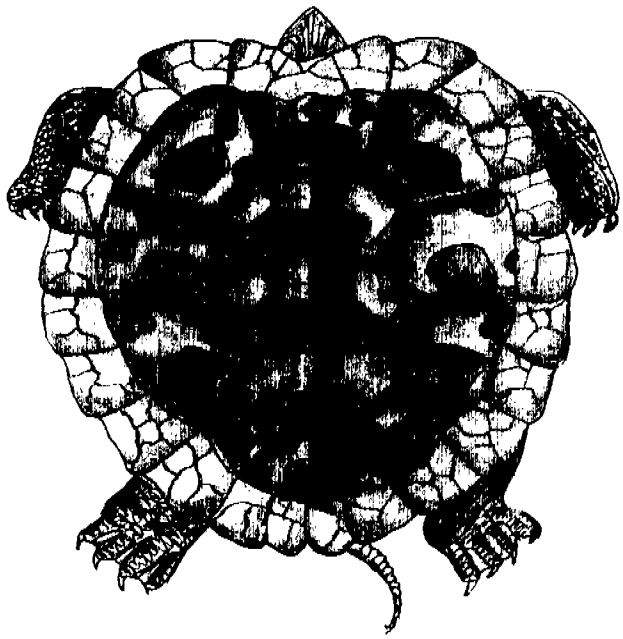
LAB. SPECIMAN

L.C.

Name_____ Date_____

B+

PAINTED TERRAPIN



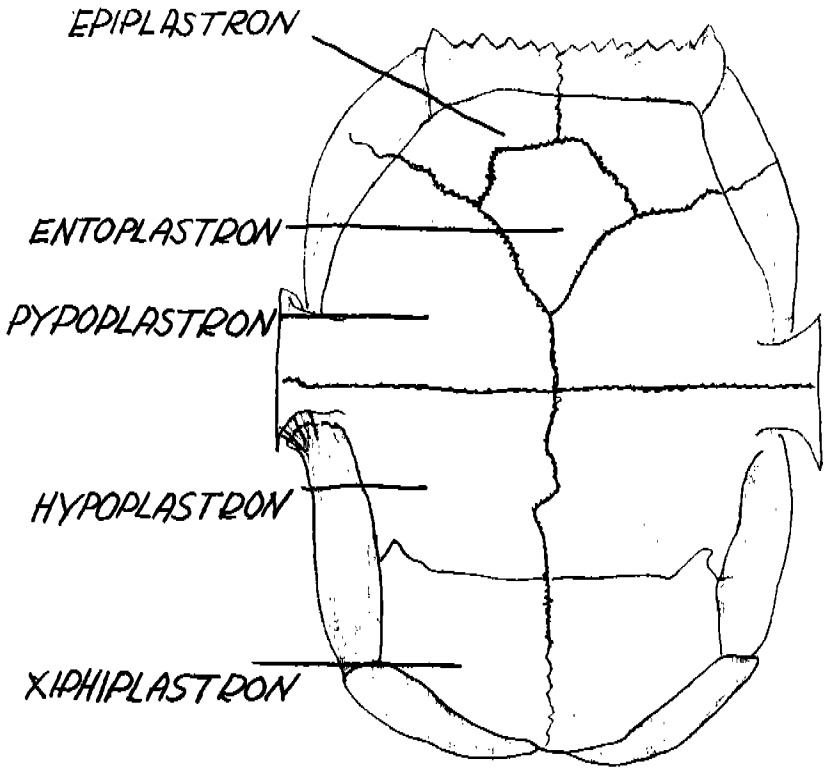
LAB. SPECIMAN

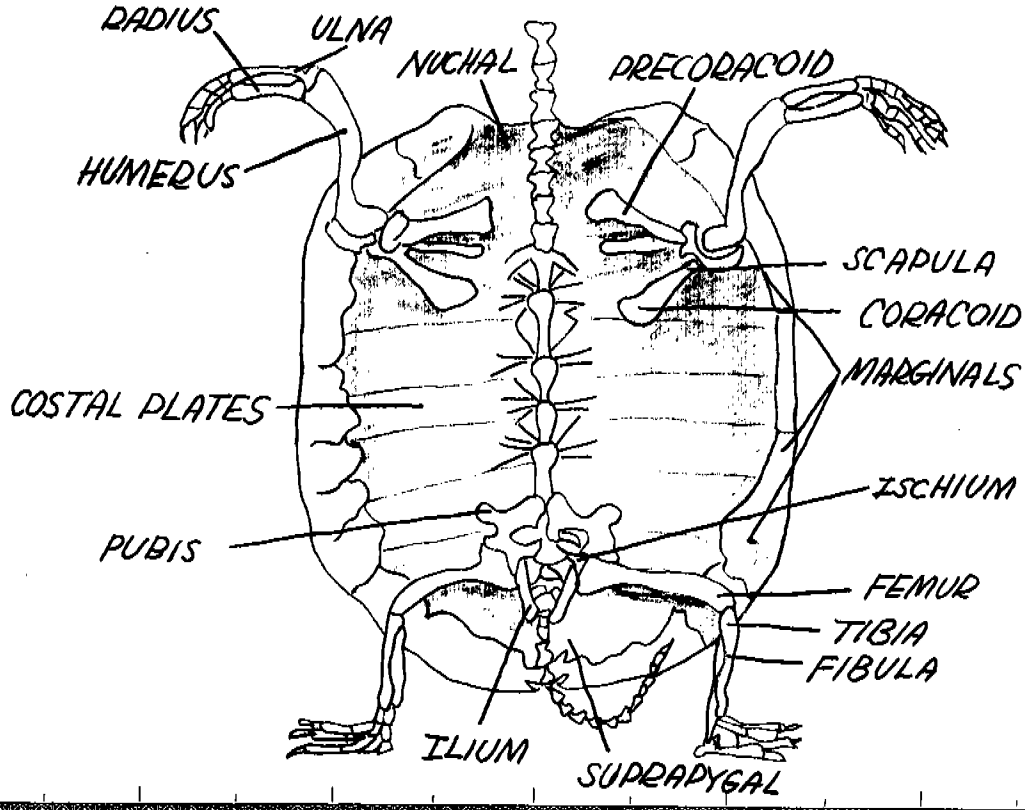
J.C.

The University of Dubuque. Course_____

Name_____ Date_____

VENTRAL VIEW TURTLE





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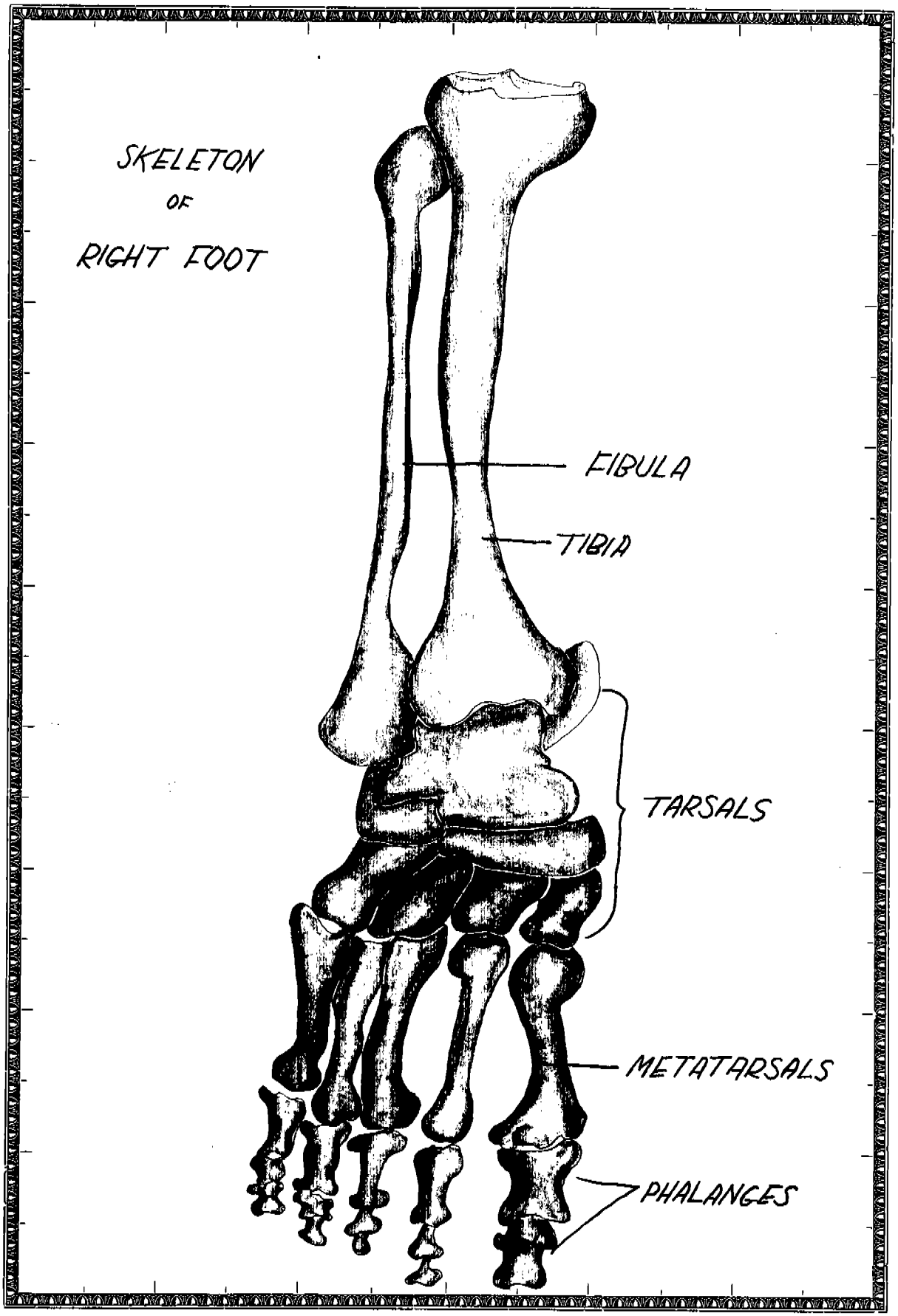
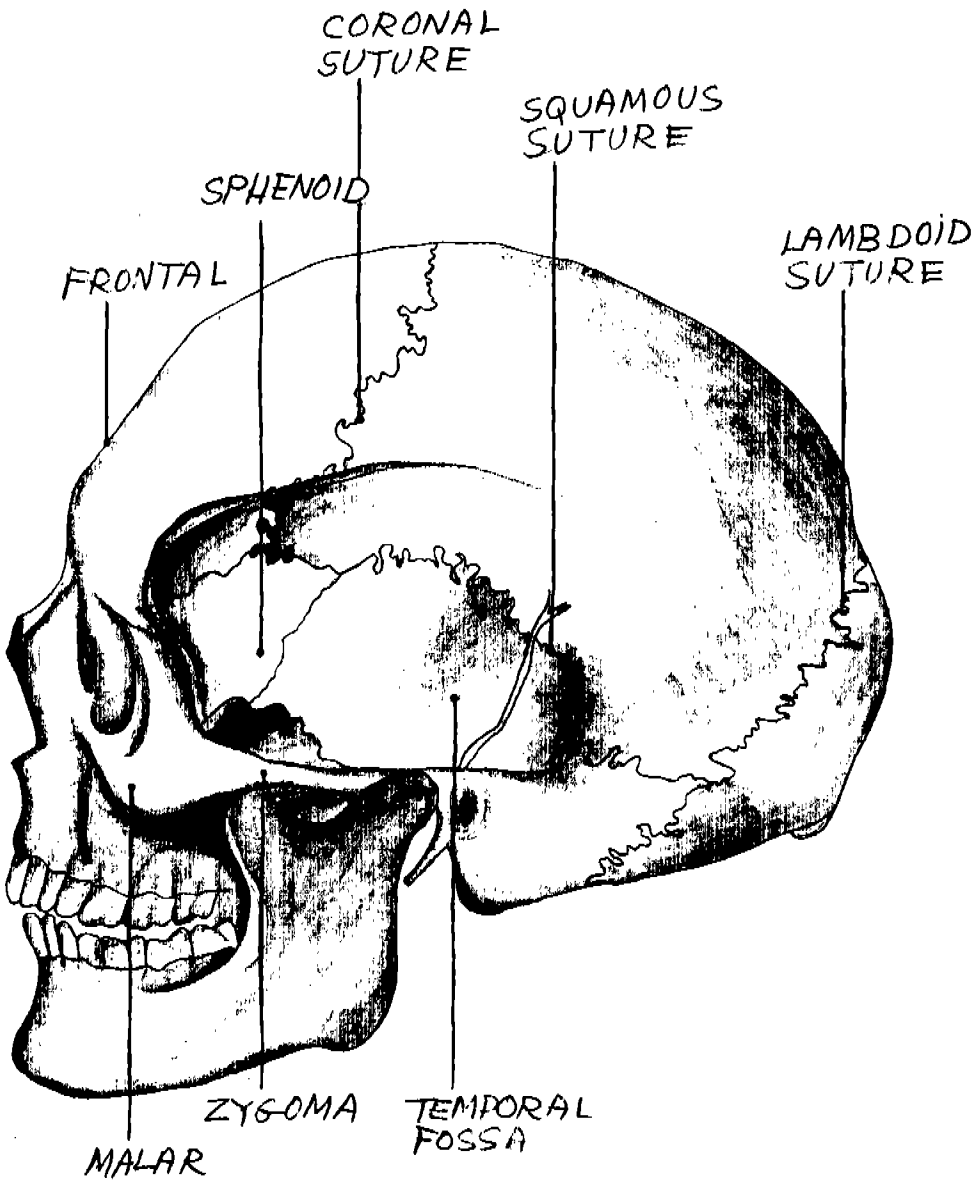


The University of Dubuque. Course_____

Name_____ Date_____

THE HUMAN SKULL



STEM ROOTS

Acro - tip; acrosome - pointed tip of a sperm cell.
Actin - ray; actinomorphic - ray-shaped actinopoda.
Albus - white; albinism - lack of pigment.
Anth - flower; brightness; anthozoa - flowerlike animal.
Anthrop - man; anthropology - study of man.
Arch - primitive, ancient; archaeopteryx - primitive bird.
Area - open space; areolar - having open spaces.
Arthr - joint; Arthropoda, having jointed legs.
Bibo - drink; bibatious - accustomed to drinking.
Bios - life; biota - the living animals and plants of a region.
Blast - bud, sprout, primitive germ; osteoblast - bone bud.
Brachi - arm; Brachiopoda - arm-footed animals.
Brachy - short; brachycephalic - short-headed.
Branch - gill; Lamellibranch - leaf-gilled animals.
Bryo - moss; Bryozoa - moss-like animals.
Bursa - pouch, sac; bursate - shaped like a pouch.
Chaet - hair or bristle; Oligochaeta - worms with few bristles.
Chir - hand; Chiroptera - hand-winged animals.
Chiton - coat of mail; chitin - found in the integument of animals.
Chlor - green; chlorophyll - green leaf.
Chromat - color; chromatin - chromosome, achromatic.
Cide - to kill; germicide, insecticide, fratricide.
Cilium - small hair; ciliata, cilia.
Coel - hollow, cavity; coelenterata, coolom.
Coleo - sheath; Coleoptera - insects with sheathed wings.
Conch - shell; conchology - study of shelled animals.
Cyt - cell or hollow place; cytology, cytoplasm, leucocyte.
Derma - skin; pachyderm - thick skin.
Echin - spiny, hedgehog; Echinodermata - spiny-skinned animals.
Entom - insect; enompnilous - to love insects.
Eo - dawn; eolith-earliest stone tool used by man.
Eryth - red; erythrocyte - a red blood corpuscle.
Ethn - people, race; ethnology - study of races.
Gam - husband, marriage; gamete, gametophyte, polygamy.
Gastr - belly; gastrula - little stomach.
Ge - earth; geotropism - turning to the earth.
Gen - to bring to life, create; Genesis, generate, engender, gene.
Genue - (plural genera) - kind, race; generic, general, generous.
Gest - to carry; ingest, egest, digest, gestation.
Helio - Sun; heliotropism - turning to the sum.
Helminth - worm; Helminthology - the study of worms.
Heter - other, different; Heteroptera - insects with unlike wings.
Hist - web, tissue; histogenesis - tissue formation.
Holo - whole, entire, holoblastic, the entire germ or embryo.
Homo - same, several in common; homology, homoptera, homozygous.
Humor - animal fluid; vitreous humor, humid, humorous.
Hymen - membrane; Hymenoptera - membrane-winged insects.
Iso - equal; isomerism - being divided into equal segments.
Leuc - white; leucocyte - a white blood corpuscle.
Lys, lyt - to unfasten or dissolve; analysis, autolysis, histolytic.
Melan - black; melancholy, black bile; melanin - black pigment.
Metr - measure; biometry, diameter, symmetry.
Morph - form, shape; dimorphism, metamorphosis, morphology.
Mut - to change; mutation, permutation, mutant.
Necro - dead; necrosis - localized death of tissue; necrotic.
Nemat - thread; Nemathelminthes - thread-like worms.
Odent - tooth; orthodontia - science of tooth straightening.
Oec, Ec - house; monoecious - single house; Ecology, economy.

Oes - will bear, carry; oesophagus, carrying what is eaten.
Olig - few; Oligochaeta - worms with few bristles.
Ornith - bird; ornithology - bird study.
Parthen - virgin; parthenogenewis - virginal reproduction.
Path - suffering; pathogenesis, apathy, sympathy, pathology.
Phag - to eat or devour; phagocyte, bacteriophage, phytophagous.
Phil - lover; haemophilia, philanthropist, Phillip.
Phobe - fear, hatred; bacteriophobia, claustrophobia, acrophobia.
Phyl - race; phylogeny - race development; phylum.
Phyll - leaf; phyllotaxis - leaf arrangement.
Phyt - plant; saccophytic - living on dead material.
Platy - flat; Platyhelminthes - flat worms.
Pseud - false; pseudopod, pseudonym.
Rheo - flow; rheotropism, rheotaxis, diarrhea, resin.
Schiz - split, cleave; schizogeny, Schizophyta, schizophrenia.
Senesc - old man; senile, senescence, senior.
Septum - fence, barrier; septate - state of being divided.
Sessile - sedentary but not stalked; sessile animals - those solidly attached to their substratum.
Style - pillar, post, beam; stylet - little beam.
Tox - poison; toxicology - study of poisons.
Trich - hair; trichinella - little hair worm.
Troph - food; atrophy, hypertrophy, trophy.
Ur - tail; Uropoda - animals with tail-like feet.
Vermis - worm; vermiform, vermillion, vermin.
Xanth - yellow; xanthophyll - yellow material in leaves, etc.
Zo - animal; azioc, zooid, zoome, spermatazoa, zoospore.
Zyg - yoke; homozygous - having similar yokes; zygote.
Zym - ferment; enzyme, zymogen, zymotic.
Seta - hair or bristle; setaceous - producing hair.

PREFIXES AND SUFFIXES

A or an - without; apoda - without feet.
Ab - away from; aboral - away from the mouth.
Ad.- toward, upon; adrenal - upon the renal gland.
-ae- plural-ending for Latin singular nouns ending in A - amebae.
Ambi - both; ambidextrous - ability to use both hands.
Amphi - on both sides; amphibian - adaptable to both sides of the shore-line.
Ana - again or through; anaphase - a later stage of cell division.
Ante - before, in place or time; antebrachium - placed before arm.
Anti - opposed to; antitoxin - opposing or neutralizing a toxin.
Apo - from, away from; apochromatic - without or away from color.
-ata - possessing; craneate - possessing a cranium.
Auto - self- auto-intoxication - poisoning produced in one's body.
Bi - double; bilateral - same on both sides.
-ble,-able,-ible,-able; flexible - can be flexed.
Cata - down; catabolism - breading down.
Circum - around; circumoesophageal, - running around oesophagus.
Contra - against or opposite; contralateral - opposite side.
De - off, away from; dementia - mind away from.
Di - two or twice; dichotomy - dividing into two branches or forks.
Dia - through; diaphragm, diagram, diagnose
Dis - bad or weak; dysgenic - poorly born.
Epi - upon; epinephres - lying upon the kidney.
Ex - without or outside; exoskeleton - skeleton on the outside.
Extra - outside; extracranial - outside the braom case.
Eu - good, well, easy; eugenic - well-born.
-form - shape; vermiform - shaped like a worm.

Hemi - half; hemisphere - half a sphere.
Hyper - above or beyond; hypertrophy - an overgrowth.
Hypo - under; hypoglossal - under the tongue.
Infra - below; infra-orbital - beneath the orbit of the eye.
Inter - between; intercellular - between the cells.
Intra - within; intracellular - within the cell.
Iso - equal; isopoda - insects with equal legs.
Macro - large; macrocephalon - a large head.
Major - greater; pectoralis major - the greater of pectoral muscles.
Mega - great; megaspore- the larger of the spores.
Mes - middle; mesoderm - the middle germ-layer.
Meta - after; metaphase - a later phase of mitosis.
Micro - small; micro-organism - organisms not seen by naked eye.
Mono - alone; monogamy - marrying but one spouse.
Multi - many; multicolored - many-colored.
Meo - new, recent; neoplasm - a new growth or tumor.
O or ob - out, inverted, against; omission, oblique.
-oid - to be added to make an adjective; odentoid - like a tooth.
Ortho - straight; orthoptera - straight-winged insects (grasshopper)
Para - beside; parachordal - lying beside the notochord.
Per - through; permeate - to pass through.
Peri - around; pericardium - around the heart.
Poly - many; polymorphic - many-formed.
Post - after; postbranchial - behind the gills.
Pre - before; prenatal - before birth.
Pro- before or early; prophase - the earliest stage of cell division.
Proto - first, preceding, primary; prototype - the primitive form.
Re - back, again; regenerate - to produce again.
Retro - backward; retrolingual - backward from the tongue.
Semi - half; semiflexion - bent half way.
Sub - under; submandibular - under the mandible.
Supra - above or upon; supratemporal - above the temporal bone.
Sym - together; symbiosis - living together.
Syn - together; syncytium - cells without dividing walls.
Sur - above or over; surangular - above the angular bone.
Trans - across; transfusion - a pouring across.
-ule - (ula, ulus, ulum, ular), diminutive suffix; cellular, molecule, nodule.
Ultra - beyond; ultramicroscopic - beyond the power of microscope.

DIRECTIONAL TERMINOLOGY

Cephalad - toward the head.
Caudad - toward the tail.
Ventral - front.
Dorsal - back.
Lateral - side.
Ecto - outside.
En, endo, ento - toward the inside.
Mesiad - toward the middle.
Proximal - near a given part.
Distal - away from a given part.

Sagittal plane - one that divides an animal into right and left parts.
Transverse plane - one that divides an animal into cephalic and caudal parts.
Coronal or horizontal plane divides an animal into ventral and dorsal parts.

XVIII. THE KIDNEY

A. Phylogenetic Relationships and Ontogenetic Development.

The student has probably observed that among the vertebrate animals, there may be found three types of kidneys, spoken of as the pro, meso, and metanephros.

1. The Pronephros.

The pronephros being the most primitive type is found in the adult amphioxus and certain lampreys. However, an even more primitive condition may be found in the earthworm. The chief excretory organ of the earth worm consists of pairs of coiled tubes called nephridia which are segmentally arranged in the coelom on either side of the alimentary canal. By dissecting an earthworm it will be noted that each nephridium begins in the coelom of one segment and after passing into the next segment coils through a number of loops and empties to the exterior on the ventral surface. These small apertures, called nephridia pores, open on every somite except the first three and last. Even though these excretory organs were studied in connectionnwith the general anatomy of the earthworm whey should again be observed. Dissect an earthworm as previously directed and note the funnel-shaped, ciliated opening, the nephrostome, which collects the waste from each segment. The remainder of each nephridium is divided into three parts; the slender distal portion, the thick and glandular-walled middle portion, and the dilated proximal portion which probably acts as a urinary bladder. Carefully remove a nephridium. Mount it on a slide, and study under low power.

EXERCISE I. Draw and label a nephridum of an earthworm.

II. The Mesonephros.

Although immature fishes and amphibians possess a pronephros, it is supplanted by the mesonephros before the animal reaches adult condition. Dissect a fish or frog, locating the mesonephros, urinary ducts and bladder. Note that the mesonephros extends the entire length of the body-cavity between the air bladder (fish) and backbone. The urinary duct is called Leydig's duct in the male frog, or Mullerian duct in the female. (Besides these notice the adrenal glands and fatty bodies (frog) in close proximity with the mesonephros which are large reddish-brown bodies on either side of the mid-line of the back.

EXERCISE II. Draw and label a typical mesonephros from a fish or frog. (Lower half.)

3. The Metanephros.

The third type of kidney, the metanephros, may be found in the adult condition of the amniotes (reptiles, birds, and mammals-animals which possess an amnion in the embryonic condition). These higher vertebrates develop the first and second types of kidneys only to lose them as the third type appears. Study in detail the anatomical structure off the kidneys of any amniote which is available. A typical kidney is somewhat bean-shaped with a deep concavity on one side. This allows an entrance for the renal artery, and an exit for the veins and ureter. The funnel-like attachment of the ureter to the kidney is called the pelvis while the indentation is called the hilus.

Split the kidney longitudinally and study the cut surface. It is made up of a light-colored peripheral layer, which is called the cortical substance, and the darker central mass which is called the medullary substance. The tubules will be seen as fine lines which converge to a large space near the concave side, the sinus. Note the connection with the pelvis.

Goldsmith

THE CHICK

A. Ontogenetic Development as A Guide To Phylogeny

Each student should place in the incubator or under a hen, not less than three supposedly fertile eggs. After they have incubated (37 degrees C.) from 32 to 48 hours remove one and study the embryo in accordance with the following directions: With the handle of the scissors carefully crack the blunt end of the egg and rapidly remove the shell fragments--at first with the forceps then later with the thumb and finger. Rapidly but cautiously break down the wall of the shell permitting the white to run out into a waste jar. If the white hangs and seems to be endangering the yolk, clip it with the scissors being careful not to injure the yolk which might be pulled in that direction. After about a third of the shell, and all of the "white" possible have been thus removed, carefully submerge the remaining shell, which contains the yolk, in warm (about 37 degrees C.) physiological salt solution (.7 to .9 grams of salt to 100 c.c. of water) and float the yolk from the shell. With blunt instruments, like the handle of a scalpel turn the yolk over and locate a small circular area the vassular area. Note its position on the yolk. The tiny beating heart will now attract your attention. Count and record the heart beat at intervals so long as it continues. Does the beat gradually slow down or does "death" take place suddenly? Watch your specimen for about 10 minutes as the heart might begin beating again.

With small sharp scissors make a circular cut through the egg membrane a short distance from the sinus terminalis--the encircling blood vessel which marks the limit of the blastoderm or vascular area. With fine foreeps take hold of the edge of the detached bastoderm and carefully float it into a syracuse watch dish. Gently raise the watch dish containing the embryo from the vessel of water. With a pipette draw off the surplus water leaving the blastoderm spread out smoothly over the damp bottom of the watch dish. In case the edge of the membrane is turned under, return some of the water to the watch dish and repeat the drawing off process--carefully pumping here and there where the membrane is not straight. The thin transparent vitelline membrane which normally covers the embryo may or may not be present as yet. It may have slipped away during the progress of the work. Now fit a ring of filter paper, which has been previously prepared, over the blastoderm in such a way that the embryo, which appears in the open center of the ring, is entirely free from the paper which adheres to the circular margin of the blastoderm. Fix the embryo by adding sufficient amount of Bouin fixative to cover it. After examining the embryo in detail with a microscope exchange with an assistant for a similar one permanently stained and prepared on the slide for study.

External Study of a 32 to 48 Hour Chick Embryo.

If the entire blastoderm is preserved on the slide, the transparent but granular area outside of the sinus terminalis will be seen. This is the area vitellina. A similarly appearing area, area pellucida may be noted along either side of the embryo. The deeply stained irregular shaped blood islands mark the area vasculosa--between the area pellucida and the sinus terminalis. Count the mesodermal segments or somites which constitute the larger part of the median region of the chick. The two rows of somites are separated by the neural tube and notochord (see cross section study). Since the somites form progressively from the anterior end posteriorly, they gradually blend into a non-differentiated region--the segmental zone, which terminates with an expansion called the priiitive knot. Posterior to this is the

EXERCISE III. Draw an exterior view of a true kidney.(Upper)
EXERCISE IV. Draw a longitudinal section through the medium region of the same kidney. (Lower half.)

B. Story of the Kidneys in Three Acts, as Seen in the Developing Chick.

ACT ONE--Pronephros (The Primitive Kidney).

Time--2nd. day of incubation. Place--somites 1 to 15.

Scene I. At dawn of the second day the nephrotomes appear out of the intermediate cell mass which separates each mesodermal segment from the lateral mesoderm (somatic and splanchnic mesoderm).

Scene II. Middle of second day cellular "sprouts" grow upward from the mid-dorsal surface of the nephrotomes of segments 5-15.

Scene III. Buds elongate--terminal portions bend posteriorally and fuse with adjacent ones, forming a rod on either side of, and parallel to the neural tube.

Scene IV. At the close of the second day the rods become hollow forming the rudimentary kidney tubules of the pronephros which opens into the cloaca about the 60th. hour.

Scene V. Tubules separated from somites by mesenchyme.

Scene VI. Anterior tubules degenerate by the time the 14th. is formed. (Note progressive growth and degeneration).

ACT TWO--Mesonephros (Middle Kidney).

Time--3rd. 4th, and 5th. days of incubation. Place--somites 13-30.

Scene I. The so-called "middle kidney" begins to develop at the close of the second day--posterior to and as a continuation of the pronephros.

Scene II. Tubules elongate and convolute to form primary, secondary, tertiary, etc. (six or seven) Mesonephric tubules. This piling up continues until a large body is formed, the Wolffian body.

Scene III. Tubule of each segment empties into a common dilation, the Wolffian Duct which eventually becomes the vas deferens.

Scene IV. Sinuses of posterior cardinals cause the Wolffian bodies to become very vascular.

Scene V. Sub-cardinals collect the blood from the Wolffian bodies, deliver it to the inferior vena cave--thence back to heart.

Scene VI. Act II proper closes the fifth day. However degeneration of the mesonephros begins the tenth day and is completed before the chick is hatched.

ACT THREE--Metanephros (Adult Kidney)

Time--Act begins fourth day (before stage is cleared of setting from Act II) and closes at death of individual. Place--At the base of the Wolffian Duct in the region of Somite 30.

Scene I. Evagination of mesonephric (Wolffian) duct as it turns to enter the cloaca.

Scene II. Formation of metanephric tubules forming an irregular shaped body.

Scene III. Piling up of the tubules forming a compact bean-shaped body, the adult kidney.

Scene IV. Diabetes and Bright's Disease. ---- CURTAIN.

C. Subjects for Discussion.

I. Verify the facts connected with the three act drama by reviewing your notes and various texts on the embryology of chick.

II. To what extent is it incorrect to speak of diabetes as a disease of the kidneys?

III. To what extent is the phylogenetic and ontogenetic story of the kidney a proof of evolution?

IV. In what respects do the kidneys of various mammals differ?

V. Name and discuss various functions and diseases of kidney.

VI. What relation exists between structure and methof of excretion.

Goldsmith

primitve streak. If the chick is slightly older than 48 hours these structures are supplanted by a condensed aggregation of cells, the tail bud which marks the terminal limit of the embryo.

If the extra-embryonic blood vessels have begun to form the large vessels, the vitelline veins and arteries may be seen connecting the vascular area with the median region of the embryo. The large heart which was studied in the living embryo may now be traced in detail. In the region of the heart note the three slits in the side of the embryo. These are the branchial grooves ("gills"). Near them may be seen a more or less circular organ, the otic vesicle or embryonic ear which is in the region of the hind-brain. Owing to a characteristic turn, the mid-brain is, at least in one stage of development (about 48 hours) at the anterior curve of the embryo. The fore-brain is marked by the presence of the conspicuous eye, which is made up of the optic vesicle containing the spherical lens.

2. Cross Sections of 48 Hour Chick

In order to understand the relative positions of the organs as they appear in cross section, the student should continually hold in mind the relation between the whole mount and the sections. A general knowledge of embryological technique is a great asset in such a study.

(1) A section through the somite region may be identified by the presence of the large mesodermal segments on either side of the neural tube. The solid circular body, ventral to the neural tube is the notochord. Lateral to, but connected with each somite, there can usually be identified an aggregation of cells containing an opening. These are the pronephric tubules or embryonic kidneys (the pronephros). The circular openings ventral and slightly lateral to each somite are the paired dorsal aortae. The somites, nephrotomes, and blood vessels are differentiated from the middle germ layers, the mesoderm. Note that the upper alyer or somatic mesoderm unites with the ectoderm, outer layer, of the blastoderm to form the somatopleure, while the lower layer, or splanchnic mesoderm unites with the entoderm, the inner layer next to the yolk, to form the splanchnopleure. The space between the somatopleure and the splanchnopleure is the coelom. The concavity (invagination of the entoderm) ventral to the notochord marks the position of the developing fore-gut or primitive intestine. The yolk serves as food for the developing embryo.

(2) Examine a cross section through the primitive streak regions and determine which of the above structures are present.

(3) In a section through the heart region, the fore-gut which may now be called the pharynx, is entirely enclosed. It may be recognized by its thick walls and flattened condition. The aortae, which may be approaching a fused condition, are dorsal to the pharynx and ventral to the neural tube and notochord. Is the notochord as prominent as it is in the somite region? The anterior cardinal veins may be seen lateral to the aortae. The heart appears as a single double-alyered sac ventral and slightly lateral to the pharynx.

Study of a Well-formed Chick Embryo.

If you were successful in removing the first embryo, you should still have two eggs incubating. At the end of four or five days, remove the embryo from one of these eggs and preserve it in 70% alcohol. The third may be removed at your convenience. You will see in the four day embryo some resemblance of a chick. Compare it with the various mammalian embryos which might be in the department's collection. The otocyst now nearly resembles a fully developed ear.

The "face" is as yet not well formed. Note the irregular shape of the fore-mid-and hind-brain. The enlargement which is snugly tucked under the "chin" is the heart, while the ridge just under the heart marks the location of the liver. The elongated swelling below the liver and along the dorsal body wall is the mesonephros, the second stage in the development of the kidneys. This region may also show small paired lateral buds, the wing-bud. In this stage of development the wings of the chick, anterior limbs of the pig, and arms of the child can not be distinguished from one another. The lower limb buds, which make their appearance soon after the anterior buds, may not be present. Note the comparatively long tail which is present in the embryo of all higher animals at this stage.

4. EXERCISE. Draw and Label:

I. The 48 hour whole mount. (Center lengthwise.)

II. Cross section through somite region. (Upper half.)

III. Cross section through primitive streak region. (Lower half).

IV. Cross section through heart region. (Center crosswise.)

V. Sketch a four or five day chick. (Center lengthwise.)

B. Subjects for Discussion.

I. Since the human embryo has only a rudimentary yolk sac, what is the source of its food supply?

II. Explain how the chick and human embryos are supplied with oxygen.

III. Show through various lines of argument that the theory of organic relationships (evolution) is further substantiated by the study of embryological development.

IV. From your observations on the development of the small embryo, when would you say that the life of a chick begins?

V. Can you surmise what initiates the original heart beat?

VI. How does the development of the chick differ from that of the frog?

VII. Show how the development of the pro, meso, and meta-nephros further substantiates the recapitulation theory.

VIII. Study all the human embryos available. What is the normal position before birth? Are the feet "clubbed"?

IX. What is a human anomalie? Do you find any anomalies in the human embryos you have studied?

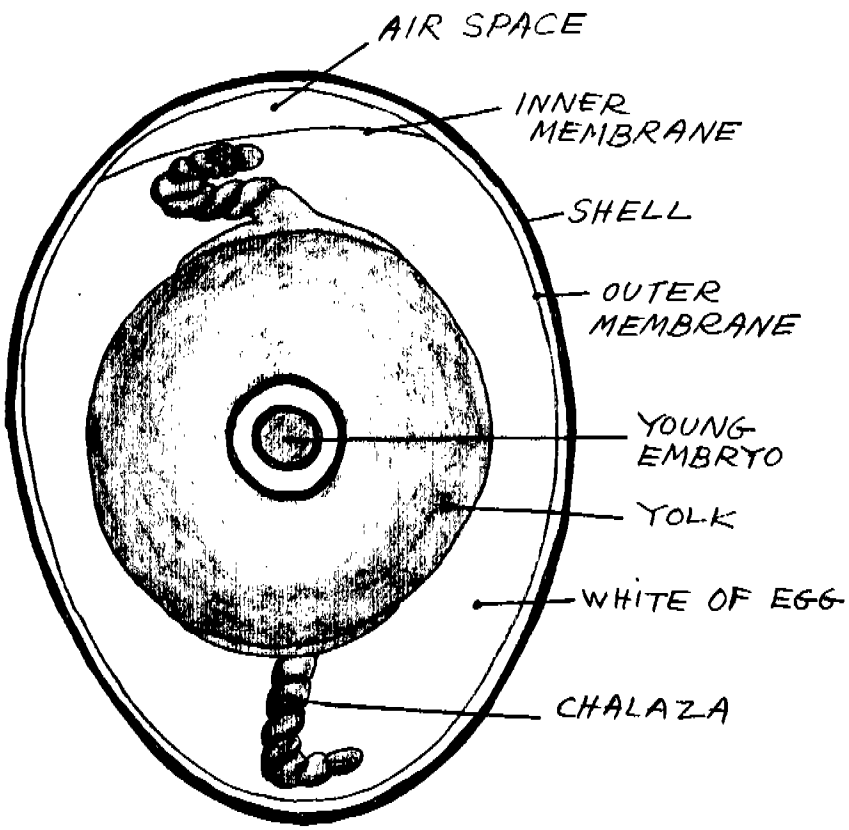
X. Sketxh one or more human embryos--showing the "sac" and attachment to mother.

XI. What changes take place at birth which make it possible for the child to breathe air?

Goldsmith

Name RAY KUEFLER Date MARCH 5.

THE EGG



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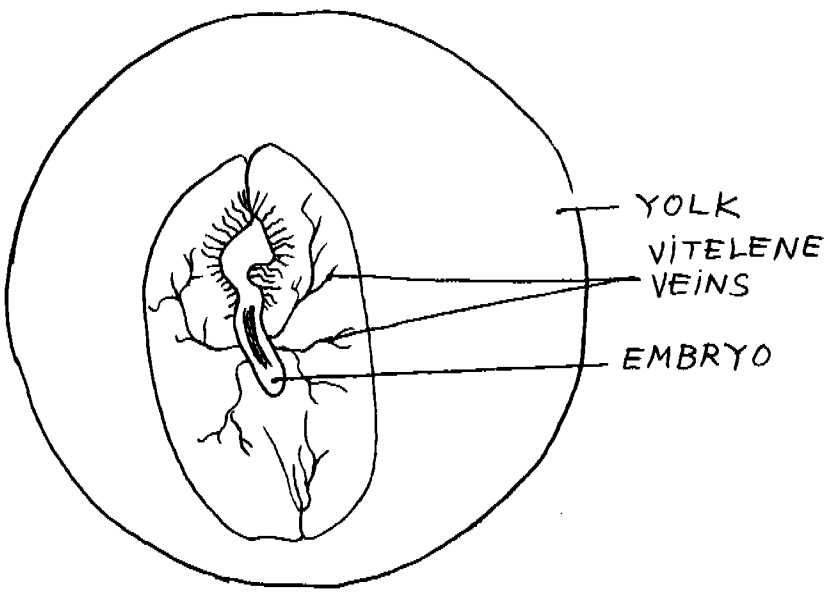
72 HOUR CHICK.



HEART BEAT 157 PER. MIN.

XV. THE FISHES

A. Natural Habitat, AND THEIR BIOLOGICAL SIGNIFICANCE

At least one laboratory period should be devoted to the study of the various ponds, lakes, and streams in the vicinity of the campus. In case there is no such body of water near, arrangements should be made for a more extended trip, transportation being furnished by the members of the class. It is usually advisable to divide the class into various sections, thus furnishing an opportunity for a comparative study of the life from various localities. Each section should be equipped with nets, pails, glass jars, bottles, etc. Notes should be taken on the general habitat of the animals collected. This should include a statement relative to the condition of the water,--stagnant, running, muddy, etc., kind of bottom, the source of water supply, etc., as well as reference to the related animal and plant life. In order to ascertain facts relative to the food of the fishes, extensive collections should be made of the water along theshore. This may be kept in the laboratory several days and in the mean time the student should determine as far as possible the kind of small animals, molluscs, crustacea, etc., which inhabit it. In case it is impossible to equip the laboratory with a large aquarium, the products of the days collection, fishes, frogs, turtles, etc., as well as smaller forms, may be kept in improvised containers such as large battery jars, pails, tubs, etc.

Study the behavior of the fishes while in their new habitat. Examine the aquarium and determine the changes which take place in the smaller animals as a result of the feeding of the fishes. If possible determine the preference of food of the fishes by placing in the aquarium prepared fish food, living active crustaceans, bread crumbs, rolled oats, cram-of-wheat, etc.

For means of locomotion, especially for change in direction while swimming, the body of the animal must be flexible, at least at one point. Since the head and trunk of the fish are quite firmly attached, the tail is used for this purpose. Note the method of locomotion of the living specimens and especially how they change direction while swimming. Make various tests to determine the types of stimuli which are most effective--tap the aquarium, pass your hand over the surface of the water, flash a bright light toward the fish, etc. From your observation determine the advantages of the wedge-shaped head, and terminal mouth. Could you suggest a better arrangement of the fins? If possible determine how the fish used the sharp spines as weapons of offense and defense. Compare the habits of the various fishes with which you are familiar. If no other specimens are available, the common gold fish will suffice for many of these observations.

B. External Features

Place a specimen in your dissecting pan and examine in detail. Note the arrangement of the <u>mouth</u>, <u>teeth</u>, <u>lips</u>, and <u>nostrils</u>. Probe the nostrils and determine their internal relation to the mouth. Examine the gills by carefully raising the large bony gill covers, the <u>operculum</u>. To the <u>gill arch</u> is attached two rows of thin-walled thread-like appendages called <u>gill filaments</u>. These filaments are provided with capillaries so that the blood is brought in close contact with the water over a very large surface. The gill arches have finger-like projections called gill rakers, which prevent food or dirt from getting into the filaments and also keep the arches separate to allow free circulation of water. The water is taken in at the mouth, which is then closed, forcing it through the <u>gill slits</u> over the filaments and thence out beneath the operculum. Observe this in the aquarium specimens.

The large eyes are witnout lids but are protected by transparent membranes, the conjunctiva, which is continuous with the epidermal layer of the skin. The head of the common fishes (the Teleostei) contains the heart and organs of respiration.

The number and arrangement of the fins of fishes vary with the species. They arise, however, from the fold of the integument of the embryo. As in the case of amphioxus, this fold is practically continuous around the entire animal, being single along the dorsal and caudal regions, and bifurcating near the anal opening. (See metapleural folds of amphioxus.) Parts of the fold disappear, leaving isolated sections which develop into the various fins. The pair of fins attached to the pectoral girdle and located on the side of the fish just back of the operculum are known as the pectoral fins, and are homologous to the anterior appendages of the higher vertebrates; while the pair posterior and ventral to these, the pelvic fins, are homologous to the posterior appendages of the higher vertebrates. Through evolutionary changes the pelvic fins have migrated from the pelvic regions, where they are found in primitive fishes. The median fins, which are merely flattened portions of the body stiffened by bony rays, are the most primitive type--the only one present in the lower fishes. The ventral fin is sometimes spoken of as the anal fin. Does your specimen have one or two dorsal fins? The more common fishes have a homocercal type (swallow type) of tail fins. Compare with the heterocercal tail of the dog fish.

Examine the arrangement of the scales on the various parts of the body of the fish. Are they properly arranged for the best advantage to the fish? Remove some of the scales, examine with the microscope, and note the radial and concentric lines. This common type of scales which overlap one another posteriorly are known as the ctenoid (pronounced tenoid) scales. Compare these with the placoid scales of the dogfish. The latter are rhombic bony plates with a central spine. They are the most primitive type of dermal ossification, a modification of which form the primitive teeth of the shark, which migrate into position as needed.

Note the color bands, and spots. Are they bilaterally symetrical? Note particularly the "lateral line" along either side of the fish. Examine scales from various parts of the fish and determine whether the pigment is located in them or on the dermis of the fish. Remove groups of the pigment cells and study them under low and high power.

EXERCISE I. Sketch the entire fish, and label all parts. (Center lengthwise.)

EXERCISE II. Draw the following: 1. a ctenoid scale of a common fish, (quadrant one); 2. a placoid scale from a dogfish (quadrant two); 3. the homoceral caudal fin (quadrant three); and, 4. the heteroceral caudal fin (quadrant four).

EXERCISE III. Sketch a group of pigment cells from (1) a fish (2) some other animal. (Lower center).

C. Subjects for Discussion

I. From your reading or lecturers make a chart illustrating the chemical carbon-oxygen-nitrogen) cycle in a "Balanced Aquarium," or in nature in general. What happens if the cycle is not "balanced?" (See Biology for Beginners, Moon, Chapter LIII; Foundation of Biology Woodruff, Chapters VI and VIII; Civic and Economic Biology, Atwood, Chapters I and II.)

II. What isthe function of the lateral line? Which of the various senses is of most service to the fishes?

III. Is the shape, size and arrangement of external parts of fishes as nearly as possible adapted to their habitat, method of food collection, etc? Suggest modifications that would be more advantageoud. Discuss the life and habits of other animals which are

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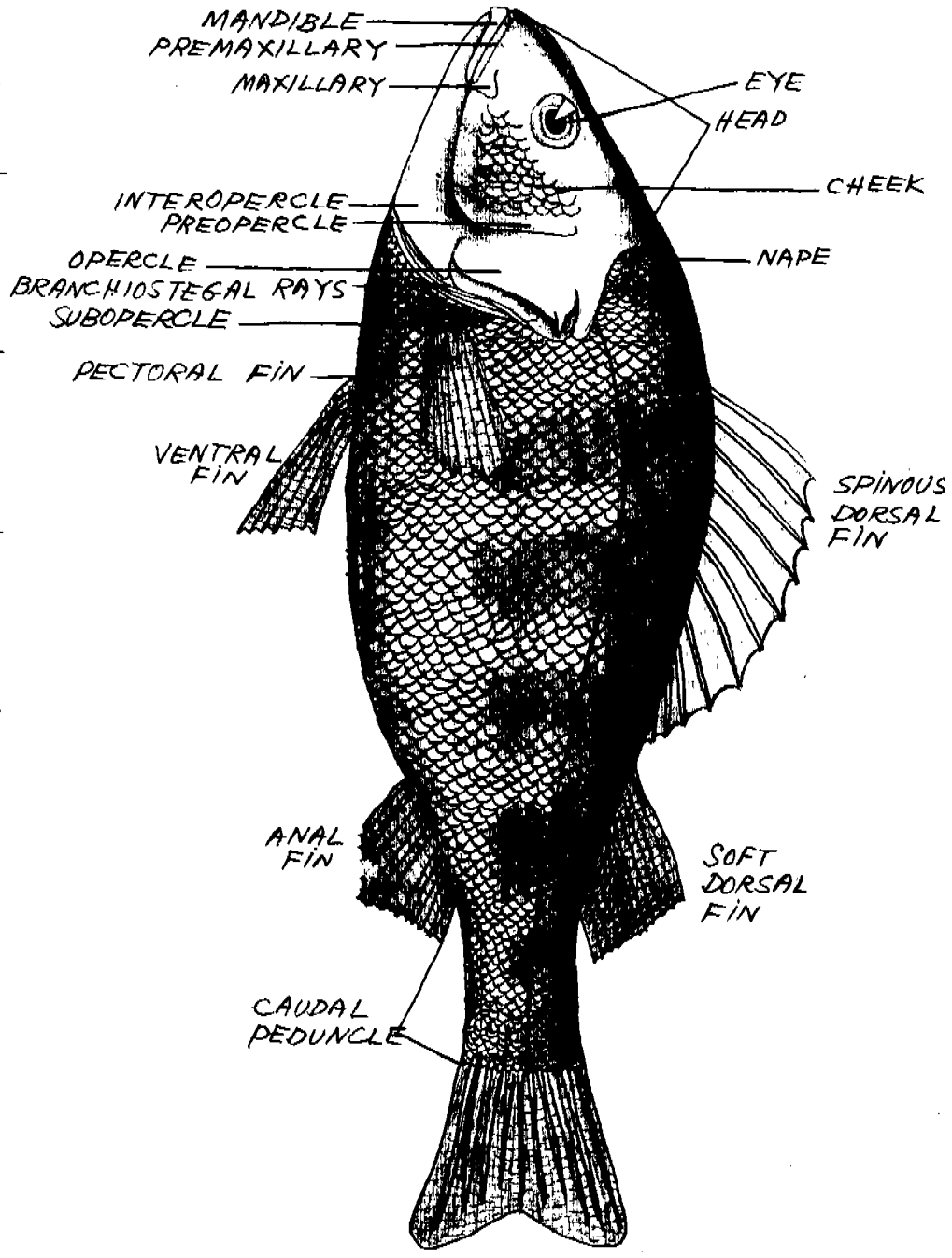
PERCH



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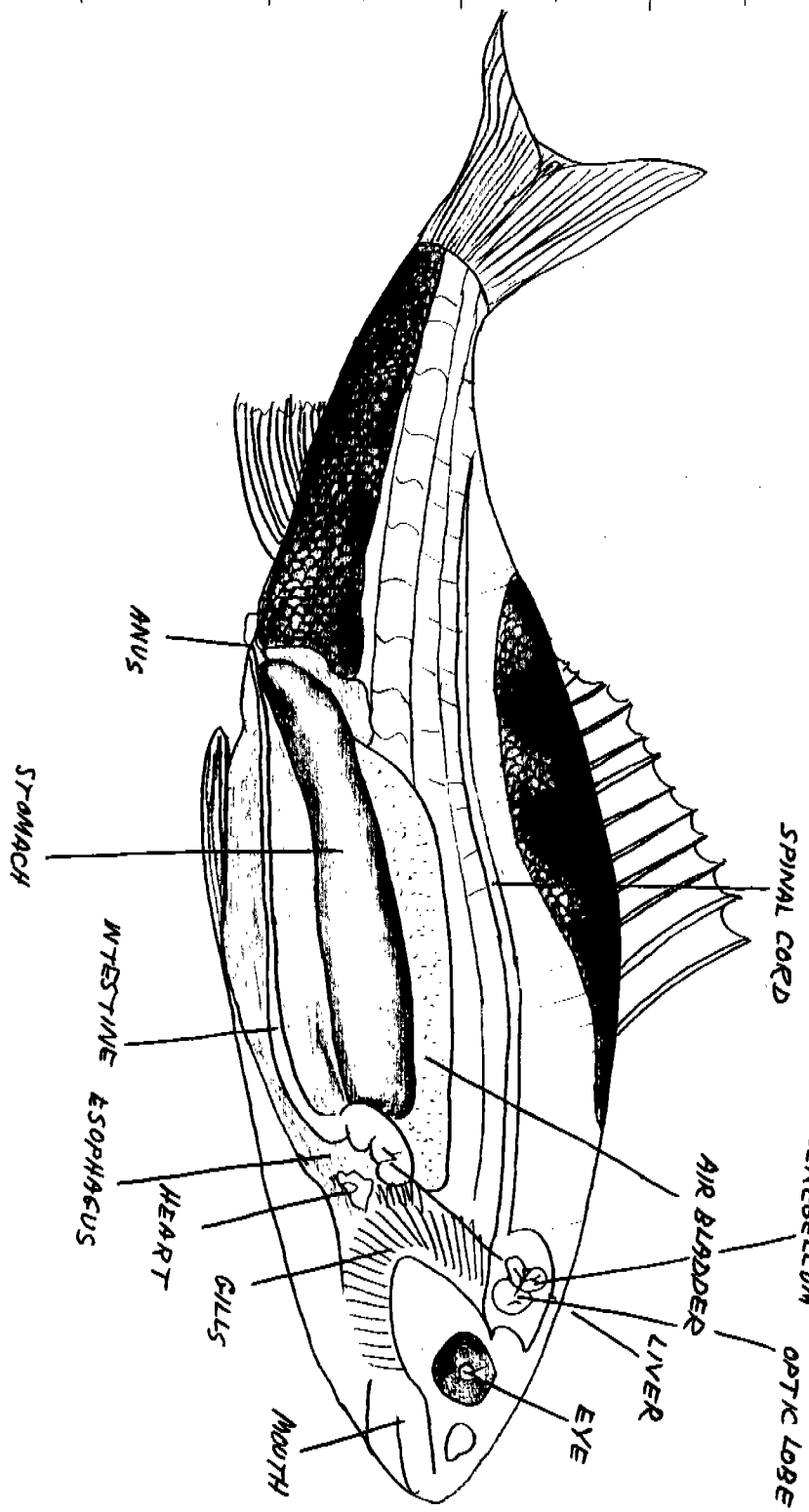

INTERNAL ORGANS OF A PERCH

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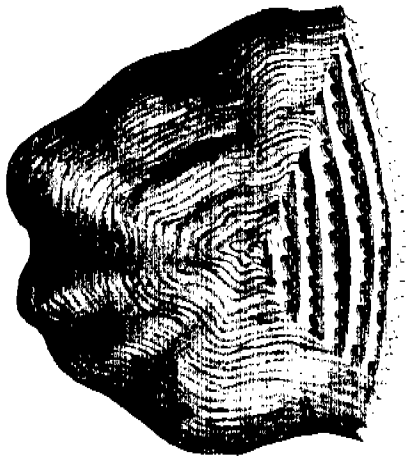
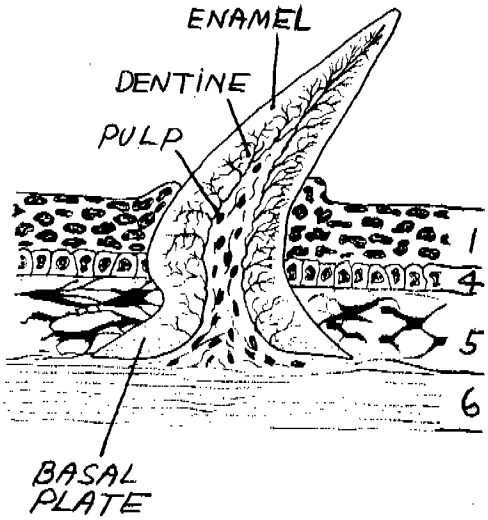
B

SCALES

1-CORNEUM
4-GERMINATIUM
5-DERMIS
6-SUBCUTIS

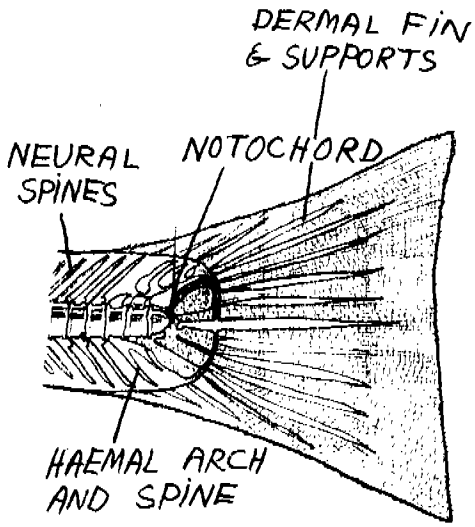


CTENOID SCALE

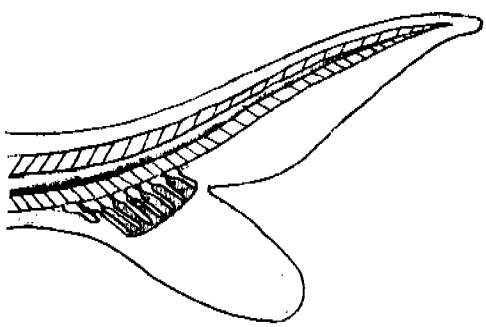


PLACOID SCALE

TAILS



HOMOCERCAL



HETEROCERCAL

J.C.

Name RAY KUEFLER Date

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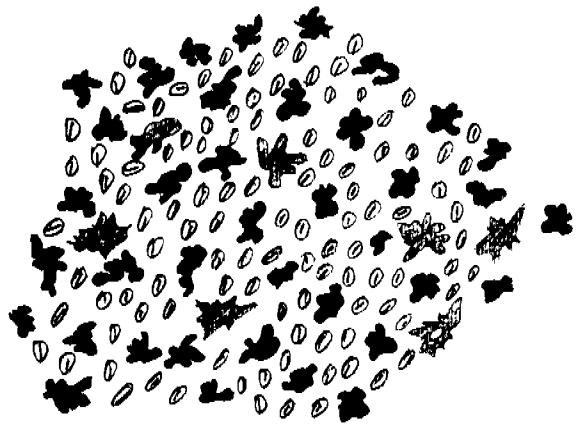
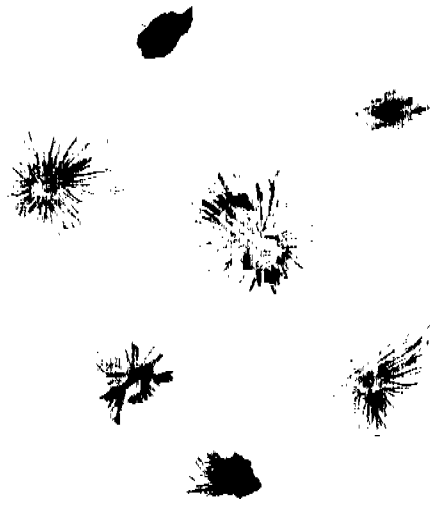


CHROMATOPHORES (RESTING)



CHROMATOPHORES (DEAD)

12.

XIX. THE SKIN AND IT'S DERIVATIVE OR ANIMAL INTEGUMENTS

The more conspicuous epidermal derivatives are: the skin, hairs, feathers, scales, hoofs, nails, claws, and teeth.

A. THE SKIN AND HAIR

1. Structure of Human Skin.

In order to meet the demands of nature, the skin is modified into various parts each being highly specialized for its own functions. The two main divisions are the epidermis or outer skin, and the dermis or underneath layer.

The rough, horny outer layer of epidermis serves for protection for the more delicate inner layers. Since this layer is made up largely of dead tissue, the outer surface of same is continually peeling off. This accounts for the presence of dandruff and the scaly condition of the skin at times. A portion of the ectoderm forms a layer of cells covering the body in the embryo. In the adult this becomes the outer layer of the skin or epidermis, and from it develops the hair, nails, mammillary glands, the sabaceous or oil glands, and the sweat glands. The deeper portion of the epidermis may be noted as a more delicate layer into the lower surface of which project the nervous papillae and blood vessels. This is known as the Malphigian layer. It is this layer which gives rise to various epidermal derivatives.

The inner thick vascular layer of skin, the dermis, contains the various blood vessels, nerves and glands. The sweat glands proper are seated in the dermis and in close proximity to the blood vessels and nerves. They appear as spherical bundles of tubules. The ducts of the sweat glands lead directly to the surface through the dermis, the Malpighian layer, and the epidermis, and open on small papillae. Both the nerves and blood vessels of the dermis end in papillae set in invaginations of the inner wall of the Malpighian layer. Since there are no blood vessels or nerves in the epidermis it functions as the protective layer. The sweat and oil glands and the hairs aid in keeping this outer skin pliable and endurant in order that it may function properly.

2. Structure of the Hair.

All the hairs of the body arise as local thickenings of the epidermis, and are consequently appendages of the skin. It is thus not surprising to note that each hair is composed of minute horny scales. The tube-like sac in which each hair is situated is called the follicle. This sac is made by the dipping down of the epidermis into the lower tissues. On the end of each hair shaft is a knob-like enlargement, the root, the basal end of which being more cellular in structure becomes continuous with the adjacent tissue. A small cup-like cavity at the end of the hair fits over a papilla which grows up from the base of the hair follicile. It is by this means that the hair receives nourishment from the blood. If the basal papilla is not injured a new hair will be regenerated as often as an old one is removed.

The hair is made more pliable by the oily semiliquid secretion from the tiny oil or sebaceous gland which opens by a single duct into the follicle near its top. A muscle which is attached near the base of the follicle sometimes causes the hair to stand erect. Make a microscopic study of a hair from four members of the class. Make a comparative study of the hairs of various animals.

EXERCISE I. Draw a section of the skin showing the above structure. (Center).

B. FEATHERS AND SCALES

Feathers arise in birds as do scales in reptiles, and hairs in mammals. As was the case with the hair, the feather is anchored in a sac, the feather follicle, and arises from the dermal papillae. When a feather or hair is young the basal papilla of the follicle, together with its contained blood vessels, extends far up into the shaft. Verify by cutting the feathers which are in various stages of development on a young chick or bird. Note that birds are not uniformally feathered. Locate these various feather tracts on a young specimen. Compare with the hairy condition in mammals.

The origin and development of scales, spines and quills is highly comparable to that of hairs and feathers. Present a chart showing the various animals grouped according to the type of ectodermal covering.

1. Structure of the Feather.

There are three principal kinds of feathers: (1) The contour which consists of the following parts: a stiff axail rod called the scalpus or stem; the proximal portion called the quill or calamus which is hollow and transparent; the distal portion called the vane, and the shaft passing through it called the rachis. The vane is composed of a series of parallel barbs, and each barb bears a fringe of small processes, the barbules, along either side. The barbules on one side of the barb bear hooklets which hold together the adjacent barbs. The whole structure is thus a pliable, but nevertheless resistant organ wonderfully adapted for flight. (2) The down or plumulae feathers possess a soft shaft with barbs and barbules without hooklets. They lie beneath the heavy contour feathers and form a covering for the retention of heat. In some of the down feathers the barbs arise directly from the quill and no shaft is present. (3) The long slender feathers with a hair-like shaft and very few or no barbs are called filoplumes.

EXERCISE I. Draw a single barb showing barbules and hooklets of a large contour feather. (Top third.)

EXERCISE II; Draw and label a plumulae feather. (Middle third).

EXERCISE III. Draw and label a filoplume feather. (Lower third.)

C. NAILS, HOOFS AND CLAWS

Although these spructuotures are developed differently according to the species they are all derived from the Malpighian layer of the skin. Nevertheless, even in adult forms they are quite similar. Make a comparative study of these three epidermal derivatives by beginning with a study of your own finger nails. The last of the phalanges extends under the nail. By pressing on the endoof your finger estimate the distance from the end of that bone to the epidermis. The end of each finger is called the torus, and the nail proper is called the nail plate. Note that the torus is not continuous with the nail plate. The epidermis is folded inwardly to form the nail fold so that the nail plate is deeply set into the finger. The horny material of the nail is developed in the lower layer of the proximal nail fold as far distad as the outer edge of the lunula, crescentic white area at the base of the nail. The nail bed is that portion of the finger upon which the nail moves in its growth. The torus and nail plate are separated by a scaley ridge known as the sole-horn. This may be readily seen by trimming the nails very closely. In diseased or injured condition the sole-horn ofttimes develops quite abnormally. In the case of hoofed animals the sole-horn is highly

developed becoming the sole of the hoof, the animal stands on the tip of the nail plate, but is partially supported by the sole-horn.

EXERCISE I. Sketch the side view of the last segment of one of your fingers and label parts indicated. Outline the possible position of the phalanges. (Quadrant 1.)

EXERCISE II. Make three other drawings (from specimens) showing the comparative anatomy of nails, claws and hoofs. (Quadrants 2,3, and 4.)

D. THE TEETH

There are normally developed in the human two sets of teeth--the milk teeth, and the adult or permanent teeth. However, it is not uncommon for a part of a third set to appear in extreme old age.

1. The Deciduel (Milk) Teeth.

This set, twenty in number, is for temporary use during childhood. They develop in the following order:

LOWER JAW	UPPER JAW
1. First incisor, 6-9 mo.	1. First incisor, 8-12 mo.
2. Second incisor, 12-15 mo.	2. Second incisor, 8-12 mo.
3. Canine or "stomach" 18-24 mo.	3. Canine or "eye", 18-24 mo.
4. First molar, 12-15 mo.	4. First molar, 15 mo.
5. Second molar, 24-30 mo.	5. Second molar, 24-30 mo.

2. The Adult Teeth.

About the seventh year the permanent teeth begin to grow beneath the milk teeth. By exerting a pressure on the nerves and blood vessels of the milk teeth, the nourishment is cut off thus causing the roots to be absorbed. Since they are thus held only by the mucous membrane of the gums they may be easily pulled. In some cases the members of the second set do not press in such a way as to cut off the nourishment and thus the permanent teeth appear in abnormal positions. In the permanent set there are 32 teeth divided so that each half of each jow contains 2 incisors, 1 canine, 2 premolars, and 3 molars. The permanent teeth appear asfollows:

1. First molars, 7 yrs.	5. Second premolars, 11 yrs.
2. Median incisors, 8 yrs.	6. Canines, 13-14 yrs.
3. Lateral incisors, 9 yrs.	7. Second molars, 13-14 yrs.
4. First premolars, 10 yrs.	8. Third molars,(wisdom teeth)17-40 yrs.

3. The Structure of the Tooth.

The tooth is divided into three parts; the root, which is set into the jaw; the crown, which projects above the gums, and the neck, the constricted region between the root and crown to which the gums are attached. The crown is covered with a very hard substance known as the enamel. The corresponding outer layer of the roots is the cement. Immediately beneath the enamel and cement is a thicker layer known as dentine. The inner cavity of this dentine is filled with pulp, blood vessels, and nerves.

EXERCISE I. Sketch one each of the incisors, canines, premolars and molars, (Quadrants 1, 2, 3, and 4.)

EXERCISE II. Break a tooth and sketch the layers as they appear.

E. Subjects for Discussion.

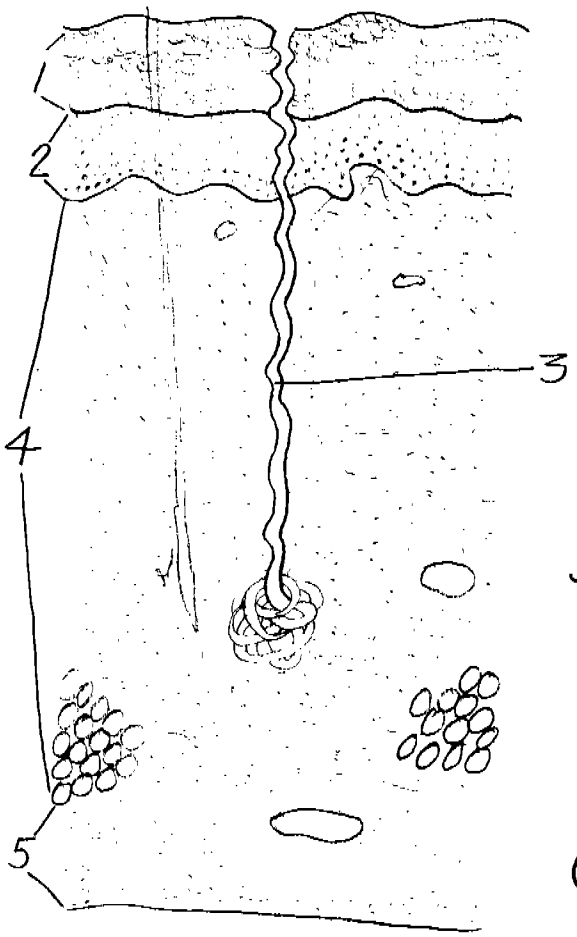
I. Consider some of the current conceptions as to the causes and cure of dandruff. From your knowledge of the structure of the skin present arguments for and against the use of cosmetics.

II. Discuss (1) Malpighi; (2) third dentition; (3) crooked;(4) misshapen teeth; (5) hare-lip.

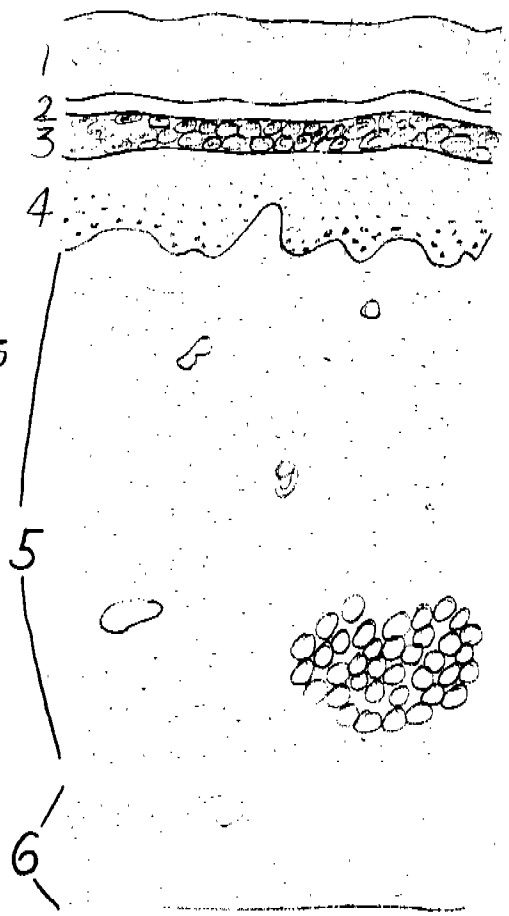
III. Formulate hygenic rules for care of skin, nails, and hair.

Name_____ Date_____

SKIN INTEGUMENTS



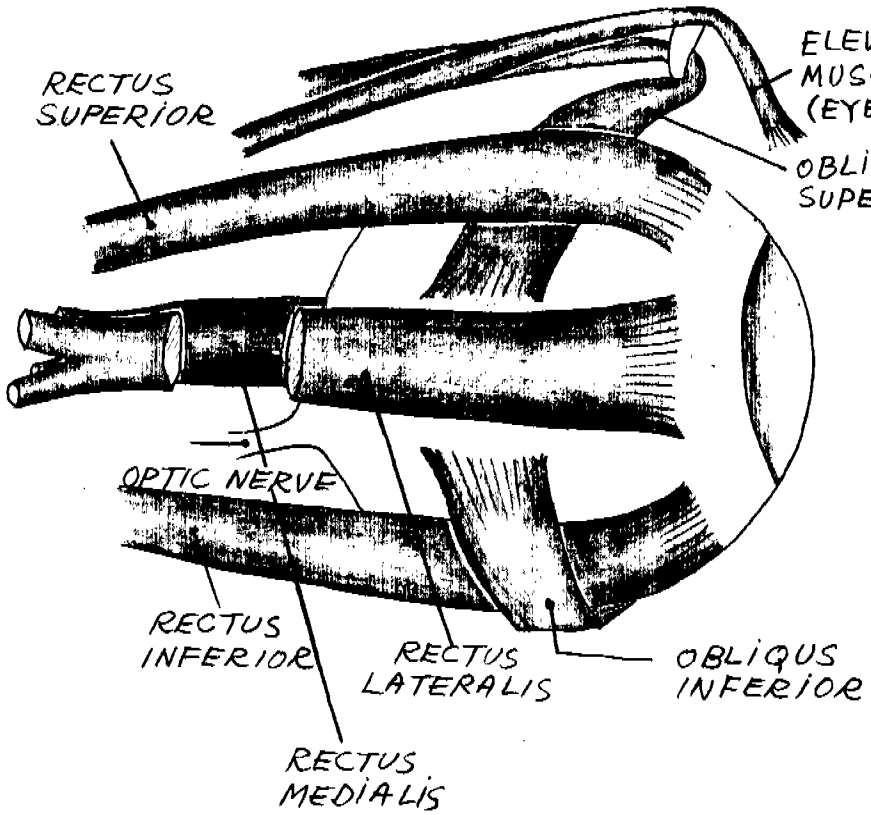
1- STR. CORNEUM
2- STR. GERMINATIVUM
3- SWEAT GLAND
4- CORIUM or DERMIS
5- SUBCUTIS



1- STR. CORNEUM
2- STR. LUCIDULUM
3- STR. GRANULOSUM
4- STR. GERMINATIVUM
5- CORIUM or DERMIS
6- SUBCUTIS

Name _____ Date _____

EYE MUSCLES



"naturally adapted" to their environment. (Snakes, moles, etc.) What has caused this adaptation?

IV. From your reading or lectures present brief comments upon the method by which many fishes, as well as other animals, change their color to conform to their background. Is this a voluntary or reflex action? Discuss the habits of various animals in relation to their protective coloration.

V. Prepare a discussion on the subject, "Strange Habits of Strange Fishes."

VI. Comment upon the work of the United States Bureau of Fisheries. How do the fishes of today differ from those of the Paleozoic Age?

VII. From your readings and lectures, compare the embryological development of the fish with that of the frog.

XVI. THE FROG

A. Development, Habits, and Relationships.

1. Collecting Frogs and Frog Eggs.

If practical the students should organize in small groups and make their own collection of frogs and frog eggs, thus giving an oportunity to study the natural habitat of the animals. The frogs may be collected at almost any time during the year except in the winter while they are hibernating. The time for collecting the eggs, however, is very brief. As soon as the warmer weather begins careful observation should be made in order that the laying season may not be missed. The eggs should be collected as soon after laying as possible. The frogs which have been collected for class work should be kept in a covered box containing moist sand and a pan of water, the pan being buried to the rim in the sand. They may be kept until they are needed for laboratory use. However, more satisfactory results will be obtained if the observations indicated in IV are made while specimens are fresh. The eggs should be placed in the laboratory aquarium (or large glass jars), and each student permitted to take all he needs for experimental purposes. Experimentations and observations on the development of the egg must of course begin as soon as they are collected, regardless of what may have been previously planned.

2. Embryological Development

Place a number of frog eggs in dishes, jelly glasses, or fruit jars on the laboratory table before you. Study the eggs with a hand lens and the microscope from day to day throughout the entire embryological development--until metamorphosis is complete. Change the water in the vessels every few days in order that development may not be hindered. Food for the tadpoles, may be prepared by mixing to a pasty constituency, raw eggs, dried and powdered alfalfa leaves, and flour. Spread out thin on glass plates, and let dry. Keep the food in dry containers, and feed the same as gold-fish food.

The eggs at first appear as single spherical cells, black on the upper surface and light below. The lower part is mostly yolk, said to be the vegetal pole, the upper, the animal. The nucleus and most of the cytoplasm is crowded to the animal pole. The first division is longitudinal. The second division is perpendicular and at right angles to the first, thus producing four equal cells. Since the third division is unequally equatorial, probably due to the large yolk supply in the lower cells, the upper cells, micromeres, are much smaller than the lower, the macromeres.

Continued cleavage produced a hollow sphere, the blastula (little Ball). The rapidly growing micromeres fold over the large

yolk laden macromeres, thus forming the gastrula, (little stomach) stage. Although this stage is marked by the beginning of the alimentary canal, it is difficult to describe in detail owing to the fact that development is complicated by the presence of the large yolk cells. However, it is highly comparable to the gastrula of amphioxus which is little more than a hollow sphere with a deep invaginated pouch is now the entoderm while the outer layer is the ectoderm, the former of course being derived from the latter. The space between the ectoderm and entoderm is now spoken of as the cavity of the gastrula. Later cells will migrate into this cavity and form the mesoderm. The gastrula cavity is the archenteron or primitive digestive cavity, while the opening into this cavity is the blastopore. Study these embryonic stages from the developing eggs and from prepared embryonic steges from the developing eggs and from prepared slides. Follow this development from day to day through the various stages.

The early stage of the tadpole is marked by the prominent exterior gills on either side of the head, and sucker-like mouth. Note the peculiar feeding habits of this fish-like larvae. From your observation compare the food of the animal, in this stage, with that of the older tadpole and later with the adult frog. Place a tadpole on a slide and observe with low power the circulation in the tail.

3. An Accelerator and Retarder of Growth

Place 100 frog eggs in each of three jars containing 500 c.c. of water. In the first jar feed the tadpoles small bits of commercial thyroid each day. In the second jar, each time the regular change is made, add 100cc of water in which the smoke of 2-5 of a cigarette has been dissolved. This is prepared by means of the mechanical smoker constructed as follows: Insert in a bottle filled with water a two hole rubber stopper fitted with glass tubes, one of which is long enough to reach the bottom, the other barely passing through the stopper. To the long glass tube attach a long rubber tube to be used as a siphon. The short glass tube is attached by a rubber tube to a similar glass tube in one of the holes of a two hole rubber stopper of a smaller bottle containing warm water. Through the other hole in the rubber stopper of a small bottle pass a glass tube long enough to reach the bottom. By attaching a cigarette holder, or pipe, to this tube and siphoning the water from the large bottle, smoke may be passed through the smaller bottle and thus dissolved in the warm water. By using two cigarettes or the equivalent amount of tobacco to 500 c.c. of water the ratio called for may be obtained. More smoke will be dissolved if the small bottle is only about half full of water and is shaken at intervals. Gradually increase the strength of the nicotine water from day to day. If the death rate is higher in that jar than others the nicotine per cent is too high. Nothing but clear water and clean food is to be admitted to the third or "control" jar. Note the difference in growth of the tadpoles in the three jars. Tabulate your results.

EXERCISE I. Present a series of drawings showing the following stages: 1,2,4, and 8 cell stages (1st, 2nd, 3rd, and 4th sixth,; blastula (5th sixth); gastrula (6th sixth); large embryo stage (upper third); tadpole stage showing : 1. Large external gills (middle third), 2. Protrusion of hind legs (lower third), 3. Protrusion of fore legs (upper half), 4. Young frog which still retains rudiments of the tail (lower half), 5. At the conclusion of the experiments on growth, make a sketch (twice normal size) of a typical tadpole from each of the three jars (upper, middle and lower third).

4. Subjects for Discussion.

1. What is Endocrinology?
2. Make a chart showing; (1) name, (2) location, (3) function, (4) inhibition symptoms and (5) acceleration symptoms of the various endocrine organs,--thymus, thyroid, super-renals (adrenals), pineal, parathyroids, gonads, pituitary, pancreas, etc.
3. Discuss some of the noted scientific experiments which show the effect of various poisons on the body of different animals.
4. Will these poisons affect the offspring?
5. Make a list of all the poisons which are being admitted to the human body and discuss whether or not they are injurious to the individual or to the offspring.
6. From your study and observation on the development of the frog, show additional proofs for the Recapitulation Law.
7. From your readings and lectures determine whether or not this law is as universally accepted as it was 20 years ago.

5. Habits and External Study.

Observe from day to day the habits of the frogs in captivity. Do they keep their skin moist? How and why? Loosely attach a small piece of meat to the end of a string and suspend it near the frog's mouth. Move it to and fro and observe the feeding habits. Place a number of toads in the box with the frogs and study difference in habits. Place various kinds of insects in the box and keep record of individual gastronomic feats. Do they exercise a preference? If the insect's color harmonizes with his background, is it "protectively colored?" Place the frog on the table before you and note the position while at rest, and also just before it moves. How does the frog jump, walk and swim? Note the movement of the throat of the frog. Count the pulsations and compare with the breathing of some of the higher forms. Slight pulsation at the right and left of the posterior end of the vertebral column may sometimes be observed, this being caused by lymph "hearts." These together with two others located near the third vertebra, assist in the movement of the lymph through the body.

Note carefully the general structure of the eye, especially a third lid, nictitating membrane, which passes over the eye-ball. From your observation, readings, and lecture notes compare the structure of the frog's eye with that of the fish and mammal, including the human eye. The frog has no external ears. The tympanic membrane is located on the outside just back of the eye. Devise experiments to show that the frog can hear. Note the spots and markings on the frog's skin. Will these change when the frog is placed on the various colored backgrounds, as black or white or green? Try this. From your study of the animal in its natural habitat would you conclude that it is protected by its color? Place a living frog on the stage of the microscope in such a way that the circulation in the web between the toes may be studied.

Kill the frog with ether or chloroform and continue your detailed study of the external structure. Open the mouth and observe; the internal nares near the angle of the upper jaw; the group of vomerine teeth on the dorsal roof of the mouth between the internal nares; oesophagus; glotus and the pharynx in the central part of the throat; the eustachian tube on either side of the oesophagus near the angle of the mouth; the tongue attached to the front of the lower jaw. Note the arrangement of the tongue and compare it with that of the higher animals. Place a glass tube in the pharynx and inflate the lungs with air. Devise methods by which a sufficient amount of air can be retained in the lungs of the dead frog to cause it to float partly out of the water. Conclude from your experiment the method by which the frog can remain motionless at various depths. Place a

living frog in the aquarium and observe this behavior. Show by density charts how it is possible for the various animals (fish, turtle, dog, man, etc.,) to float. Make a detailed study of the anterior and posterior limbs of the frog and compare these with those of higher animals. Compare the various bones of these appendages with those of prepared skeletons of other forms, including the human. The prominent hump in the middle of the frog's back marks the position of the sacrum. Examine this in prepared skeletons.

EXERCISE II. Make an outline drawing (upper half) of the fore arm of the frog and a miniature drawing of your own arm and hand. Sketch in the bones as seen from skeletons or pictures. Place a single set of labelings in the center which will serve for both drawings.

EXERCISE III. Make a sketch (lower half) showing the arrangement of the bones of the posterior limbs of a frog in comparison with those of man. Label

B. Internal Anatomy

Expand the limbs of a freshly anaesthetized frog and pin securely to the wax in the dissecting pan. With forceps lift the loose skin near the posterior end of the abdomen and with sharp scissors make an incision along the median line to the chin. In a similar manner make a transverse incision across the pelvic region, and another just posterior to the anterior limbs. Pin the flap to the wax on either side. Hurriedly note the large lymph spaces under the skin. In what way are these related to the vital processes of the animal? How and where is the skin attached to the muscles? Note the large cutaneous veins and arteries on the inner surface of the skin. These vessels are of unusual importance. Why?

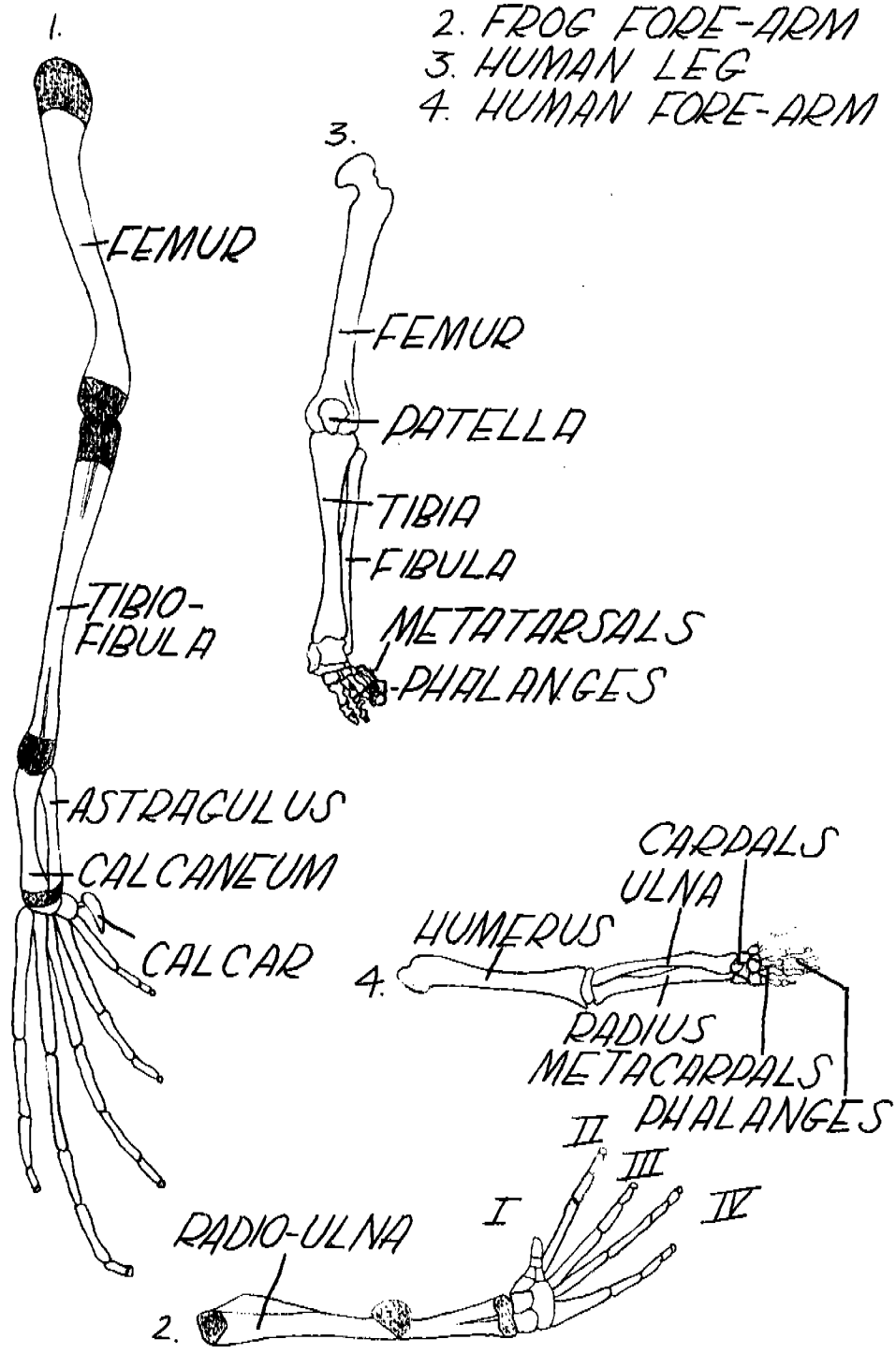
Note the muscles of the abdominal walls and chest region. In case you are dissecting a dead specimen before opening the body cavity, study in detail the principal muscles. However, if your specimen is only anaesthetized, omit this paragraph for the present. The broad submandibular muscle stretches across from one side of the lower jaw to the other with only a small median tendon which separates the right and left halves. The pectoral group of muscles, four in number, radiate from the base of the fore leg on either side, and extend fan-like over the delicate breast bone. The three pairs of abdominal muscles form the ventral and lateral walls off the abdomen. The two longitudinal muscles, the rectus abdominis, which lie in the midventral area, are separated by a narrow tendinous band, the linea alba. Note the four or five tendinous bands which cause segmentation in these two muscles. This metameric condition which was undoubtedly inherited from the forms (studied in the Amphioxus) can be traced through the higher vertebrates up to and including man. Has this any evolutionary significance? The external oblique muscle are the broad thin muscles which form the lateral walls of the abdomen. Beneath these may be found the third pair--the transversus.

Make a longitudinal and transverse incisions through the muscles of the body as you did the skin. Cut through the shoulder girdle on either side of the median breast bone, the sternum. After you make these incisions, pin the flap of the body wall back over the skin, exercising great care not to injure the underlying organs. There should be no delay as it is desirous to reach the internal cavity before the heart ceases beating.

In the anterior region of your incision you will note the pear-shaped heart pulsating in the sack-like pericardium. Carefully lift the three lobes of the reddish brown liver from over the heart and count the pulsations per minute, either continuously or at intervals until the beating ceases. Record any possible unusual fluctuations.

Name_____ Date_____

1. FROG LEG
2. FROG FORE-ARM
3. HUMAN LEG
4. HUMAN FORE-ARM



Does the heart cease beating suddenly or gradually? When would you say the frog is dead? Is death marked by the cessation of the heart beat, respiratory movements, or cell division? Do these three vital processes cease instantaneously? Define "death". You have seen "life" end, now when does it begin? Define "life."

The two delicate lungs, containing a small amount of air, may be found in the anterior end of the abdominal cavity. Pass a tube into the frog's trachea and inflate the lungs. Note the delicate membrane the peritoneum, which is continuous over each organ in the body. What is its function? Inflammation of the corresponding lining in man's body is called peritonitus. Locate the curved stomach with its expanded cardiac end and its tapering pyloric end, and also the coiled intestine suspended by the mesenteries. If the frog be a mature female, the ovaries and oviduct will probably fill the larger part of the body cavity. These may be removed without injuring the other organs. The two testes of the male are small yellow ovoid organs suspended by membranes from either side of the dorsal body wall, usually against the ventral surface off the large flattened kidneys. The spleen is a dark red spherical body located at one side of the forward portion of the rectum. The pancreas, an elongated whitish gland, lies in the bend made by the stomach and the adjoining part of the small intestines, the duodenum. What can you say as to the function of the large finger-shaped fat bodies which are so conspicuous?

EXERCISE IV. Sketch the internal organs as they lie in the body cavity. (Center.)

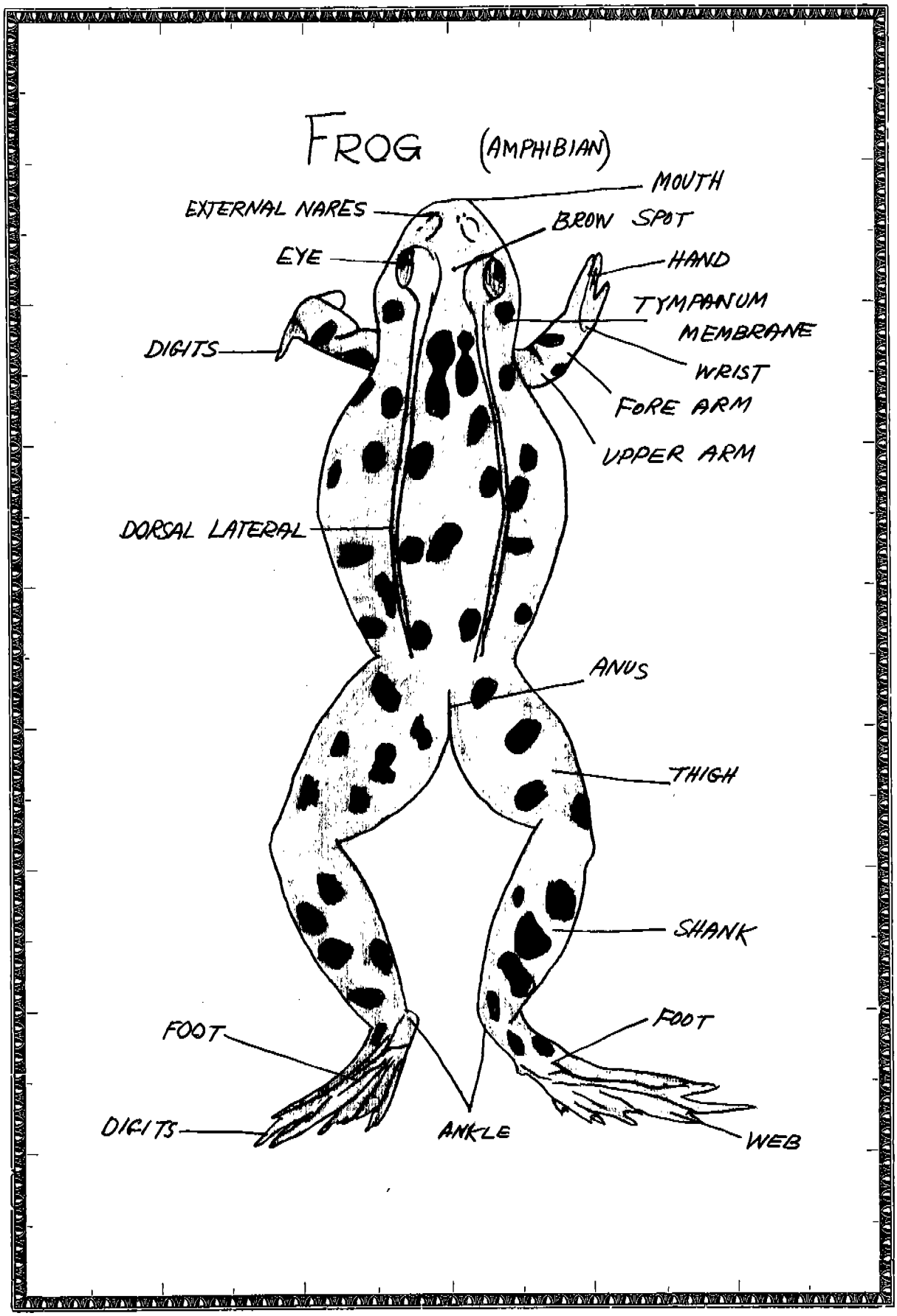
1. The Heart and Principal Blood Vessels of the Frog.

The heart is composed of the following five divisions: 1. A conical, muscular ventricle; 2 and 3. Two thin-walled auricles; 4. A thick-walled tube, the truncus arteriosus which carries blood from the base of the ventricle; 5. The sinus venosus, a thin-walled triangular sac which returns the blood to the right auricle. (Note exception.) Since this sinus is on the dorsal side of the heart, it cannot be seen without pushing the heart to one side. As the truncus arteriosus leaves the ventricle it divides into a left and right arch.

The arteries. The basal portion of the truncus is called the bulbus cordis. The anterior portion divides into two large vessels each of which inturn divides into the three "Aortic Arches" which send blood to all parts of the body. The most anterior pair is the left and right carotid arches which carry blood to the head, while the posterior pair, the pulmocutaneous carry blood to the lungs and skin. The middle or systemic arches after passing right and left around the heart unite to form the single dorsal aorta. Branches from the aorta supply the posterior limbs and the various organs of the abdominal cavity with blood. Before uniting to form the aorta each systemic arch sends off a branchial artery which sends off other small branches that carry blood to the fore limbs and others to the vertebral column, the vertebral artery, and to the jaws and nose, the occipital artery.

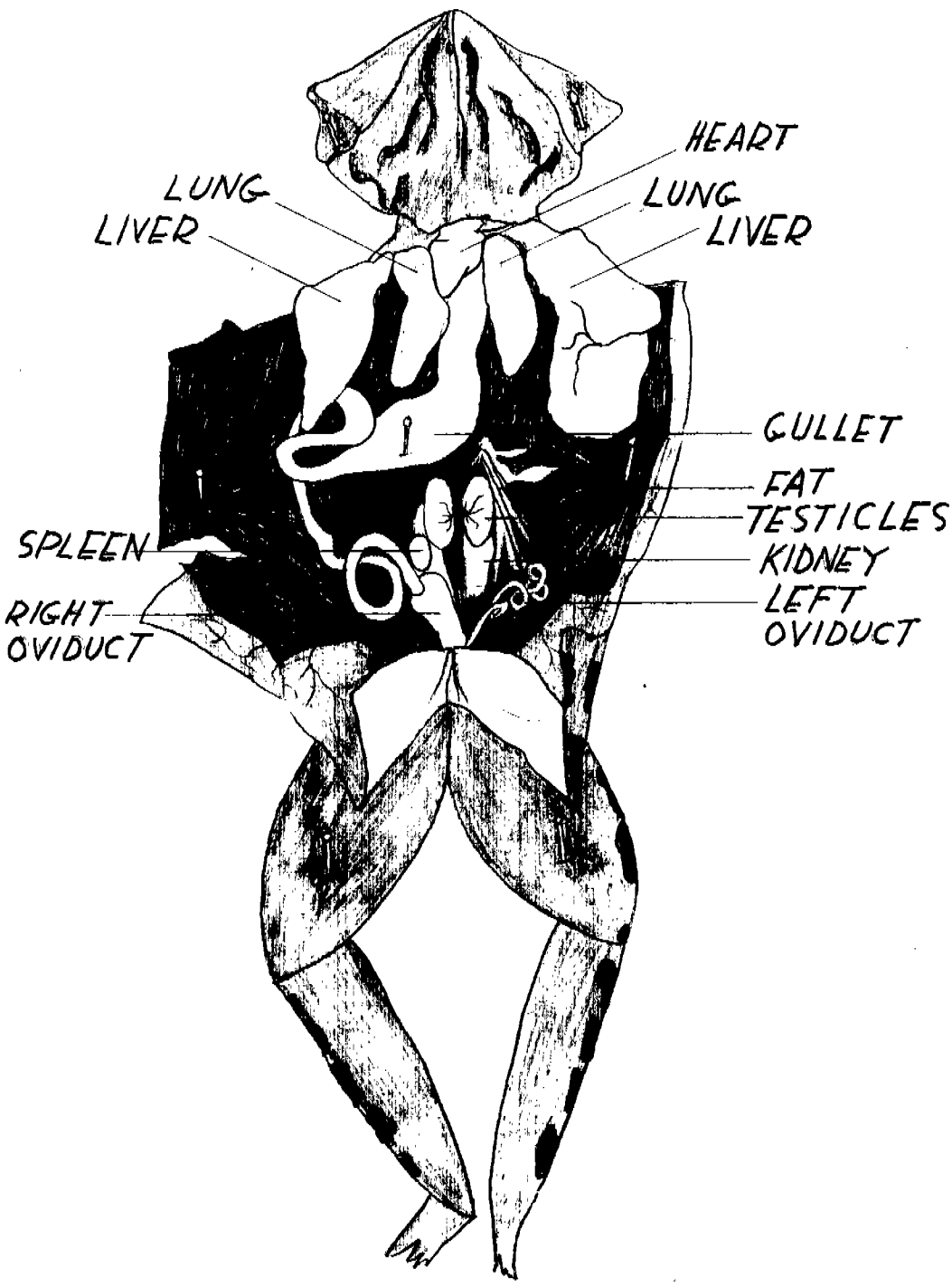
The veins. Withe the exception of the blood from the lungs which is carred to the left auricle through the pulmonary veins, all blood enters the sinus venosus, the two anterior venae cavae, the precavals, and the single median posterior vena cava, the post-caval. The two anterior veins receive blood from the head through the internal and external jugulars and from the fore limbs by means of the branchial vein. The single post-caval receives blood from the liver by menans of six renal veins. The renal portal vein which supplies the kidneys receivas bloodxfrom the posterior liibs through the sciatic and femoral veins, and from the body wall through the dorso-lumbar vein.

Name_____ Date_____


FROG (AMPHIBIAN)
MOUTH
EXTERNAL NARES
BROW SPOT
EYE
HAND
TYMPANUM
MEMBRANE
DIGITS
WRIST
FORE ARM
UPPER ARM
DORSAL LATERAL
ANUS
THIGH
SHANK
FOOT
FOOT
DIGITS
ANKLE
WEB

Name_____ Date_____

INTERNAL ORGANS FROG

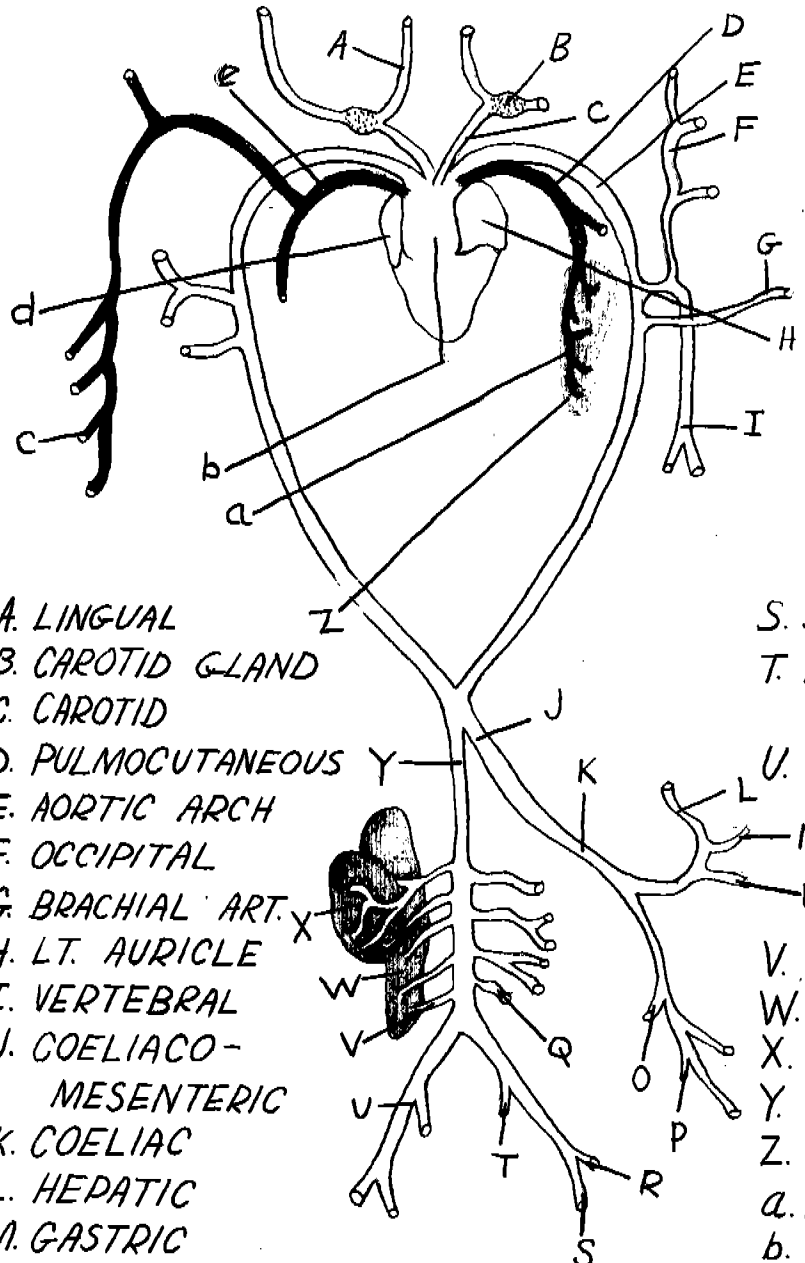


The University of Dubuque. Course_____

of the frog were selected from Kansas State Agricultural College Laboratory Manual. The author takes pleasure in expressing appreciation tion to the staff of the Zoological Department of that Institution for the privilege of using same in this connection

Name_____ Date_____

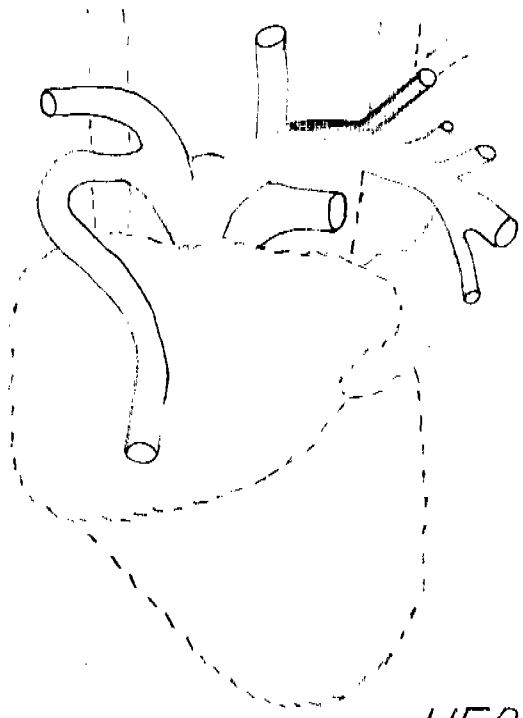
CIRCULATORY SYSTEM



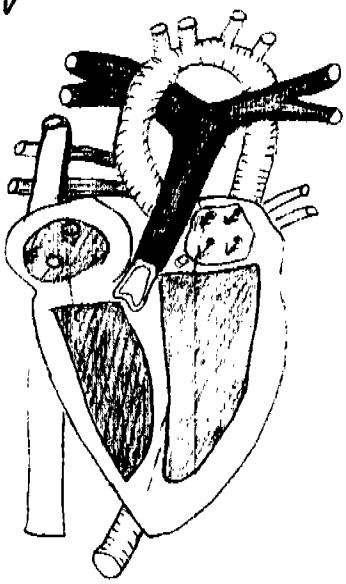
A. LINGUAL
B. CAROTID GLAND
C. CAROTID
D. PULMOCUTANEOUS
E. AORTIC ARCH
F. OCCIPITAL
G. BRACHIAL ART.
H. LT. AURICLE
I. VERTEBRAL
J. COELIACO-MESENTERIC
K. COELIAC
L. HEPATIC
M. GASTRIC
N. PANCREATIC
O. SPLENIC
P. HOEMORRHOIDAL
Q. POSTERIOR MESENTERIC
R. FEMORAL
S. SCIATIC
T. EPIGASTRICO-VESICAL
U. COMMON-ILIAC
V. RENAL
W. KIDNEY
X. TESTIS
Y. DORSAL AOR.
Z. LEFT LUNG-
a. PULMONARY
b. TRUNCUS ARTERIOSUS
c. CUTANEOUS
d. RT. AURICLE
e. PULMOCUTANEOUS.

Name_____ Date_____

BIRD HEART



HUMAN HEART



house of reserve food and do not belong to either reproductive or excretory system.

The Adrenal bodies are a pair of yellowish streaks upon the ventral surface of each kidney, are not related to the excretory system but are glands of internal secretion (also called Harmone or Endocrine glands).

EXERCISE I. Make a drawing of the female urino-genital organs, the cloaca and the bladder as seen from the ventral view. It may be well to show one of the oviducts in dotted line only, so as to show the ureter on that side. In case the ovaries have been removed indicate the size and position of one by a dotted outline.

3. The Male Urino-Genital Organs

The kidneys are a pair of dark colored elongated organs attached to the doraal body wall.

The testes are a pair of small light colored elongated bodies suspended from the anterior end of the kidneys.

The thin mesentary-like fold which supports each kidney is called a mesochium.

The fat bodies are a pair of yellowish structures with finger-like lobes near the anterior end of the kidneys. They are not a part of either the reproductive or excretory system but a storehouse of reserve nutriment.

Running along the outer margin of each kidney is a slender coiled structure, the rudimentary oviduct, corresponding to the oviduct of the female, but non-functional in the male. These connect with the cloaca in the same position as the oviducts of the female.

The ureter. Same as in female.

The adrenal bodies. Same as in female.

The testes discharge the seminal fluid containing the spermatoza through the vasa efferentia (singular vas efferens) several very slender ducts which can perhaps be seen, along the blood vessels, running through the Mesochium to the kidneys. These connect inside of the kidney, with the ureter through which the seminal fluid reaches the cloaca.

EXERCISE II. Make a drawing, ventral view, of the male urino-genital organs, the cloaca and the bladder.

E. THE NERVOUS SYSTEM

The nervous system is often divided, for convenience, into the central nervous system, the part encased in the bones of the cranium and the spinal cord, and the peripheral nervous system, including the nerve branches which traverse the body. It is, of course, understood that these two are united and comprise a single system.

1. The Peripheral Nerves.

Remove the kidneys and reproductive organs. On the dorsal wall of the body cavity the spinal nerves are now exposed as whitish cords running out from the sides of the spinal column. They arise from the spinal cord and emerge in pairs between the vertebrae.

Surrounding the base of each nerve where it emerges is a light mass, the periganglionic gland.

There are ten pairs of spinal nerves designated by numbers beginning anteriorly: the large nerves, already seen in examination of the Subclavian Artery, are the II pair. Trace one of them as far as you can, laying open the muscles of the arm as necessary.

The I nerve is a small one just in front of II. It sends a branch to II.

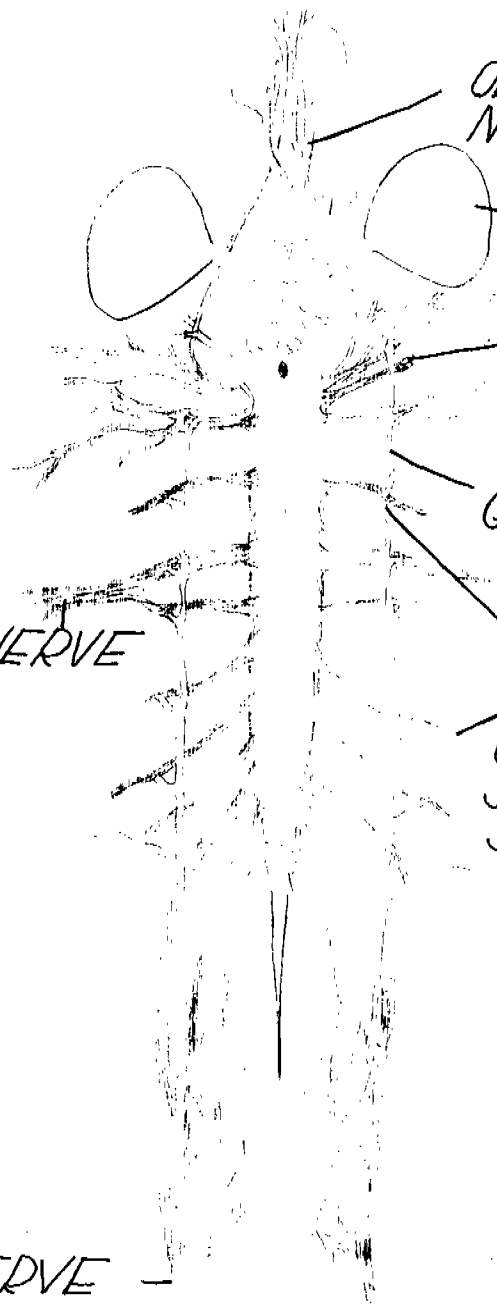
The III nerve is a small one which comes close to II sending off a communicating branch. These unions between the first three nerves comprise what is called the brachial plexus.

The IV, V, and VI are very slender nerves and run obliquely outward, over the muscles of the back.

The VII, VIII, and IX are large and run almost directly backward.

Name_____ Date_____

NERVOUS SYSTEM



OLFACTORY NERVE

EYE

GASSERIAN GANGLION

GANGLION OF VAGUS

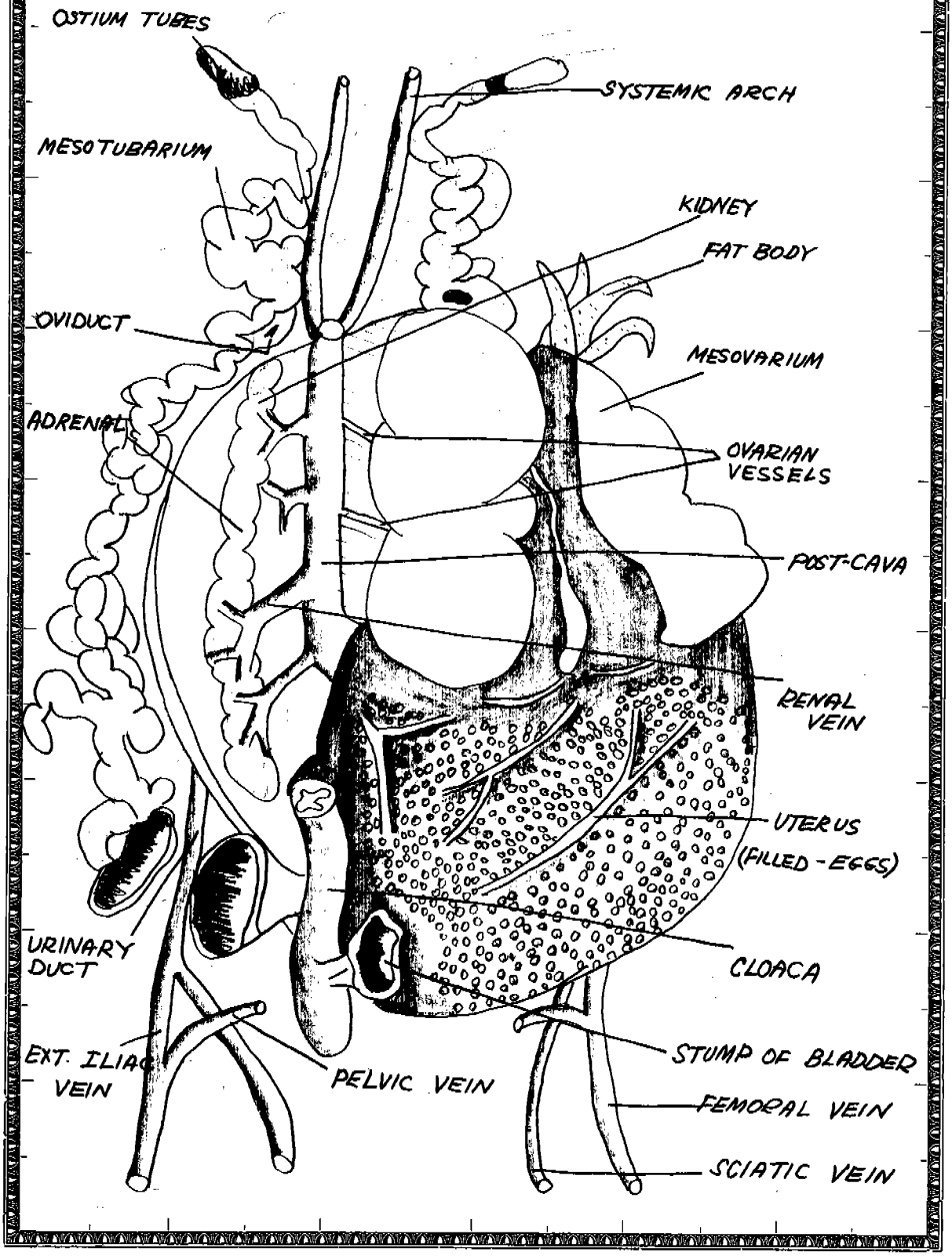
BRACHIAL NERVE

TEN GANGLIA OF SYMPATHETIC SYSTEM

ISCHIAL NERVE

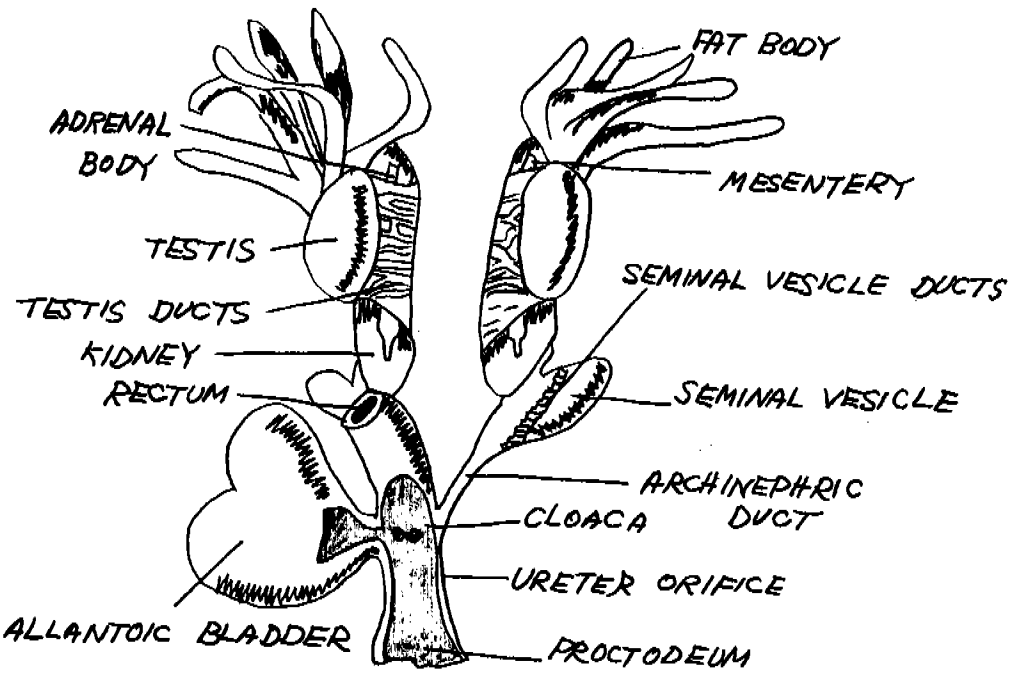
Name_____ Date_____

Female Urino-Genital System



Name_____ Date_____

Urinogenital Organs (male)



CLASS

PROBLEM.

Exercise

There are sections of our lungs which tend to resemble the old fashioned parlor of yesterday it gets a good airing out only at long intervals Ordinarily an adult breathes 15 times per minute and exercise increases this rate. During heavy muscular work the lungs use Oxygen at the rate of 3 liters per minute. In such spontaneous exercise as sprinting the 100 yard dash, the lungs use about 30 liters per minute. It is foolish to think that the lungs can supply more than 1/7 of this amount and consequently the runner becomes tired in a fraction of a minute at this pace. This fatigue apparently is due to the lactic acid present in the muscles of the body and the inability of the heart to supply the cells with blood enough to overcome this condition.

It is apparent that some sort of a synchronizing agent must be at work in order to keep this equilibrium between the Circulatory and Respiratory systems and this medium is the Nervous system. During exercise the the pores in the skin do a great deal to eliminate waste from the body through perspiration - taking away some of the work of the "over-worked" kidneys.

It is a great mistake among athletes that drinking water during a football game or basketball game is detrimental in one way or another - this contention is ungrounded.

It is very true that drinking too much will make him water-logged and sluggish but the imbibing of a few swallows is alright.

Physical fatigue tends to produce sleep. Three hours of moderate outdoor exercise are better than many barbiturates as inducers of prompt, calm sleep. Physical exhaustion, to be true, may make one too tired to sleep. This is different from nervous fatigue. In physical tiredness the large muscles are used and become tired. In nervous fatigue the small muscles are used. In reading, for instance; this is largely a neuromuscular activity and probably 100 times as many muscles are used as in a normal form of exercise. Piano playing is another exercise in the same category.

By "getting in condition" we mean the elimination through careful training, of all the waste products, fat etc from our bodies in order that our muscles may function at there very best. The results of such procedure are interesting from a physiologic point of view and include effects on muscles, coordination, heart & blood pressure:

1. The muscles gain in strength, size and endurance by training.

2. The coordinations, at least for the particular type of activity that is being practiced, are improved and needless

movements are eliminated.

3. In trained men the arterial blood pressure is lower than in the untrained man doing the same amount of work.

Taking off weight is a combination between dieting & correct exercising. For the business & professional man who must earn a living & still wishes to lose weight the most encouraging plan would be to restrict the intake.