********** Mechanics of Evolution Fall 1958 **********

[Transcript & comments on the class notes compiled by Byrd Curtis in 1958-59. My comments in brackets, all **bolds** added by HVH2. Text not in brackets is from Byrd's class notes. The information for each new day of class includes the page from Byrd's notes, period from the Outline, calculated day of the week & date and title from the Outline. {Outline Titles are shown in these brackets}]

[At the top of page 1 are some notes Byrd added:] due at end of course, Hand in 5 biographies of 5 famous scientists – info on the man – how his work changed people's thinking. 4 typewritten pages. Aristotle, Galen, Euclid, Archimedes, Galileo, Copernicus, Spinozi[1], John Lock, Newton, Harvey, Pasteur, Plank, Thomson

[Page] 1 [Period 1 – Monday, Sept. 15, 1958] Mechanics of Evolution

Monday 1:30 – 3:30 pm

Saturday 9:00 – 11:00 am

Sept. 15, 1958 : Cosmology and Cosmogony { Cosmology and Cosmogony}

George Gamow – The Creation of the Universe 523.1 G194c

Fred Hoyle – Frontiers of Astronomy 520 H 867f

Scientific American – Sept 1956

Morrison, Philip – The Overthrow of Parity; Sci. Amer. 196(4): 45-53, 1957

Brown, Harrison The Age of the Solar System; Sci. Amer. 196(4):80-94. 1957

Gell- Mann, Murray & E. P. Rosenbaum – Elementary Particles, Sci. Amer. 197(1):72-88 1957

[1] This may have been the philosopher Baruch Spinoza. See also: http://plato.stanford.edu/entries/spinoza-physics/.

Burbidge, Margaret & Geoffrey Burbidge – Formation of Elements in the Stars. Sci. 128(3321): 387-399. 1958 [This should let you read the first page of the paper, at least. HVH2]

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The history of the nature of matter.

Democritus – named the atom. Atomic theory (holes in H_2O – salts get in)

Not much further progress until renaissance. Newton Atoms w/fields

Boyles – gas laws (measurements)

[This name was added in the left margin by Thompson:] Geisler

[Then the next on the list is:] J. J. Thomson – director of Cavendish Inst. Thomson – discoverer of electron 1/1840 the wt of Hydrogen. [See Thomson in list above.]

Roentgen 1895

Becquerel – discovered radiation in Pitchblend

Marie & Pierre Curie Nobel Prize in 1903

Rutherford – purified pitchblend in container. Directed rays [small diagram showing α going up, γ in the middle (not moving) and β going down. and a note on the side:] X-ray, gamma ray – electrons, magnetic phenomena, [then] β – stream of electrons.

[from the name "Rutherford", above is an arrow pointing down to below the diagram:]

Demonstrated that atoms are mostly space – electrons are way out. [and another note:] α rays – nucleus of He w/wt of 84. [then at the bottom of the page Byrd wrote:]

Sent rays thru chambers containing many things – discovered proton – knocked out of all materials studied. – as well as α, β & γ radiation.

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1910 Frederick Soddy – made great intuitive discoveries in science. "Isotopes" – deduced that isotopes caused variation in atomic wt. of an atom, even thought the neurons, protons & electrons were the same.[2]

Aston – Nobel Prize in 1934 – Demonstrated isotopes by mass spectrometer. [below this Byrd drew a little diagram showing how a mass spectrometer would show different isotopes]

Chadwick – Nobel Prize 1935 – discovered Neutron – mass different than proton.

Anderson – discovered positron

Plank – Quantum theory [See Plank in list above.]

Einstein – Mass energy equivalent

2p	2.01516
2n	2.01786
	4.03302
2He =	4.00280
	0.03022

$E=mc^2$

[Below this Byrd has another diagram with Binding energy on the Y-axis and numbers 20, 40, 60, 80 on the X-axis and a solid line going up at 20, flattening out and trailing off towards 80]

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Hahn (1939 January) Germany – bombarding uranium U235 w/ neutrons

[2] I disagree with this. In the various isotopes, the number of Neutrons varies, while the number of protons & electrons remains the same. HVH2

Meitner, Lise assist. to Hahn

{below this is another diagram and below that :] See Arnons Paper

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[Per. 2 – Sat.] **Sept 20, 1958** {Cosmology and Cosmogony}

Reading for Sat., Sept 27

Crafts, A. S. et. al. Water in the Physiology of Plants

Chapt II p 3-18

1. Why do we want to know about the origin of things?

    a. Human nature is to want to learn.

    b. if we apply our reason we will see that knowledge of what has happened may help to direct us in our future work.

2. In older times we accepted the explanation that God created things as such. Now, some are skeptical because more is known about the universe. (Bacteria diseases and man).

    God is the creator – who is the creator? (Purely a definition of God).

Our first ideas were that the earth & universe were created for man. Earth was the center for all things. Planetary motion studies revealed that this was not so. Copernicus thought that the sun was the center (of our solar system). Hubble in 1927 caused us to appreciate the full size of the universe. We are on the tail of a galaxy. We are not in the center of things. Our present solar system is not the oldest thing in the universe.

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If man is rational, he has to apply logic and man wants to know.

[Byrd put this note on the left margin] Suppl. Reading The Universe and Einstein by Barnett

Know - Ylem theory (Gamow)

Mass was in condensed mass – Neutrons, protrons & electrons came together (after they were formed in expansion from heat) condensed.

Kinds of stars

Population I – inner stars are older because gaseous clouds are on fringe of galaxy.

To build elements must have extreme temp. (how to get extreme temp – must have been high pressure to cause explosion, thus high mass at beginning.)

[in left margin] β process – process where a β element (electron) is given up causes change in element.

[main notes] % of elements by numbers

H & He = 98.75

Lighter non-metals ¼

Metals 1%

The ability of the heavier metals for the heavier metals to capture neutrons caused a leveling off at 100 atomic wt.

[below this is a small graph of a curved line coming down (left to rt. and leveling off]

Mass 5 causes great unbalance. [at the very bottom of the page there are 5 circles grouped together. On left side two circles have N inside and on the right the two have P inside. A smaller circle at the top has nothing in it, but it may be the 5th mass and it may be Oxygen.]

[He finished up the class with a discussion about Gamow's theory "Ylem" in which Gamow and his coworker, Ralph Alpher, proposed a very dense and condensed original state of matter in which all the material of the entire universe was, at first, contained. He called this material "Ylem". Then the Ylem ball exploded and as it cooled out, it condensed into protons and electrons and then atoms. Ralph Alpher was a mathematician extraordinaire who produces the mathematical computation to back up Gamow's ideas. As the exploding ball of mater/energy expanded it continued to cool, stars formed under their own gravitational pull and larger clusters of stars formed, resulting in the galaxies we know today. This author believes that Dr. Harlan preached this message at home, too. The above lesson was continued on September 7, 1958 and ended with instructions to find and study the:] ***Hertzsprung-Russell Diagram of the evolution of stars*****.**

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[Per. 3 - Mon.] **Sept. 22, 1958** {Cosmogony: Water}

[in upper right margin:]Frank Blair,

Prof. Zool.

PO Box 7536, Union St.

Austin, Texas.

Bonner & Galston - Ch 2, 9, 10 & 11

Harlan – Ch. 6 Theory & Dynamics[3]

Ombreit – Metabolic maps 612.015

[3] This is a reference to Harlan's new book: "Theory & Dynamics of Grassland Agriculture" 1956. To see a review of this book: https://scholar.google.com/scholar?q=Theory+%26+Dynamics+of+Grassland+Agriculture+Harlan&hl=en&as_sdt=0&as_vis=1&oi=scholart&sa=X&ved=0CBsQgQMwAGoVChMI0uyK7-3wyAIVRuImCh1r0wzc.

Sci. Amer. – Sept 1957 issue

Crafts et. al. – Ch 2 – Water 581 c885w

Science 127(3305) 1026-1034, 1958

Sci. Amer. 199(2): 77-82. 1958

[Note: re the above articles and chapters:] Outside reading to be discussed Sept. 27, 1958

Cont'd Cosmology

Cont'd Gamow

General Theory – one time aggregation w. extreme density. Mass exploded – temp dropped – stabilization of radiant particles, nucleus formed by alpha process & neutron capture, essentially elements formed in present abundance. Energy was converted into form & mass & gravity took over. Large matter pulled together and condensed – producing groups of galaxies of numbers of stars.

H_1 – $4H^{++}$ + $4He^{++}$

Spectrum of the gases of the universe gives a good idea of how abundant are the elements.

Earth has much water – has blanket O_2 over atmosphere which screens out ultra-violet (U. V. disassociates water into H_2 & O_2). Earth water stays.

Jupiter [here is a diagram with concentric circles, representing Jupiter. Inside ring:] 2% rocky core, [middle ring:] 8% frozen H_2 & ammonia. [outer ring:] 90% 4H++ helium)

[on left margin:] The denser the galaxies become, gravitation become greater & mass pulled together with rise of temp. to form nuclear reactions.

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Large planets can hang onto large mass of Helium while smaller planets – like earth – cannot.

Sept. 27, 1958: {Photosynthesis: Metabolism}

Water – know properties

H_2O = water vapor

$(H_2O)_{2+3}$ = liquid water

Ice = rigid structural lattice

[Byrd has drawings of two different lattice structures &:] angstrom = 1/10,000,000 micron[4]

Why is water a liquid?

H boils at -253^0 c		Tendency of Hydrogen to be attracted to 2 Oxygens gives
O_2 boils at -180^0 c		liquid water the cohesion
Water boils at 100^0 c		
S boils at 444^0 c		dielectric constant = a non conductor - insulator
H_2S boils at -61^0 c		a slight shifting of positive & negative. Water is a polar
Dielectric constant		liquid
HCN	94.4	
H_2O	56.6	
CH_3 CH_2OH	28.4	
Benzene	2.2	

[4] This is incorrect. One ångström = 10^{-10}m and 1 micron = 10^{-6}m; so, 1 Å = 10^{-4}µ

Heat of fusion

Polar liquid	Normal
High dielectric	low
High surface tension	low

Polar molecules have a greater attraction or cohesion (internal pressures, surface tension & heat of evaporation.) Normal molecules have greater symmetry and polar have less symmetry.

The unique properties of water play a great role in environ.

Water 7% of earth's mass

$1.41X10^{18}$ metric tons

$328X10^{6}$ mi^3 [today's estimate in 333 million cubic miles]

$49.4X10^{15}$ tons salt

Ocean water is 3% [salt]

Human body = 65% H_2O

5 unique properties of water

a. High heat of fusion
b. Di-electric constant
c. High heat of vaporization
d. High surface tension
e. Dipole attractions

[Page] 10 cont'd Sept. 27

Metabolism

Light cleaves water [molecules] – amt of cleavage proportional to intensity of light

And enzyme usually requires a co-enzyme – metals may act as co-enzymes; minor elements play important part here. Vitamins may also. Co-enzymes are very important in nutrition.

Continue glycolysis & Krebs cycle –

Read on Phosphate bond system – how energy may be transferred by these bonds.

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"Readings in Cytochemistry 1958"

Jour. Biophysical & Biochemical Cytology 576.308 J86 1958 (Esp. Siekevitz & Palade)

Cold Spring Harbor Symp. XXI 1956 (Esp. Mirsky et. al. & Brachet & Chantrenne genetic mechanisms)

Int. Rev. Cyt.

(Esp. Hackett on mitochondria in plants) 1955

Fine structure of Cells – Leiden Symp. 1954 (Esp. **SJÖSTRAND** on mitochondria) [Not sure if this is the exact article, but it is close in subject. HVH2]

(Just look) Soc. Exp. Biol. Symp. X 1957. Mitochondria – other cell conclusions [Can't find this one]

Function of various organs within the cell. List functions of the cell constituents.

[Page] ?[, Per. 5 - Mon.] Sept. 29, 1958: [Seems to be missing. Did Byrd miss a class?]

[Page] 12[, Per. 6 – Sat.] Oct. 4, 1958: {Cytochemistry: Viruses; Origin of Life}

Ergastoplasm – endoplasm reticulum

Cells of high metabolic rates are used for studies of cell particle function.

First particles of cell fractionation

1. Nuclei
2. Zymogen – enzyme precursors.
3. Enzymes – TAPase etc. (digestive hydrolytic proteins.)

Know. Structure of Mitochondria (Sci Amer. July, 1958 Green) Systems of membranes.

Function of mitochondria

Respiratory enzyme system – converting oxidative energy into usable form

Aerobic system

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Microsomes

Structure – fragments of endoplasmic reticulum

Function

Produces granules that may be precursors of zymogens

1. Protein Synthesis

   Role of RNA in protein synthesis – linkage of amino acids to each other forming a chain – coiling in cytoplasmic reticulum.

   AA (amino acid) + ATP + enzyme → activated AA

   RNA is template for amino acid chain.

Ref. → Weis, Ase, Tipman. Proc. Nat. Accad of Sci. 1958. Pigeon pancreas.

Amino acid corporatin

Helen Gay's work

Salivary glands of drosophila

Found Blebs or outpockets of nucleus membrane into cytop0lasm

Blebs → ergastoplasmic lamellae → secretion granules. [Here Byrd drew a little diagram of a bleb bulging out of a nuclear membrane.] Blebs assn. with certain part of ch. – believes heterochromes high in RNA. Blebs transport material to cytoplasm from nucleus. Correlated w/appearance of granules in cyto (ergastoplasmic lamellae) – Blebs disintegrate into these.

[at top of page 14:] Microsomes formed from dense granules of lamellae.

Blebs

[Page] 14 [, Per. 7 – Mon.] Oct. 6, 1958: {Viral Genetics}

Readings for Oct. 11, 1958[5]

Demerec, M. What is a gene – Twenty years later, Amer. Nat. 89 (844): 5-20, 1955 [can't find]

Bernzer, S. Fine structure of a genetic region in bacteriophage. Proc. Nat. Acad. Sci. 41(6) 344-354, 1955 [see: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC528093/?page=2. This paper is very interesting in that in 1955, they just got Watson & Crick, but were not sure what to do with it. They knew that DNA somehow was responsible for providing genetic instructions. They did not know how this happened, yet. "Genes" had been known for some time and somehow DNA was responsible for the action of genes. Watson and Crick demonstrated that DNA had a double helical form at the molecular level. The following website is a good timeline of genetic research:

https://www.genome.gov/Pages/Education/GeneticTimeline.pdf.]

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[5] [Note that Watson & Crick had released their structure of DNA in 1953, five years previous to this class, but Harlan does not mention it in the class notes. On Oct. 5, 2015 Byrd emailed me that Harlan did mention Watson & Crick in this class. The lecture/discussion was about the parts of the cell and what they do. It seems to touch on DNA & RNA, but nothing much is known about these molecules at this time, or at least Harlan did not get into that aspect or Byrd did not record it.]

Benzer S., The Elementary Units of Heredity, Chem. Basis of Heredity, pp 70-93

Swartz, Drew, Speculations on Gene Action and Protein Specificity. Proc. Nat. Accad. Sci. 41:300-307, 1955 [Note that Dr. Swartz is struggling in this paper with how DNA can specify a particular sequence of amino acids in proteins. He proposes several possible mechanisms but does not come up with the mechanism (the 3-nucleotide code) which we now know to be the case. It is interesting how Jack Harlan is taking his students out to the frontiers of knowledge in this most arcane field of molecular biology. HVH2]

Ris, Hans, Chromosome Structure, Chem. Basis of Heredity, pp 23 – 61 [can't seem to get this one]

Allfrey, V. G. and e. M. Mirsky. The Role of DNA in Polynucleotide Synthesis. Proc. Nat. Accad. Sci. 43: 589 -598. 1957 [I can see that his paper was referenced by many, many others in the field after its publication, but I cannot find it online. HVH2]

Oparin (3rd Ed.) Origin of Life on Earth

Alexander. Book on Origin of Life [these last two are] For general reading for basis of thought, summaries.

575 1W 1348 Genetics and Metabolism – Ch. 8 Metabolic Patterns.

[In 1944 Barbara McClintock discovered "Jumping Genes". Harlan had his students study this paper. In 1952 Alfred Hershey & Martha Chase show that DNA is the chemical substance that is the heart of the gene. One year later, in 1953, Watson & Crick showed that DNA has a double-helical structure. There must have been a lot of work on DNA in those days.]

[Page 15] Endoplasm

Endoploidy

Increased number of chromosomes

Increased amt of Ch. material in cell.

Structure of Mitochondria

Contain cristae (appears as lammations) [lamellae?] appears to be a tunnel inside – increases surface area.

Functions:

1. Provides enzymes for Citric Acid Cycle
2. Electron exchange – oxidizes – producing energy rich bonds.
3. Energy relationship
    a. Synthesizes ATP
    b. Glycolysis probably does not occur. If so is a minor thing.
4.

Microsome

Separate from mitochondria by centrifugation

Principal constituents

RNA is principal constituent.

Function:

Chief cycle of protein synthesis

RNA

? does RNA in microsomes receive coded message from inside nucleus by means of blebs (endoplasmic reticulum) [On right side is a diagram of ER – a double sinuous line, closed at both ends, with little dots on the outside surfaces labeled:] roughened surface, thought to be endoplasmic reticulum [and] endoplasmic reticulum H. Gay thinks that may have

come from DNA of Ch. [In the lower left hand corner of the page is a sketch showing a Bleb coming out of the nuclear membrane. And a note below it:] H. Gay's paper. Blebs look like endoplasmic reticulum.

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Golgi apparatus – remains obscure as to what it is.

Nuclear cytoplasmic relationship

[now we have a diagram: a larger oval shape and inside it is a double circle – it looks like it is a cell with a nuclear membrane inside it. If so, the cytoplasm is between the inner double walled circle (the nucleus) and the outer circle (the cell wall). There is a single note pointing to the inner, double-walled circle:] Considerable production of RNA near nucleus. Some nuclear material goes out into cytoplasm and carries message for production of proteins. Protein formation probably requires energy obtained from ATP in mitochondria (Plastids)

Energy for cell division probably comes from ATP inside nucleus.

De-nucleated cell can grow & synthesize protein for some time but sooner or later stops producing proteins.

Composition of Nucleus

1. Chromosomes
2. Nucleolus
3. Nuclear membranes
4. Nuclear fluid
5. Spindle apparatus

[And on the right side of this list, and apparently having nothing to do with it, is a diagram of a cell with Krebs Cycle and Cytochrome system, both inside dashed circles and various things coming in & out of the cell.

[Page] **17** [Per. 8 - Sat.] **For Oct. 11, 1958 {Microorganisms: Chemistry of Gene Action}** [see also page 104]

[The notes begin with a discussion of Cis & Trans and he has some little diagrams illustrating these two terms. To review genetics as of today, but sort of vintage 1958 see Biology:]

Recon – shortest unit of Ch in which can have a crossover or recombination

Muton – 5 nucleotides long – shortest length that can give rise to a mutation that can be detected by into phenotype

Cistron – old locus – has to do with a particular ch. site in which a number of pseudoalleles can occur.

[to the left of these words Byrd copied:] Originator of terms not known. [Under the three terms he wrote:] How short a distance required by a mutation may be quite different among organisms.

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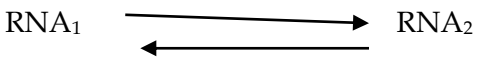
I Origin of Life

How can we demonstrate living from non-living?

a. Metabolism – can live, transport & use energy. Viruses have: (contain most features of living things.) Proteins & nucleotides
   Conditions probably occurred in sea. Soup of materials may have accumulated in oceans – no predators of any sort to destroy.
   Must have had a reducing atmosphere – one lacking in O_2. NH_3, Hydrocarbons, small
   amt CO_2. Water vapor. Iron & Sulfur used in cytochrome system.

Iron using bacteria may have been in tremendous numbers at one time.
Some studies have been made having these conditions & running spark thru.
Some amino acids have been produced. First long step in producing proteins – purines and pyrimidenes.
Now possible to synthesize DNA by using DNA as a model.. Now DNA has been synthesized but is "nonsense DNA"

Relationship of polynucleotide & DNA



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Needham, Joseph, Biochemistry and morphogenesis, 1942 574.19 N374b.

[Page] 20[, Per. 9 - Mon.] Oct. 13: {Chemistry of Gene Action: Evolution of Sex}

[On Monday, October 13, the class received another list of eight papers on various topics of embryology, the biochemistry of genetics, the action of hormones. The title for this list was:]
"Readings in Morphogenesis"

Bonner, J. T. Amer. Nat. 86:79-91, 1952 [I cannot find this issue. HVH2]

Bonner, J. T., J. Exp. Zool. 106:1-26, 1947 [This organism (slime mold, *Dictyostelium discoideum*) starts off as a single cell organism, but as it grows it forms itself into a multi-cellular organism with differentiated parts.]

Bonner, J. T., J. Exp. Zool. 110:259-272, 1949: "The demonstration of acrasin in the later stages of the development of the slime mold *Dictyostelium discoideum*." [Referenced many times, but can't find paper online. HVH2]

Bonner, J. T. & M. K. Slifkin, *Amer. J. Bot.* 36: 727-734: "A study of the control of differentiation: The proportions of stalk and spore cells in the slime mold *Dictyostelium discoideum*."

[So, Dr. Bonner was studying slime molds and published in both Zoological and Botanical journals. But, slime molds are considered very primitive forms of life and Harlan was exposing his students to these little creatures. Notice the progression: Molecular Biology and DNA, then slime molds, then …]

Sussman, M. J., Exp. Zool, 118:407-417, 1951, ["The origin of cellular heterogenty in the slime molds Dictyosteliaceae." I could not find the article, but I got the title from a reference.]

[From a more recent publication we read: "Slime molds are a remarkable lineage of amoebas that live in soil. While they spend part of their life as ordinary single-celled creatures, they sometimes grow into truly alien forms. Some species gather by the thousands to form multicellular bodies that can crawl. Others develop into gigantic, pulsating networks of protoplasm." *Can Answers to Evolution Be Found in Slime?* by CARL ZIMMEROCT. 3, 2011, New York Times, found at: http://www.nytimes.com/2011/10/04/science/04slime.html?_r=0. So, here is a more contemporary scientist looking for answers to evolution's never ending questions in slime mold. Now, Harlan turns towards plants:]

Leopold, A. Carl, Auxins and Plant Growth, Chapt. IV & V, 1955

Thimann, K. V., The actions of Hormones in Plants and Invertebrates, 1952 [This book is referenced a lot, but I cannot find it on-line]

Needhaur, Joseph, Biochemistry & Morphogenesis, 1950, Section 2.3 Amphibian development page 141-188 – read first. [I found a review of an earlier (1942) which praises it in many ways. The whole field of discovering the biochemical basis of morphogenesis (the origin of forms and functions) was just opening up. This book is very thoroughly put together. See:

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2601294/pdf/yjbm00507-0108b.pdf.]

Waddington, C. H. Principles of Embryology 1956

Easier to read than Needham & Joseph. Evocation & Indivication (middle of book.

[At the bottom of the page Byrd wrote:] "Try to understand how organisms are organized (Waddington)."

[Page] 21 [Oct 18, Per 10? {Morphogenesis}]

Viruses have certain properties of life

A. Consist of
    a. Polynucleotides arranged in special manner
    b. Proteins
B. Qualities of viruses characteristic of living things
    a. Ability to reproduce by polynucleotides – only type chemical known that can reproduce [Now, he has several diagrams showing how a virus comes into a bacteria and he has a note:] enzyme in tail of phage that causes hole for DNA entrance. Short time after virus is in cell it is inactive. Bacterial DNA (by whole bases) is transferrcal to viral DNA then formed followed by the tail.

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A b c λ d e lambda, behaves as if it were a virus stuck into a ch.

Viruses appear to be so closely related to bacterial DNA that they may be inserted.

    b. Virus cannot support itself. No metabolic action. Host cell does all work at a cost of its life.
    c. Sources of energy are required. Reaction systems that supply energy require specific enzymes & proteins.

Chromosomes

RNA is synthesized in the nucleus and sent out (blebs?) carrying info into for the synthesis of protein.

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Evocator – carries out several useful functions of "regional determination" or "individuation" we require a word for what is left. This was at one time called induction. Secondly, evocation is given to all substances which are known to stimulate gastrula ectoderm to neural differentiation.

[Page] 24 [Oct 20, Per 11?]

Life History of Dictyostelium

1. Life history of Dictyostelium [And, then there are diagrams of:] spore → splits, myxamoebae → divides many times & forms many unicella, forms acrasin (evacuator), → Acrasin – Chemical substance all myxamoebae start streaming together – attracted by acrasin [now there is a diagram with a irregular shape with four sets of wavy lines coming out from the shape and lots of little dots around them. Vegetative stage [with an arrow pointing back to the figure just described and:] animal stage [with an arrow pointing to a more circular figure which is shaded. The irregular figure described above also has an arrow pointing from it to the shaded circle. Beneath the shaded circle was a note:] psuedoplasmodium (multiple cell organism) [from this word is a long arrow going down the right side of the page and across to the middle of the page and points to another figure which represents the organism in the reproductive stage. The figure shows a profile view of something sticking up out of the ground. The lower part is labeled:] stem [beneath the figure:] last cells to arrive becomes the serus; first cells act as base. Basal or stalk cells die. [Off to the right of this figure is writen:] Determination is reached completely.
   [At the bottom of the page:]

   Determination – fate of cells decided and reverse action cannot occur. This is a process and there is various degrees of it.
   Differentiation – tissues set apart. (above- disks & sorus. Disk cells die – spores live)

   Determination or differentialism has not occurred when new plasmodium formed. Then acrasin starts moving to front end – which moves faster.

[to the left of this:] center of psuedophasmodium begins when several cells get together & secretion of acrasin becomes more concentrated.
Any myxamoebae is toda-potent i.e. any single one can start over again.

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Dictyostelium has:

Evocation – a response to an evacuator (chemical substance Acrasin in this case.

differentiation

determination

individuation – process that organizes the responses into a system of orderliness.

Competency – ability to respond. After determination there is loss of competence.

Induction – one tissue calls forth another. Includes both evocation and individualism.

Dictyostelium reduces morphogenesis to as simple a situation as possible – yet does not explain it.

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Gastrulation

[Here Byrd has a series of diagrams taken from Harlan's work on the black board. Underneath the first line of diagrams, two of which are X'ed out, he wrote:]

Zygote developed by cleavages until hollow ball is formed.

[Below this are two circles. The one on the left is labeled:] Blastula [And the one on the right, which has another figure inside it and is labeled:] invagination of Blastula

[Below these figures he wrote:]

Vogt's Fate Maps (important contribution in embryology uses vital stains on gastrula)

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Evocation – [Evocation seems to be the action of an evocator or someone or something which evokes something else to happen. In the field of embryology or developmental biology evocation has to do with causal effects which bring about the development of certain features of the developing embryo. Johannes Holtfreter was a pioneer of developmental biology – or the discovery of evocation in embryos. HVH2]

Holtfreter

> Many tissues (liver, chemicals, etc.) if boiled can produce evocators. Boiling causes protein coagulation. [What Harlan was saying seems to be that Dr. Holtfreter boiled an organizer region of an embryo, thus killing it, and yet it still was able to act as an evocator. See: http://embryo.asu.edu/pages/chemical-induction.
>
> O. Mangold – developed technique of tissue transplants in gastrulation. insertion of tissues may cause other tissues to develop secondary embryos.
>
> > Can get responses from tremendous number of tissues if they are boiled.
> >
> > What chemicals are involved? Do not know.

[Page] 28 [Per. 12] {Morphogenesis}

Readings for Sat. Oct. 25, 1958

[Byrd just had the references. I found the titles. HVH2]

Charles E. Wilde, Jr. J. Morph. 97(2):313-344, 1955 [The relationship between pheaylalanine metabolism and the differentiation of neural crest cells. Open this and search for Wilde for a paragraph about this paper.]

C. H. Waddington – Evolution 7:118-126, 1953. [This experiment was conducted before Watson & Crick's discovery and was probably given for the class to see how various theories had been floating around.

Abstract

1. A wild Edinburgh strain of D. melanogaster produced no flies showing a break in the posterior crossvein when bred at 25° C., but a certain number occurred (as phenocopies) when the pupae aged 21-23 hours were subjected to 40° C. for four hours. 2. Selection was practised for and against the appearance of the phenocopy, and rapid progress occurred in both directions. After about 14 generations of selection, some flies in the upward selected strain were found to show the effect even when not exposed to the heat shock. From these, lines were built up which threw a high proportion of crossveinless individuals when kept continuously at 25° C. (and even more at 18° C.). 3. The crossveinless character, originally a typical 'acquired character,' has become incorporated into the genetic make up of the selected races. A process of 'genetic assimilation' is described by which this might be supposed to happen; it depends on the tendency of selection not merely to increase the frequency of any favorable character, but also to stabilise its development. A similar suggestion has been advanced by Schmalhausen (1947). 4. The genetic basis of the assimilated crossveinless character is polygenic. There is little evidence of any definite distinction between canalising and switch genes.]

[Another article by Waddington in 1952: On The Existence of Regionally Specific Evocators, found at:
http://jeb.biologists.org/content/29/3/490.abstract. Which, as the title suggests, there something, pieces of tissue, organs (?) which call for other embryonic structures to be constructed. It would seem that in these days researchers really did not have a very clear idea about how genes expressed themselves. Today (2015) we have it all worked out, knowing in detail the molecular machinery which, not only replicates DNA from building blocks, but makes RNA and then proteins which are responsible for doing all the work involved in living cells. They didn't know all this then; so, there were a lot of ideas going around that, today, seem to be way off track. In those days they really didn't know what the real story was, so they kind of believed in these strange stories. It would seem that Dr. Harlan was not really teaching a serious course in embryology, but was exposing his students to some of the more far-fetched and colorful ideas. On the other hand, he very seriously told me about the hopeful monster idea. He did not use that term, but he said that, "it may just be that evolution goes in fits and starts, rather than the gradual change that Darwin talked about." He was looking for something that could knock Darwin off his pedestal. As a scientist he was always looking at ways to revolutionize man's thinking the way that Einstein did with his simple equation $E=mc^2$. HVH2]

Barbara McClintock, Cold Sp. Harbor Symp. XXI: 197-217 [this one was marked to study]. [McClintock's early work in the 1940's & 50's was controversial and revolutionary. The work she did on the possible controllers of the genetic process in 1951 went ignored, but was rediscovers in 1961 and verified. She won the Nobel Price for Physiology or Medicine in 1983

for her work in cytology and for the discovery of "jumping genes", genes which could change places in the chromosomes. She studied corn as her organism and became the very best cytologist of her day. The paper that Jack Harlan gave his students to really study involved McClintock's study on elements which control genes. Following is an extract, in absence of an abstract, found at: http://symposium.cshlp.org/content/21/197.

> In a recent brief review (McClintock, 1956), a description was given of types of elements carried in the maize chromosomes that serve to control gene action and to induce, at the site of the gene, heritable modifications affecting this action. These elements were initially discovered because they do not remain at one position in the chromosome complement. They can appear at new locations and disappear from previously determined locations. The presence of one such element at or near the locus of a known gene may affect the action of this gene. In so doing, it need not alter the action potentials of the genic substances at the locus. Therefore, these elements were called controlling elements. It was also shown that controlling elements fall into groups, the members of each operating as an integrated system in the control of gene action.]

[Two papers by R. B. Goldschmidt, which he said to just know the concept and not to study. Goldschmidt was saying that a single mutation could have a huge affect, like the antenna of an insect being converted to a leg. This has since been largely disproved. Although I remember my father saying something like: "It just may be that evolution occurs in 'fits and starts', rather than slow, gradual change." Sometime back then I remember reading a theory that the first mammal hatched from a reptile egg. At the time I sort of believed it, but how I am thinking "how could such a creature live? It would be rejected by its mother and it certainly could not mate with anyone else, being the only one of its kind. As you look into the layers of rock laid down in the earth what you will see is one population fairly stable and then – at some other location, far away from your trench – another similar population is evolving and becoming very successful and then it suddenly invades the area where you put your trench and it seems like suddenly the creature evolved into something much different. It would seem that Jack Harlan is delving into the sensational at his point. It is things like this that probably made his course so interesting and challenging. Comments by HVH2]

[But, Harlan was most probably operating out of the Modern Synthesis of Evolution proposed by Julian Huxley in 1942 and the teaching of his PhD professor, Leonyard Stebbins., although Harlan does not have his students study Stebbins until later.

The following were just given for the students to read, but not to study as in the McClintock:]

Rose, S. Meryl Amer. Nat. 86(831) 1952 [A Hierarchy of Self-Limiting Reactions as the Basis of Cellular Differentiation and Growth Control. This is in JSTOR.]

Bonner, J. T. Morphogenesis 1952 (look over pictures)

Wardlaw, C. W. Ebryogenesis in Plants 1955

[A new topic of this day (Sat. Oct. 25, 1958):]

Consequences of Gastrulation

Development process which gives and inside & outside tissues. [Byrd then has a diagram showing a blastula, or something of that stage, with a double line, the outside of which is labeled:] ectoderm [and then he three words listed to the left of the figure:]

Ectoderm

Endoderm

Mesoderm

[then, below the whole thing:]

Ectoderm – scales, hair, epidermis, teeth, eye, ear placade.

In chordates & Echinoderms blastopore comes to lie near anus

Meaning ← Deuterostomia

[here is a sketch of a double-walled C-shaped structure w/large anus on the right side and small mouth on the left side. By the mouth he wrote:] mouth formed from ectoderm. [And below that – at the bottom of the page w/ arrow back up to the word "meaning", above:] In other phyla the blastopore becomes mouth.

Proterostomia [Protostomia]

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Cont'd

Endoderm – lining of intestinal tract, bulk of liver tissue, endocrine glands (thyroid, parathyroid, etc.), lining of lungs (air sacks in birds, etc.)

Mesoderm – Parts of skeletal &muscle system

What chemicals have been tried to take place of tissue transplants of mangold.

Steroids

Estrogen

Cartirrogens [I could not determine what this word is. HVH2]

Proteins

Above chemicals using blastocoel technique were disappointing in that all were relatively successful.

What then does it indicate?

1. May release evocator that is already present. Puts burden of development on competent tissue i.e. they develop the organs

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Urodeles [amphibians] – teeth, balancers

Anurans [frogs and toads] – horny jaws, suckers

Put competent tissues of Urodeles into anurans & teeth go ahead & form. Thus the evocator can be given by either organism – does not require much evidently. Competence of tissue (anywhere on body) already there for making teeth if teeth evacuator present, i.e. tissue in mouth is exposed to teeth evacuator, thus teeth formed. If same tissue place elsewhere then tissue will form whatever tissue that there is an evacuator for. [This sounds like Waddington. HVH2]

[Now he has a figure showing the embryonic eye with:] eye cup [on the bottom and below that:] Ectoderm [and pointing to the inside of the eye a black oval labeled:] becomes lens

[Below all this he has two empty circles with this explanation, first on the left, then right:]

Regulatory egg (lower phyla) No particular part of egg fated prior to fertilization.

Mosaic egg (upper phyla) Egg has pre-fated parts – pre-destined prior to fertilization.

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Primary Organizer – dorsal lip of the Blastopore. [This concept has held up over time. See: http://medical-dictionary.thefreedictionary.com/primary+organizer.]

[Byrd has drawn a diagram of a circle with the left side indented to form an embryo. At the lip of the top part of the figure has some small arrows pointing back into the main part of the organism. This tip is labeled:] Cells coming from influence of this area are organized.

Hierarchy of organizers

All kinds of organizers

Head group

Secondary Organizers & Teratoma

[Page] 32

Wood's Sigma Xi lecture. Stereochemistry.

Principles of organization of cells: [Suddenly, all this seems to me (HVH2) to be very strange, indeed. Embryonic growth is under genetic control. Now we know that DNA is transcribed into RNA which is transcribed into proteins. Each protein is responsible for performing a very specific task and we may have thousands of proteins acting simultaneously vying for building blocks, each protein going about its business building something every specific. And, it all comes together to form a certain living organism! How in the world does it do that? There must be someone with a master plan for the organism who is directing things. The timing is very important. Who or what is orchestrating this? On Nov. 5, 2015 I ran across two websites which helped answer this: One is called Storage Proteins and the other is Biochemical reactions. It turns out that the organelles inside the living cell each have their own function. They provide task-specific platforms where various, specific reactions take place. TYJ. HVH2]

Cytoplasm –

Amphibian eggs –

Mechanism for asexual reproduction is available in almost any organism but not to be used.

Echinoderms

Animal Poles – divisional slightly more active

Vegetable pole – yoke & food material conc.

Metabolic gradient more conc. At animal poles

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Cont'd Echinoderm

[A circle with latitude (vertical) lines making it look like a sphere, with A at the top and V at the bottom. Just to the right of this is:]

4 [with 4 circles in a row, then:] A [and a glob of 8 circles, then:] 8 mesomeres

4 [with 4 circles in a row, then:] V [and a row of 4 circles:] - 4 macromeres, etc. →

[a row of 4 smaller circles:] – 4 micromeres

[8 circles] animal 1 [8 circles] 8 an 1

[8 circles] animal 2 [8 circles] 26 an 1

→ → [4 circles] 4 mac [4 circles] 8 veg 1

[4 sm circles] 4 micr [4 sm circ.] 4 mic

Animal tissue less vegetatal will not gastrulate completely. Varying amounts of animal & vegetal tissue in various combination have been brought together to det'n if pluteus formed.

Chemical blocking tissue formation

Veg	An
Li	SCN
Li+KCN	SO4
Li+CO	Ca
Mg	I

Above chemicals must act on chemical system of org causing some system to mal-function.

Above gives an idea of synchronization of organism

[Page] -34-

Wildes Paper indicates the importance of a chemical substrate in being specific for particular cell differentiation. Phenyl alanine (amino acid) affects differentiation of neural crest into pigment cells, + mesenchryme.

Evacators are quite general in action (anything can trigger a neural tube) in early stages, but later on evacuators are much more specific in action.

Homaeotic mutant – leg may become replaced by balance, wing by leg, or wing by balancers.

- a change in serial. The appendages are

homology of an organism. [below this he put six small boxes with short lines coming out of them at the bottom and before the first box is a smaller circle. Beneath all this he wrote:] serially homology … Wing let, or balancers are serially homologous.

Hoe

Podoptera – wing replaced by leg.

- A type of homoerotic mutant.

Homoetic

Penetrance – frequency of phenomena (all degrees)

Expressivity – rating – how expressed – degree of expression

Oct. 27, 1958

-35 - [Per. 13 – Mon.]

{Chemistry of gene action in higher organisms: summary on the gene.}

Organization of organisms through genetic control.

Read Goldschmidt Theoretical Genetics

a. Action on genetic material
b. Natue of genetics material
c. Discussion of heterochromatin
d. McClintock's work discussed in detail.

Cont'd Goldschmidt's paper –

Heterochromatin area active in Podoptera effect. Stains dark before & after division

Euchromatin stains dark during division. Since heterochromatin ch can be eliminated without effect so this must be inert.

Podoptera & tetralta appear to be controlled by several genes scattered throughout ch. Genes can not be pinned down.

Time of action of a gene very important. Phenocopy – a modification of development by some developmental process.

What doe phenocopies tell us?

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Controlling Elements McClintock – what are they?

Ac = Activators & Ds' affect pigmentation of kernel

A_1a_1

Ac – activator type of gene.

Ac has to be present to activate Ds. Ds can break chromosome. Ac can be found at random, maybe some non-randomness. They apparently get moved around.

Controlling elements duplicate themselves but not a gene because moves around.

Goldschmidt's idea of above is due to position effects – fusion – break – fusion Repatterning.

Morphogenesis of Plants

Plants simpler than animals, do not understand system any better than animals.

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Auxin – closely related to tryptophane – have auxin producing tissue, auxin response tissues, auxin, inhibitor tissues

Auxin produced in growing point & diffuses down to root

Light annihilate auxin activity [here he has a series of little figures showing how something grows]

From universe creation to life [These are partial notes on the review of Qtr. 1]

1) Reducing atmosphere
   Methanes, etc.
   Run spark through can form some amino acids

Proteins far from life but protein & DNA would be enough. If DNA came about DNA would or could reproduce itself.

[This class included part of the summary of Quarter 1. The next meeting (Nov. 1, 1958) was the first quarter exam.]

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=Read Hardy, G. H. Science 28:49 1908

* Harlan, H. V. & M. L. Martini, J. Ag. Res 57:189-199 1938

* SG Suneson, C. A. Agron. Jour. 41:459-461. 1949 [again pop. biol. re barley]

* SG Mumaw, C. R. & C. R. Weber – Agron. Jour 49:154-160. 1957

* SG Woodworth, C. M. ER/ Leng & R. W. Jugenheimer – Agron. Jour. 44:60-65. 1952

Dobzhansky, Th Evolution 10:82-92. 1965 (also see Evolution 11:311-319. 1957

Epling, C. & WR Lower. Evolution 248-257. 1957

Cold Spring Harbor Symposium XX 1955

Introduction (Dobzhansky)

Concluding Survey (Lerner)

Also Mayr, Ford, Carson, King, etc.

Dobzhansky, Th Genetics and Origin of Species 3rd Ed.

Read sections on mutation & selection.

Population Genetics

What happens to large numbers of genes in natural populations?

Be familiar w/ Hardy-Weinberg equilibrium.

[Note: Harlan's PhD professor G. L. Stebbins was one of the great pioneers of the evolution of populations; however, he did not have them read him – at least not yet. HVH2]

[Saturday, Nov. 1, 1958: **Midterm Exam**, no page for this.]

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[Per. 15, Mon.] Nov. 3, 1958 {Review: Genes in populations}

Evolution of Sex

What is involved in sex?

Sex causes variation. What happens when cyto-plasm is brought together. Are there cases of cytoplasmic inheritance. What is first evidence of sexuality – What about sex in bacteria? Is recombination proof of sexuality?

Is recombination a means of signifying sex? Viruses can recombine if two different strains enter one cell of bacteria. Is this sexuality? Lysis produces all combinations.

Apomixis. All offspring identical to mother.

In Bacteria [to the right are two circles, labeled:] Cell I & Cell II [and an arrow going from Cell II to Cell I, and below them:] Conjugation with unequal transfers

F+ can mate w/F+

F- can mate w/F+

F- cannot mate w.F-

Lederberg worked out sexual nature of K12. Can have tri-sexual i. e. three parents. Can have all gradations of sexual mechanisms.

[See The Joshua Lederberg Papers. This is a great review article that I came across.] [It would seem that Harlan is, once again, going for the sensational rather than just teaching the basics. What I found out about this, however, is that Esther and Joshua Lederberg conducted experiments in 1950's which greatly increased our understanding of genetics through their use of bacteria, which - before their work - was considered to be too simple a life form to be worthy of scientific study. These evolution classes come right at the time when a lot of good science is being conducted which was increasing our understanding of how inherited traits are maintained and passed on to the next generation in living things.]

[at bottom of page is a small diagram of two chromosomes with one gene stained dark and the two dark genes appear to be in somewhat different places on the chromosome. Below the two chromosomes are some little figures which I cannot decipher and the word:] Zygote

[Page] 40-41

[Now, he seems to be talking about fungi and the various ways in which they reproduce. Curtis has a lot of diagrams and explanations which I will not try to describe at this time. HVH2]

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Population Genetics

$g^2 : 2g(1-g) : (1-g)^2$

Above occurs in random mating

Large enough

No Sel'n.

No mutations.

No outcrossing would require many generations to reach an equilibrium.

[Page] 43 [Per. 17 & 18 – Mon.]

Nov. 10, 1958 {"Natural" selection experiments}

Harlan H. V. & Martini & H. Stevens USDA Tech. Bul. 720 1940 [Can't find this paper, but it is referenced quite a few times and as No. 3 in a series discussing HVH1's long term experiment with mass cultivation and breeding of Barley in California.]

Suneson, C. A. Agron. Jour. 48:188 1956. [This seems to have to do with something called "Evolutionary Plant Breeding" in which a mixed population of crop plants of various varieties is grown together and harvested in bulk and replanted, using the forces of evolution to select out the highest yielding and more vigorous types. This is what HVH1 did w/the Davis plots. See: http://www.jourlib.org/paper/171305#.VdsbIflViko.]

Harlan, J. R., in Brookhaven Symp. 1956 ["Distribution and utilization of natural variability in cultivated plants". I am unable to view a copy of this paper, but it has to do with the utilization of natural variability in cultivated plants. Harlan is teaching about modern (ca. 1958) experiments that demonstrate natural and man-directed evolution in crop plants.]

Harlan, J. R., Amer. Nat. 85:97, 1951 [American Naturalist, 85: 97-103. **The Anatomy of Gene Centers**, American Naturalist March-April, 1951 [Note this can be found in JSTOR. HVH2]

Abstract:

Observations made by the author during an expedition to Asia Minor in 1948 led him to conclude that the geographic regions referred to by N. I. Vavilov as "centers of origin" or "gene centers" have a structure which is subject to study. Such geographic regions include areas of actual varietal paucity as well as small regions of enormous varietal wealth. The small areas in which is concentrated the varietal diversity of a crop are referred to as gene microcenters. Microcenters of a number of crops frequently coincide. Microcenters may be located on the plains or in mountainous regions, near civilization or remote from it; husbandry may be very primitive or moderately advanced. The one characteristic which is common to all microcenters is that evolution is proceeding at a rapid rate at the present time. An intensive survey of microcenter populations should yield immensely valuable information not only to the student of evolution but also to the agronomist and plant breeder.

This paper is still being quoted. The following was copied from "Wild Manihot species" by Nagib M.A. Nassar, D.Y.C. Hashimoto and S.D.C. Fernandes Departamento de Genética e Morfologia, Universidade de Brasília, Brasília, DF, Brasil, (page 18 – 19), found at: http://www.funpecrp.com.br/gmr/year2008/vol7-1/pdf/gmr389.pdf.

> There are four widely known centers of diversity for Manihot species: Mexico and northeast and central Brazil, plus southwest Brazil and Bolivia. Microcenters of diversity of these species exist within central Brazil where large numbers of species are concentrated in small areas, i.e.,

< 50 km in diameter (Nassar, 1978a,c, 1979b, 1980a, 1982, 1992). These microcenters arose from the frequent hybridization between species and the heterogenic topography of their habitats, which help isolate fragmented gene pools that lead to speciation. For example, Goiás Velho and Corumbá de Goiás are regarded as two micro-centers of cassava diversity (Nassar, 2003a), **following Harlan's concept** of geographic pattern of variation of cultivated crops (Harlan, 1951, 1971). Likewise, tree-like species such as M. glaziovii and M. pseudoglaziovii are found in northeastern Brazil, whereas short species and subshrubs are found in central Brazil.

The original 1951 paper, Anatomy of Gene Centers is of great importance in the life of Jack Harlan. Here, Harlan takes NIV's idea of "Centers of Origin" or "Gene Centers" and comes up with his own improvement of that. Vavilov is still leading him. He is still standing on his shoulders and those of his father. It turns out that HVH1 did a lot of pioneering population biology and JRH begins his study of that topic in Evolutionary Mechanics with him.]

OR S. E. B. Symposium VII, 1953, Evol. [Society for Experimental Biology. This is now available in book form. I could not find an abstract.]

K. Mather 66-96

Jim Thoday 96-114 [These two seem to be associated with the SEB Symposium.]

[Lerner, I. M. Genetic Homeostasis Seln. Expts. (Early parts) [**genetic homeostasis,**
the maintenance of genetic variability within a population through adaptation to varied or changing envi ronments and conditions of life as a result of shifts or resistance to shifts in allelic frequencies. Found in: http://medical-dictionary.thefreedictionary.com/genetic+homeostasis.

Lerner,

I.M., U.S. population geneticist, 1910-1967.

Lerner homeostasis -
the restorative mechanisms that tend to correct perturbations in the genetic composition of a population. Synonym(s): **genetic homeostasis.**

This is saying that in a population of a given species, a variability will be maintained over time, because some individuals will be successful in certain circumstances and others will be so in other circumstances.]

Anderson, E. Introgressive Hybridization [This is a book pulling together much of what is known about natural hybridization in 1949, by a man (Anderson) who has spent many years studying it. "This is largely a book about methods for studying hybridization in the field." "In this book the more usual methods of analyzing hybridization (transplant studies, cytological analysis, pedigree culture, repetition of suspected hybridization) receive little more than passing mention. It goes without saying that these methods should be used whenever the facilities for them are at hand. All these techniques were employed in the special studies of Tradescantia, Iris, and Nicotiana, from which these newer methods derive their theoretical and experimental verification. It should be emphasized, however, that from a corollary of the demonstration of multiple-factor linkage (see p. 43) we have a new and powerful criterion for hybridity.

Furthermore, the general method (pp. 92 to 99) of extrapolated correlates (and the more specialized techniques here described as '^pictorialized scatter diagrams," radiate diagrams, standardized photographs, etc.) have proved to be of wide adaptability in analyzing the effects of such hybridization. Though these methods are here described in full for the first time, they have been rather widely used by my students and colleagues."

This study was done with two kinds of Iris plants with striking differences in size & coloration. Horticulturalists have for years crossed the two to obtain unusual combinations of colors and patterns. But Anderson studied these and used this study to illustrate introgrerssive hydridization. Just two years later Harlan went on his epic 10-month sojourn across Asia and Ethiopia and he would spot introgression in grasses all over the place. I would think that introgression in grasses would be very hard to spot and takes a tremendous amount of expertise and experience.

Note, also, that Harlan is now looking at higher levels of evolution beyond what Darwin saw and what has been commonly seen as survival of the fittest individual, the one with the "best genes". Here we see the survival of the population – the colony, the system of two or more

fields of closely related populations who are able to mate and, therefore, share their genes for the preservation of the whole population (both, or all the fields).

Dobzhansky Th. Genetics & the origin of App. Ch. V, Adaptive polymorphism [The following is a book about Dobzhansky and Adaptive polymorphism. His book was about 1951:

Abstract
The hypothesis of adaptive polymorphism as proposed by Dobzhansky cannot as yet be considered well established. It is generally agreed that genetical variability enables a species to evolve in response to changes. Dobzhansky has made the important suggestion that variability also allows a population to exploit a constant, or a changing, environment more efficiently than a single genotype could do. Consequently he believes that arrangements which maintain variability, notably balanced polymorphism, give the populations in which they occur an adaptive superiority over others. However, it appears that by adaptive polymorphism is usually meant only polymorphism maintained by selection. Such polymorphism can occur in a population without affecting its adaptation. The relative adaptive value of populations is a very difficult concept which has not been clearly defined. Observations on relative coefficients of selection of different polymorphs within a population give no direct evidence on the ability of any one polymorph to survive as a pure stock. And further, the evidence which has been adduced to support the hypothesis is capable of different interpretations. In no case has direct evidence been obtained that different polymorphs in a population are in any sense exploiting the environment in different ways, and thereby affecting the adaptedness of the population significantly.]

[This brings up the whole issue about human intervention into the natural evolutionary process with their cultivated mono-culture row crops, with all identical genetics making an impact onto the wild relatives around them – that just occurred to be as I was writing. No, human intervention into the natural evolution of plants and animals. People breed them to suit their purposes – produce huge, monster, seeds, for instance. Do we see weeds getting large seeds? I know my flower garden gets infested with plants which look very similar to my plants, except that they have tiny flowers, quite unlike the large flower varieties which I have labored so long and hard to cultivate. In his 1948 expedition to Turkey JRH commented on human intervention into crop evolution by saying that it did not matter whether the farmer's tools were primitive or modern, he was still meddling.]

Stebbins, G. L. Jr. Var. & Evol. in plants chapt. on Nat'l selection & variation in plants [I found this quote from "Variation and Evolution" by G. L. Stebbins, 1950 in a volume found at: http://www.cabdirect.org/abstracts/19510302133.html;jsessionid=25126CEA98AC325183D45C41947D552A.

The author's statement on page 152, that " the problem of the evolutionist is no longer that of finding unknown causes for evolutionary progress or direction but of evaluating on the basis of all available evidence the role which each of the known forces has played in any particular evolutionary line ", is perhaps the best commentary upon the progress that has been made.

This sounds like what Harlan was having his evolution students do when they had to come up with a story about how something may have evolved.]

Use Mayr's book to get a start on speciation problem. [Byrd left no indication as to the title of book referenced and Ernst Mayr wrote a number of books of evolution.]

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Harlan & Martini Paper

Simple paper

Features of populations

Inbred lines may be like genes. A fluctuation is evident. Best varieties in pure stands not always best in mixture.

Drosophila

Thecuations [??] of pop.

In number & constitution.

There is a very heavy load of deleterious genes in most wild populations.

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Read 1st 2 chapters in Lerner's new book "Genetic basis of seln" [I cannot find the first two chapters of this book on line, but the following was copied from a review of the book: "The book begins with a general review of population genetics and the inheritance

of quantitative traits. There is some discussion of natural selection and evolution, but the main emphasis is on the special opportunities for selection which are available to the animal breeder, such things as progeny or family selection, selection indices, inbreeding and crossing, selection for combining ability, and the eventual hope for some utilization of asexual propagation." So, it can be assumed that Chapters 1 & 2 gives the students an introduction to population genetics with an emphasis on breeding for selection.]

Read & summarize Dobzhansky, Th. Introduction of Cold Srp. Harbor Symp. XX, 1955
[Byrd's notes on this paper. The following are lecture notes:]

Balanced concept – Structural heterozygotes, cross fertilized. [This is a Dobzhansky concept.]

Classical system –

Higher degree of homozygosis & adjustment of genetic systems no lethal, fixed & stable less total variance.

Both classical & non-classical systems occur –

Classical system

D. prosaltans – has relatively few lethals when compared w/ D. pseudoobscura. There is a basic diff. in ecology – the former is rare & isolated, whereas the latter is common, evenly dist., non-isolated. Genetic system of prosaltans prob. could not exist in pseudoobscura environ.

Genetic drift – fixation in small pop. by inbreeding. Much inbreeding undoubtedly occurs in small pop. which may cause complete fixation by chance.

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Lerner's work

Crooked toe

[he has a chart entitled "Flies" with Generations on the X-axis and No bristles on Y-axis, showing the number of bristles on the flies with selection and relaxed selection.

Underneath it has the following written:]

Inheritance of metric traits – do not know what we are dealing with. Multiple factors first proposed – now been replaced by polygenic concept of integrated systems of something what system involved – not known.

[Evidently, I. M. Lerner did some experiments with his flock of chickens and found that by carefully selecting mates he could select for several traits, including crooked toes. When he relaxed the selection pressure, things tended to return to normal. He had a much quoted book: Genetic Homeostasis, Oliver and Boyd, Ltd., Edinburgh, 1954]

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[Per. 19 – Mon.] Nov. 17, 1958: {Breeding Structure in Populations}

[This was written in the top margin to the right side:] USDA 1067 Tech. Bul.

[Harlan gave them another list of papers and book chapters to look up in the library:]

O. R. Stebbins, G. L. Jr. Variation & Evol. in Plants, Ch. on Nat'l Seln & var. in plants

Also, Chapt. on Polyploidy & Karyotype

O. R. Darlington & Wylie – Chromosome Atlas of Flowering Plants

O. R. Makings, S. Atlas of Chromosomes in Animals

O. R. Matthey, R. Les Chromosomes of vertebra's Bakshi

White – Animal Chromosomes

Why would a barley pop. continue to show variation (other than mixture of homozygous types after 30 years?)

Internal over- Ab Cd Ef Gg Hh May be way of getting better fitted types –

dominance Ab Cd Ef Gg Hh that is by internal adjustments.

[The above was hard to reproduce on the computer the Ab Cd … had the same thing right under a horizontal line. Below this was a list of 5 things and written in the left margin was:]

Homeostasis – resistance to change –
org. adjusting itself to variable
conditions. Genetic system which is
variable enough to resist change.

What are the features of a population?

1. Genetic variance. A system (built in) designed to maintain variance. An equilibrium is reached.
2. Internal genetic homeostasis adjusted on environ. – one resisting change.
3. Sporadic occurrence of off-types.
4. Integrated systems of mutations, natural seln, etc.
5. Maintenance of high number of lethal.

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[Byrd drew a diagram at the top of the page with a dark dot and wiggly lines diverging out from it. Below that he wrote:]

Developmental homeostasis (individuals follow certain patterns within limits)

Genetic homeostasis

Certain genotypes fitted, others not.

Ex.: seln. For several different traits deficient

To do. Seln. For one factor can be made but other characters may decrease in fitness. We are unbalancing a balanced system.

[Harlan then left a question for the next class:]

What is the importance of sex in Evol.?

[Page] 49

[Per. 20 – Sat.] **Nov. 22, 1958** {Introgression}

Importance of sex in evol.

Evolution to higher forms has in general occurred only in diploids – a system of storing genetic variance. Haploids do not have this capacity. Haploids in general are not as highly organized as diploids. Buffering and regulatory mechanisms can operate in diploid conditions.

Effects of bringing together contrasting alleles

1. Dominance (one type covers up another)

   A/a because of fixing of recessives natural seln tends to favor recessives.

   Recessive genes may be changed to dominant genes thru so-called modifiers

   Major genes may become quantitative thru actions of modifiers.

   [and he has this little chart:] A/a – a/a – a/a – a/a′ – a′/a″ etc.

   What was recessive at one time has now ~~has~~ become ~~a~~ dominant.

   Major genes may become quantitative thru action of modifiers.

2. Additive effect

   A++/a+ interaction within locus.

3. Over dominance AA Aa aa

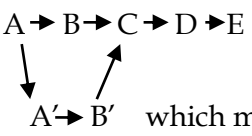
   Pheonotypes merit greater than either homozygotes.

4. Intermediate conditions of all sorts.

   AA Aa aa AA Aa aa

[Page] 50

[Harlan is talking about the advantages of heterozygous individuals. Included are some charts which I will not try to replicate.]

[He talks about a:] chain reaction 

which may be a result of a heterozygous condition. Reaction from A → B may be slow and the A′ → B′ much faster to give higher amounts of C, D, E, etc. thus heterosis. [It would be good to see the original notes. HVH2]

AA too little substance produced

aa too little too late

Aa just right amount at right time.

Aa probably gives better regulated system. certainly shows that recessive has some action. Probably a synergistic action. Even recessive lethal may be advantageous in heterozygous individuals.

Crooked Toes in Chickens

Present in all lives of chickens. In large populations random breeding but seln for crooked toes was very ineffective. Inbreeding w/or w/o seln gives much crooked toes. Inbreeding with seln gives high amt crooked toes.

Crossing of lines very unpredictable. Low penetrance & many genes.

What might be some differences between genetics of primitive & higher organisms

[The next two pages are not numbered, but appear to be notes from a paper by Dobzhansky which may be the one I could not find. Return to page 45 if visiting from there.]

Chetverkov initiated experimental work in pop. genetics. [then his notes on Dobz:]

Dobzhansky, Th. A review of some fundamental concepts and problems of population genetics. Cold Spr. Har. Symp. XX, 1-4, 1955 [Go back to page 45]

Mendelian Population – "a reproductive community of individuals who share in a common gene pool" [Dobzhansky, 1950, quoted from the above paper, page 1. This paper, page 2, introduces the idea of "adaptive norm".]

Adaptive norm – an array of related genotypes consonant with the demands of the environment is the adaptive nor. Of a pop. The "norm" is, thus, neither a single genotype nor a single phenotype. The gene pool of every Mendelian pop. contains a greater or lesser variety of genes, every genotype may give rise to a variety of enverosi [?][6]. In contrast to the adaptive norm every large pop. contains some genotypes and phenotypes which are not competent to survive and reproduce in at least some of the environments which the pop. has to face. The adaptive norm of a Mendelian pop is a product of its evolutionary history.

Origin of adaptive norm

A. Classical hypothesis – evol. Changes consist in the main in gradual substitution and eventual fixation of the more favorable in place of the less favorable, gene alleles and chromosomal structures. Superior alleles are established by natural seln, & supplant inferior ones. Most individuals should, then, be homozygous for most genes. Heterozygous loci will be a minority.

Cont'd classical hypothesis **[2nd unnumbered page between pages 50 & 51]**

The chief sources of heterozygosity and heterogeneity in a pop. will be 4. (1) The occurrence of more or less deleterious mutants, responsible for various hereditary diseases and malformations, ranging from slightly subvital conditions to complete lethals. Eliminated by natural seln.

[6] This is a direct quote from Dobzhansky's paper, but Byrd did not get it all down. What is missing is the following: every genotype gives rise to **a variety of phenotypes, and every population meets a variety of environments.** See **http://openpsych.net/forum/attachment.php?aid=654,** page 3, left column

(2) Genetic variants which are adaptively neutral, or which possess slight adaptive advantages at some times and in some places, but which are slightly disadvantageous at other times and in other places.

(3) Adaptive polymorphism maintained by the diversity of the environ which the pop inhabits.

(4) The rare good mutants which have not had time enough to displace their alleles.

The adaptive norm of the species will, then, consist of a fairly small number of genotypes; the genetic diversity will be either neutral, or transient, or morbid.

(B) Balanced Hypothesis

The adaptive norm is an array of genotypes heterozygous for more or less numerous gene alleles, gene complexes, and chromosomal structures. Homozygotes occur only in a minority, and make these ind. more or less inferior to the norm of fitness.

The action of natural seln leads only in part to gene substitution – what Mather calls the relational balance between the components of pop. genotype. – more –

[Page] 51 Nov. 24, 1958

[Per. 21 – Mon.] {Chromosomal evolution; the Karyotype and polyploidy}

How does genetics in micro-organisms compare with higher org.

Mendelian genetics (similar)

haploidy

Quantitative difference

Physiology of gene action based on microorganism (cistron)

recon (min unit of crossover)

muton (min unit of Co for phenotype change)

[The terms *recon*, *muton* and *cistron* were defined by Benzer (1957) [2] as follows:

- **Recon:** "The unit of recombination will be defined as the smallest element in the one-dimensional array that is interchangeable (but not divisible) by genetic recombination. One such element will be referred to as a "recon.""
- **Muton:** "The unit of mutation, the "muton" will be defined as the smallest element that, when altered, can give rise to a mutant form of the organism."
- **Cistron:** "A unit of function can be defined genetically, independent of biochemical information, by means of the elegant *cis–trans* comparison devised by [Ed] Lewis…Such a map segment, corresponding to a function which is unitary as defined by the *cis–trans* test applied to the heterocaryon, will be defined as a cistron." (from: https://en.wikipedia.org/wiki/Complementation_(genetics))

So, Benzer helped them understand, back in the 1950s, that there were these three functions going on in genes: they could recombine (recon), they could mutate (muton) and they each had a function, or they prescribed an activity in the cell (cistron). The last one, the cistron, could be determined with an elegant *cis-trans* test. "A **complementation test** (sometimes called a "cis-trans" test) can be used to test whether the mutations in two strains are in different genes." (See above Wikipedia article). There is a good explanation of this found at the aforementioned website. In succeeding years when the actual molecular structure of DNA/RNA/protein, along with all the enzymes was worked out these three terms fell out of favor, but they were pretty useful in 1958.] [Back to Byrd's notes:]

In higher org. things like heterochromatin, knobs, etc, enter into the picture. We see effects in large org after it has gone thru a chain reaction. Also see increasing amt of intergenic interactions.

evolution → mendelian inheritance obscured. Drosophila, corn, tobacco, neurospera, E. coli, mouse, barley, chickens.

Adaptive polymorphism –

of an organism in a genetic region of a species in different environ.

Example:

Ch. Arrangements

St wet, hot lower alt

AR Dry-cool lower alt

CH – more constant than other 2. In different environ above occur together – much adv. Of structural heterozygote. Thus, pop. can always adapt to the environ. Genetic variance maintained

[Page] 52

ST/CH has sel. adv. in all environ - this balanced polymorphism. st/st will build up in lower wet areas at expense of CH & vice versa.

Balanced polymorphism apparently occurs in most populations of plants & animals. Sel. for extremes usually leads to physiological unbalance

Introgressive hybridization

[Page] 53

[Per. 22 – Mon.] **Dec. 1, 1958** {Cryptic Hybridity – Apomixis – Introgression}

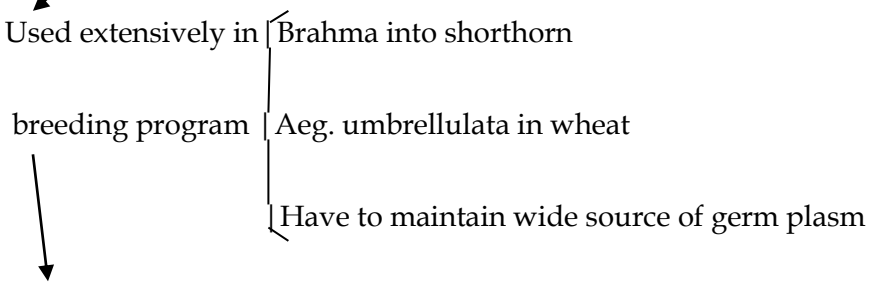
Cont'd Introgressive hybridization

[I put this Per. 22 in there, but Byrd says it is a continuation. We both could be right. The previous page has just a few lines at the top and then the rest is blank, indicating that the class ended with that thought and picked up with a continuation of "Introgressive hybridization" with the Dec. 1 class.]

Linkage in introgression.

Causes 2 distinct types to remain in population with the introgression of a few genes in from one species to another. Morphological barriers are not broken down but do get some new combination.

(1) Have in effect an insertion of a new or strange link into a ch. May have position effect. Important source of new variation.



Mixing up the germ plasm.

Value of introgression in evolution

Provide new types.

Reserve germ plasm

A rapid method for keeping up w/changes. Faster changing of environment causes faster introgression. A change in environment causes greatest genetic change.

[Note: Harlan spotted introgression on his expeditions and made note of it, many times.]

[Page] 54

[Boyd has a diagram at the top of the page illustrating polymorphism and new balance. Three circles: first has in it: CH, AR & PP. Second has x in it. The third has CH, PP & XXZ in it. The word Polymorphic was written under the first circle and the phrase: new balance written under the middle circle.]

Introgression is an important element in evol. mtn. bldg.

POLYPLOIDY

Much better known in plants than in animals since throws sex mechanism out of balance in animals. May be in part due to different types of chromosome evol.

Polyploidy important from mosses & ferns up.

1. Autopolyploidy – may give erratic response

   - doubling of genomes.
   - not common

   Common in vegetatively propagated apple & other Rosaceae (cultivated forms) Aenothera (gigas), galax.

2. Autotriploid – duplication
3. Allopolyploid
4. Cryptic structural hybridity ➡ Inversion within an inversion causing good pairing but high sterility.

-internal isolating mechanism – may lead to new species. Occurs in many plants.

[Then he has a little sketch I will not try to duplicate and writes:]

Structural hybridity advantageous in Drosophila but causes internal upset in many plants. [See above link.]

[Page] 55

[Per. 23 – Sat.] **Dec. 6, 1958** {Summary of Population and cytogenetics}

[At top of page he wrote:] Read Feedback in the differentiation of Cells - Scientific Amer. Dec. '59 ['58? I could not find this article. I don't think that this topic would be suitable for Scientific American. HVH2]

Manglesdorf reproduction of corn (ancestors) Sci. 128 (3335). [The paper I found was "Ancestor of Corn, A genetic reconstruction yields clues to the nature of the extinct wild ancestor." By Paul C. Mangelsdorf. Nov. 1958. If this is the article that was referenced it is 1) very much hot off the presses, in that it was given Dec. 6, 1958 and 2) is significant because of Harlan's professional interest turning to corn in the early 1970's, when he went to work at the U of I.]

[These two courses in evolution moved Harlan to spend hours every day in the library looking up a wide range of loosely related topics in such magazines as Science & Scientific American, not usually a rigorous scientific journal like Science, but it gave him a way to keep up on the latest in a number of disciplines and helped to shape him into the Renaissance Man that he finally became.]

Cont'd Polyploidy

Suppose we have a polyploidy series what effect results in distribution.

[Then we have a diagram which I will not try to duplicate.]

Ordinarily diploids restricted to less area than polyploids. Not the case in blue gamma.

In new areas polyploids appear to have an adaptive value, i.e., they move in first.

Bothriochloa intermedia gangetica

Cytogeneticists

Interfertile – same species

Part sterility – probably same species (may or may not)

Total sterility – different species.

Can't cross – different genera

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Polyploid Complex

What is the basic pattern of polyploid complex.

[Now he has a diagram of a polyploid complex Superstructure, showing how the number of chromosomes (2n, 4n 6n, etc.) can build up by adding chromosomes during mating (in plants).]

Complexity depends on amt of auto and allo ploidy.

Diploid species are usually good species. Other combinations of superstructure may occur.

Where does this lead in evolution?

Genetic adv.

1. Spontaneous species

   Most normal =

   clear cut numbers

   higher numbers are a multiple no. ordinarily, little evidence of dribbling back to lower numbers. Should find less than multiples but do so very seldom. Generally the aneuploids are reverting back to exact multiples.

The nuclear cytoplasmic balance is thrown out of balance. Too many messages for too little cytoplasm.

[Page] 57

Apomixis:

a. Increases potential for storing genetic variation can store structural heterozygosity, if this is important.
b. Allows complex polyploids
c. Quite widespread in plants
d. Accomplished in wide variety of ways.
e. Can break polyploid barriers – can bridge gap – escape from sterility. Permits recombination to be propagated.

f. Labile – can fix new combinations
g. Rigid system – danger of extinction.
h. * Facullative apomixes – most efficient step known for evolution.

[then, after this list, he put the following notes:]

some sexual

some apomixes 4n

sexual 2n

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Jan. 10, 1959 [This is not on Harlan's schedule of classes. This was a special lesson by Dr. Celarier (guest lecturer) on Evolution and may have been after the class ended and Byrd just put the notes for this in his Evol. 593 notebook.]

Dr. Celarier (guest lecturer) [Robert Paul Celarier was a cytotaxonomist specializing in grasses. He passed away in 1959 and was a good friend of Jack Harlan.]

Evolution

General look at the evolution of Bothrichlocae.

Gramineae

Tribe: Andropogoneae

Subtribe: Ischaeminae

Rotlbaellinae

Saccharineae (sugar cane)

Evandropogoneae (andropagon)

Will discuss today ← Bolhrichloeae (old world bluestems – will discuss today)

Sorgheae (sorghum & relatives)

Maydeae (Indian corn)

Bothriochloeae

Six genera of concern

Bothriochloae

Dichanthium

Euclasta

Eremopogon

Capillipedium

Pseudosorghum

[page 59, blank]

[Page] 60

Bothriochloa	Dichanthium
A. Old world Bothriochloa	D. annulatium
Bothriochloa ischaemium	D. caricosum
B. pertusa complex	
B. intermedia complex	

B. New World Bothriochloas

B. erianthoides

C. Australian

B. ischaemium

Occurs throughout temperate Europe and Asia, Atlas mtns. in N. Africa.

3 ch. groups

2n = 40 B. ischaemium. var ischaemum. {2n = 40, 2n = 60} slightly irregular

2n = 50 & 2n = 60 B. isch. var songarica. very irregular – when deviating morphologically the deviation is in direction of intermedia.

'B. Intermedia involved in above.

B. pertusa

Typical type – 2n = 40 sl. irreg.

insculpta – 2n = 50 or 60 extremely irreg.

'B. intermedia – involved in above

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[this is the last page number Byrd gives, but I will continue to number the pages in pencil in the lower right corner of each page so that we can track this better.]

Dichanthium annulatum (some B. involved)

Same dist. as above – 2 species

Tropical - 2n = 20, 2n = 40

Mediterranean: 2n = 40

S. African 2n = 60

Deviation in direction of B.

B. intermedia

D. caricosumin

aristatum 40 ch. sl. irregular – S. Africa

Typical 40 ch. sl. irregular

60 ch. more irregular

Two types of evolutionary activity in above species

Genome addition – mostly involving species crosses

Introgressive hybridization.

Mechanics by which above occurs.

[what follows is a number of pages of notes on various papers and books, including diagrams, etc. The pages are not numbered and it would appear that these are Byrd's notes on the assigned papers and book chapters. I will continue to transcribe this:][End of Celerier lecture]

[page 62]

Cont'd Dobzhansky. Concepts & prob. of pop. genetics. XX [cont'd from what?] [Return to Page 46]

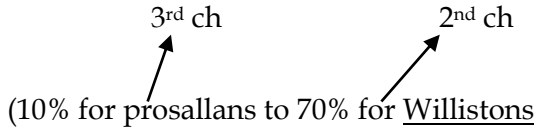
If the fitness of homozygates for many gene alleles and gene complexes is low, there will be a seln. pressure favoring the develop. of series of multiple allele at many loci and of a multiplicity of alternative gene complexes in most chromosomes. This process will lead to

reduction of the incidence of genic & chromosomal homoygates & to improvement of the adaptiveness of the pop. as a whole. The fate of an allele or a gene complex under seln. will then depend chiefly on its effects in heterozygous comb. with the other alleles & gene complexes present in the gene pools of the same pop. The gene pool of a pop. becomes an organized system, and acquirers the property which Lerner has called genetic homeostasis.

Above two theories are not mutually exclusive. It is most probable that a whole spectrum of cond. ranging from the "classical" to the "balanced" when the genetic structure of all forms are known.

Ubiquity of deleterious recessives in Drosophila pop.

(1) From 10-60% lethabity reported in homozygous flies
(2) Great amt. of sterility present when not lethal.



(3) 41 to 98% of each of 3 prs. of autosomes present in D. pseudobscure & D. persimlias are sub-vital when in double dose. Much less in prosaltans.

over

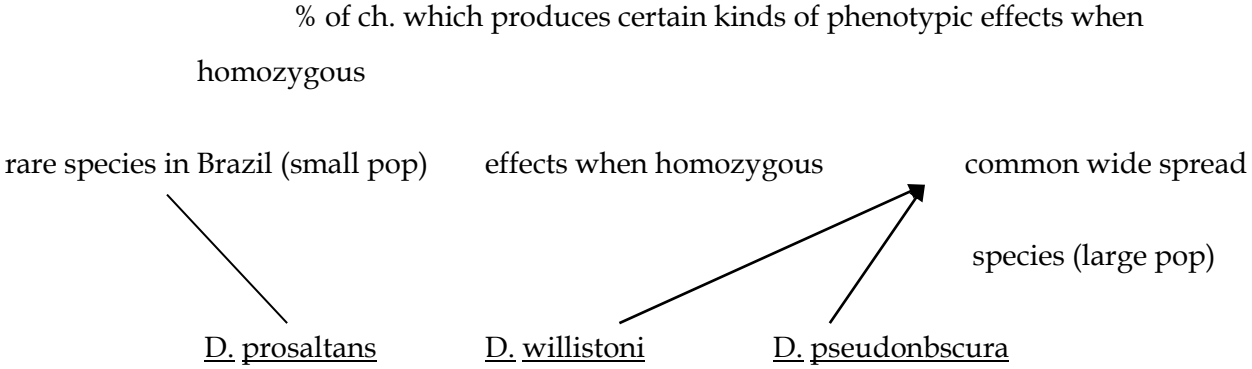
[page 63]

Why are deleterious genes carried along? Are they merely the unavoidable debris left by the evol. process in its train? Or are they useful in some ways?

The study of the effects of deleterious recessive mutants in heterozygotes suggests some answers. Muller found that heterozygotes for "recessive" lethal tend to be less viable than individuals free of lethal. However, there are exceptions to this. Some of thelethals (1 in 10) are heterotic in heterozygotes.

Two kinds of Mutational Loads

A. One load is what the classical hypothesis of pop. structure leads to; It consists of dominant, semi-dominant, & incompletely recessive genetic variants which are deleterious to their carriers in most environ.
B. The other load accords better with the balanced hypothesis. The components of the load are deleterious when in double dose, but they give rise to heterosis in heterozygotes.



2nd ch.			
Lethals & semilethtals	32.6	41.2	?
Subvitals	33.4	?	97.3
Female sterility	9.2	40.5	17.5
Male sterility	11.0	64.8	20.8
3rd ch.			
Lethals & semi-	9.5	32.1	25.3
Subvital	14.5	?	93.5
Female sterility	6.6	40.5	10.6
♂ sterility	4.2	66.7	8.3

[page 64]

Cont'd Dobzhansky Concepts & problems of pop. genetics

Homeostasis

very similar to "canalization" of Waddington

Homeostatic maintenance of the "steady state" of the organism in the face of changing environ. is possible only thanks to a remarkable plasticity of the physiological machinery. Fox example, the ionic conc of the blood in mammals remains constant because kidneys work differently when too much or too little salt is ingested. Inversions or ch.

Balanced polymorphism - A/B adaptively superior

to A/A & B/B.

Euheterosis – heterosis or coadaption in forms having common evol. hist.

Luxuriance – apparent heterosis in crosses between forms which apparently have not had common evol. history. [End Notes on Dobzhansky Concepts & problems of pop. genetics Return to page 46]

[page 65, Blank]

[page 66]

Harlan, J. R. Anatomy of Gene Centers. MER. NAT 85:97-103, 1951

[Herein we have Byrd's notes on Harlan's paper "Anatomy of Gene Centers", which I have found in JSTOR. Byrd is quoting from the paper without quotation marks and skipping sections. I will now transcribe what he has written and then compare it with what Harlan wrote in the subject paper. The material that Byrd was reading is from the 2nd paragraph of Harlan's paper.]

In 1926 Vavilov included Asia Minor in the Asiatic, Med., Balkan, and Transcausasian gene centers of wheat, including the vulgare, durum, & monococcum groups, and of barley, rye, oats,

peas, lentils, chickpeas, buttervetches, vetches, broadbeans, & flax. In 1935 he established 8 basic world centers in which most of the varietal wealth of our major crop plants are conc. The 8 primary centers are separated one from the other by great deserts or mountain ranges. Only in Asia Minor do 2 basic centers overlap. As a consequence this part of the world is immensely rich in varietal resources of nearly a hundred species of cultivated plants.

A typical Turkish Thrace wheat field contains a wonderful mixture of forms which according to some classifications would comprise a number of species, many botanical varieties, and dozens if not hundreds of agronomic varieties. Species of Triticum found in a single field might include T. vulgare, T. durum, T polonicum, T. compactum, T. monococcum, T. spelta, T. turgidum & others. Around the borders of the fields, in the weedrows, the roadsides, the roadsides, the waste spaces, and to some extent in the field themselves, the wild relatives are found in abundance. The borders of many fields are actually carpeted with forms of Aegilops, Haynaldia & wild forms of Secale & Triticum. [The above matched very closely the second paragraph on page 98 of "Anatomy of Gene Centers", under the subtitle A Thracian Wheat Field. [Note: When I first found Anatomy of Gene Centers I was particularly struck by the section about the wheat fields in Thrace and I copied it down. Then when I came to Byrd's notes on the same paper he copied down the same thing. And this part played a big role in the development of the thinking of JRH.]

-over –

[page 67]

Most wheat fields of Thracian are simple mechanical mixtures resulting from a primitive husbandry and represent a remarkable accumulation of variant forms which we might refer to as a gene microcenter.

Wheat microcenters

Turkish Thrace

Kars basin near the Russian border

T. decorcium, persecium, wild ryes.

Anatolia in upper Mesopotamian plain

Each of the microcenters were characterized by the

Highly variable types of pop.

[Below this is a map of Turkey with all the surrounding nations or seas labeled. This is taken from Harlan's paper. It has some shading on it and some black or white circles and a legend telling us what they are. On the left margin, written from top to bottom is the following:]

The fundamental characteristic which is common to a center is that evolution is proceeding at a rapid pace now. No form of husbandry is too primitive or too specialized to have its effect upon the development of crop plants. Selns are made, natural hybrids occur. The very act of reaping & sowing forces one compliment of a pop. over another, new forms arise & are preserved or discarded to their fate under competition of a pop.

[page 68] Pop. Genetics

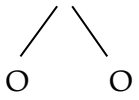
Mather, Kenneth. The genetical structure of populations. Soc. Exp. Bio.: 66-95, Symposia VII Evolution 1953. [see K. Mather]

1. Polyploidy plays little part in adding to the store of variability within a pop.
2. Structural variation – serves to trap genic variation which co-exists in a pop.
3. Genic variation – 2 kinds of genic differences appear in wild populations: those associated w/balanced polymorphism, and those maintained in the pop. by mutation pressure. Gene differences assoc w/polymorphism have an adaptive significance & those assoc w/a polymorphism which controls the breeding system certainly have such a significance.

Action of seln:

1. May favor one extreme phenotype (directional as in artificial)

2. May favor average expression (stabilizing seln.)
3. May favor both extremes at the expense of av. (disruptive seln)



Leads to speciation [below this is a diagram with three sign curves. The first one is labeled "stabilizing"; the second "directional" & the 3rd "disruptive" and there are arrows pointing this way and that. Below them are three more figures: Note that there is a labeled X-axis & Y-axis for the whole diagram. The X-axis is labeled "Phenotype" and the Y-axis is labeled "frequency". So, this chart is plotting the frequency of the appearance of a particular trait in a population and showing how the three types of selection might work themselves out. Now, below the first curve, which was labeled "stabilizing" we see an identical bell shaped curve below it. The next generation is pretty much like the generation before it. In the center set we have something called "directional" selection and the bell shaped curve below the first one has been offset to the right. Here we see two vertical arrows which mark the apex of the top curve and of the bottom curve and, indeed the bottom curve has been offset from the top curve. Now, the third curve on the right side, which has been labeled "disruptive" we see that the bottom curve now has two humps; so, the uniform population above now has two different kinds of individuals – as far as this one trait is concerned and, therefore, has two phenotypes in the population. Under the lower vertical arrow of the second, middle, curve is a note:} will not occur if extremes happen to be heterozygotes.

[page 69]

The prime factors governing the genetical structure & fate of a population are its system of variation and the selective forces to which it has been and is being subjected.

Equilibria of Pop.

Inbreeding – locks up variability – freed only by outcrossing.

Outbreeding

A population can be pictured as stable not because it is static & rigid, as in an inbreeding pop., but because 2 opposing influences are balanced.

The genetic systems we see today are the ones which have been, for their various reasons, successful in the past, and they will continue to show the same balance of success in so far as the circumstances of the future repeat those of the past. Only the outbreeding system can meet the requirement of change.

[page 70]

Hardy, G. H. Mendelian Proportions in a Mixed Population, Sci. 28:49-50. 1908

Mr. Udny Yule made some suggestions in the "Proceedings of Royal Society of Medicine", as a criticism of the Mendelian position, that if brachydactyly is dominant "in the course of time one would expect, in the absence of counteracting factors, to get 3 branchydectylons persons to one normal."

Random mating

AA Aa aa

p 2q r

$F_1 = (p+q)^2 : 2(p+q)(q+r) : (q+r)^2$ or $P_1 : 2q_1 : r_1$

AA aa
| |

Ratio of 1:10,000 then p=1, q=0, r=10,000

$F_1 = p_1 = 1$, q = 10,000, r = 100,000,000

F_2 = p = 2, r=10,000 will not change.

The above information was published in answers to Yules statement.

[page 71]

Harlan, H. V. & M. L. Martini, Natural Seln, in mixture of Barley Varieties. Jour. Agric. Res. 57:459-461. 1938

A mixture of 11 var. of bar. Was grown at 10 stations for a period of 4 to 12 yrs. Mix. was seeded, harv. & threshed w/station equip. Seed was planted following year & pop. counts made annually on 500 plants (tillers?). At all places there was a rapid elimination of the less adapted sorts. At most places the var. that would eventually dominate the population was quickly evident. The leading variety varied with the location of the station. A var. dem. at 1 sta. Some var. inc. for a time & then decreased.

The population trends in general agree w/ a series of theort. Curves here presented. At all places the poorest varieties show the same type of descending curve. The best var. exhibits a typical ascending curve, which for a time approaches a straight line. Trends of many of the intermediate var. are of the same type as the compound curve suggested in the theort. scheme, first increasing then decreasing.

[Below this was drawn a series of curves with X-axis dates: 1924 to 1936 and the Y-axis "No. Plants". One curve was "poorly adapted var" and it fell off and then flattened out. Another was "better than av." And it was a bell shaped curve. The third was "well adapted var. and it went up as a straight line and then sort of tapered off, but was still rising after 1936.]

Over

[page 73]

[At the top of this page is a large graph of Generations on the X-axis from 0 to 24 and unlabeled numbers from 0 to 260 on the Y-axis. On the graph were 9 curves, all beginning at – anywhere

from 30 to 50. There is a whole spread. One did really well. Others were bell-shaped and others just sank down to 0. Below the graph was written:]

Theoretical curves of var. beginning with 45 seeds production for worst var & 90 for best. Remaining 8 spaced by intervals of 5 seeds each.

[page 74] Population Genetics

Evolution 573

[is this paper out of place? Should it be with FC 573? Or is this a reference to the other course? Just ignore this.]

Suneson, Coit A. Survival of 4 barley varieties in a mixture. Agron. Jour. 41:459-461. 1949

Summary

A mixture of 4 similarly adapted varieties of barley grown for16 years brought practical extinction for 2 of the component varieties. One of those had a significantly better yield and leaf disease record than any of the others when grown in pure stands. The variety which ultimately dominated the mixture had the poorest leaf disease record and a mean yield below the median for component varieties. This suggests that the bulked population method of breeding will not necessarily perpetuate either the highest or the most disease resistant progenies, but that the otherwise intangible character of competitive ability may measure other very important plant characteristics.

Methods

4 var. grown in mixture in 1/50 acre plots, 1933-1948. Cleaning & harvested carefully so as to not have any selective interference. The mixture was grown in same test 2/component var. so ylds were comparable.

[Below is a table:]

Progressive changes in plant percentages in comp. of a mix of 4 barley var. Davis Calif. 1932-1948

	1933	1936	1940	1944	1948
Atlas	24.5	42.8	63.1	74.5	88.0
Club Mariout	24.7	22.7	17.3	14.6	10.5
Hero	24.7	12.5	8.3	3.5	0.7
Vaughn	25.2	19.9	11.3	2.4	0.4

over

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Cont'd Suneson

Relative growth & prevalence of severe disease reactions in varieties, 1937-48

			Disease Reaction			
Var	Head date apr.	Ht.	% Acid	% netblotch	mildew	
Atlas	15	40	61	55	S	Outstate yields 1929-43
Club Mariout	16	39	28	42	S	100 % of atlas
Hero	19	39	24	13	I	105
Vaughn	13	38	7	10	I	107

In the component varieties disease data relate closely to yield but not to competitive ability. In 1947 when net blitch was bad: Vaughn 91 bus.

Club Mariout 71 bus.

Atlas 54 bus.

Atlas 46 in years when scald diseases were bad yielded 16% more than Atlas indicating influence of scald on yld.

Growth Habits

Atlas upright, Vaughn more prostrate has early vigor.

Perhaps out classical characterization of a good variety + of superior germ plasm is inadequate. Vaughn is superior when grown alone but not in mixtures. [End of discussion of barley]

[page 76] [Beginning of discussion of Dobzhansky's drosophila.]

Salivary glands etc.

[in upper margin:] AR, PP, etc. are inversions that are recognizable by the arrangement of bands that characterize them.

Dobzhansky, Th. Genetics of Natural Populations. Evol. 10:82-92. 1956

Pop. of D. pseudoobscura[7] in the Yosemite region of the Sierra Navada of Calif. show seasonal changes in the relative frequencies of ST & AR ch. Similar types of changes were observed in D. persimilis in the same region.

During the period (1945 – 1954 mimis 4 yrs), the freq. of AR ch first inc. and later decreased from year to yr in D. pseudo. While ST ch showed opposite change. In D. persimilis during same period WT ch first inc. & then decreased in freq. KL ch showed opposite ch. Changes may have been caused by climatic conditions.

[7] Drosophila, fruit flies

During same period PP gene arrangement arose in D. pseudo pop. of Yosemite region from 0& in 1945 to 2.8% in 1950 to 11% in 1954. The gradual rise of PP was at the expense chiefly of CH arrangement.

Although the actual cause for the rise of PP is not known argument was shown that the phenomena cannot be explained by mutational origin or by introduction of PP from elsewhere. Spontaneous origin of such mutants have been rare in Th's expt.strains – too rare to be used as an explanation of PP inc. The rise of PP is thought to be due to environmental factors favoring heterozygotes of PP.

This kind of change may be an instance of a kind of Evol. change which is both common & important. A ch w/a given gene arrange. may contain, or may evolve by mutation & recombination, a linked gene complex which is useful in a certain range of environ. The coadaptation of the gene

[page 77] over

Complex in this ch. type with gene complexes in other types of ch in the same pop., is gradually perfected by natural seln. The components of the ch pool thus become altered & a reconstruction of the whole pop. genotype gradually ensues. The function of Ch inversions is simply to guard the integrity of gene complex from too frequent destruction by recomb. [end Dobz's fruit flies]

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Stebbins, LG Variation & Evolution in Plants. 1951

Developmental correlation – The direct action of genes is on the process of development & metabolism, hereditary differences between adult individuals in visible characters are produced indirectly through the effects of genes on developmental and metabolic processes. Because of this fact, character differences which are affected by the same developmental or metabolic process are necessarily correlated with each other, since they are influenced by the same genes.

Adaptive compensation – a gene or series of genes may be favored by seln because of one of their effects, but other effects of the same genes may be disadvantageous to the same organism. Under such conditions, still different genes which tend to compensate for the harmful effects of the original ones will have a high selective value.

Selective correlation – once a group of genes have been established in a race because of their role in adaptive compensation they and their initially valuable genes form an adaptive system which must be maintained as a unit if the race or species is to retain its adaptiveness.

Developmental correlation brings about adaptive compensation which results in a selective correlation. [end of Stebbins]

[page 79, Blank]

[page 80]

Population Genetics

Evol. 573[8]

Woodworth, C. M. et al: Fifty generations of selection for protein & oil in corn. Agron. Journ. 44:60-66. 1952

Selection was begun in 1896 from a foundation seed stock of 163 ears of Burr White variety of corn. Four selected strains were established, namely:

Ill. High Oil (HO)	Ill. High Protein (HP)
Ill. Low Oil (LO)	Ill. Low Protein (LP)

[8] Again, the course we are reviewing is Evol. 593, not 573. I am not sure why Byrd put this here.

Ear to row seln practiced 1896-1924 – 28 generations 120 ears selected. In 1925 breeding system altered. No of ears selected – 60, 12 most extreme in desired direction of oil or protein content were saved for seed.

6 ears in one row, 6 in another. Hand pollination between rows used for obtaining next generation. Continued until present.

Selection for Oil Content (Effect of 50 generations of selection on oil content of corn.)

[Below this is a graph of the results: X-axis: Generation of Selection (0 to 50). Y-axis: % Oil (0 to 16). Two curves are on the graph. Both start at 4.70% at generation 0. One curve goes almost straight to the upper right hand corner and ends at 15.36% at the 50th generation. The other curve sags down to the end at 1.01% at generation 50. Below the graph is a statement:}

High oil selection progressed at a uniform rate throughout the expt. Low oil progress has been small in the last 20 generations.

[page 82]

Cont'd Woodworth

Effects of 50 generations of selection on protein content of corn.

[Below this is a graph. X-axis: unlabeled, but assumed to be same as above graph - generations (0 to 50); Y-axis: unlabeled, but assumed to be % oil (0 to 24). Again, there are two straight lines which are averages of other irregular lines. Both lines begin at 10.92%. The top line ends at 19.45% and the bottom line ends at 4.91%. Below the graph is an explanation:]

Progress toward low protein was very slow during first 25 generations but has been more rapid and consistent during 2nd 25 generations. [This does not match the graph as all. HVH2]

When measured by the coefficient of variability – variation was found to decrease in both high strains and to increase in both low strains for the first 28 generations.

*Variability studies for 50 generations saw that low oil stain has increased in variability. No real change in variability in high oil.

Variability has slightly increased in high protein and decreased slightly in low protein.

Random selection showed a slight reversion towards the composition of the original Burr White variety. This tendency was greatest in high oil.

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Cont'd Woodworth

In reverse selection expts (i.e. selection of lowest oil % in high oil & highest in low oil) high oil has been more affected by a change in the direction of selection than have the other 3 strains. Two years of reverse seln have produced no apparent change in the mean oil content of low oil.

Morphological characters & yld of selected strains

	Ear	kernel	germ	yield (lbs.ac)
High Oil	small	small	small	
Low Oil	large	large	small	
High Protein	small	hard		51
Low Protein	large	long & starchy		56

Grain yields only 50% of adapted hybrids.

[page 83, Blank]

[page 84]

Dobzhansky, Th. D & Olga Pavlovaky. An Expt. Study of Interaction between genetic drift & natural seln. Evol. 11:311-319 – 1957.

Question is whether genetic drift and selection are alternates. Wright defines random genetic drift – includes all variations in gene frequencies which are indeterminate in direction. Believes that random drift alone is not likely to bring about important Evol. progress. Random drift may be important in conjunction w/systematic pressures on gene freq, particular w/nat. seln.

[Below this is a graph with X-axis: generations (0 to 18) and Y-axis % PPch (20 to 50). Plotted on the graph are two lines; both start at about 50 and decline to about 35 at 8 generations. Then one, unlabeled line gets higher and remains at about 40 and the other unlabeled line drifts lower to about 25 at 18 generations. Below is a caption:] Changes in freq. of PP ch in 2 rep. expt. Pop. of mixed geographic origin (Texas & Calif.).

[In the left margin opposite the graph it is written:] In small pop. much more variability than in large pop. q varied from .1 – approx. .5 in small pop. & only 2 - 3 in large pop.

[Below the graph the text of the notes picks up:] The results of this study showed that both seln & random drift occurred in 18 gen. test.

Mayr's interpretation of random drift "Isolating a few individuals (the founders) from a variable pop. which is situated in the midst of a stream of genes which flows ceaselessly thru every widespread species will produce a sudden change of genetic environ. of most loci. This change is the most drastic.

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(except polyploidy & hybrid) which may occur in a pop. since it may effect all loci at once. Changes in any locus will in turn affect the relative values at many other loci, until finally the system has reached a new state of equilb.

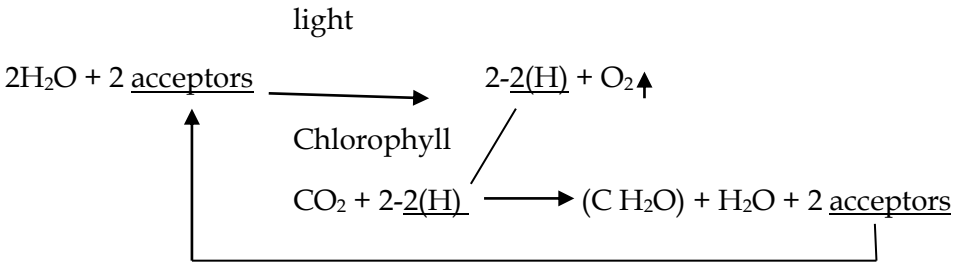
In this study the heterogensity is significantly greater in the pop. descended from small numbers of founders than in those from large numbers.

[page 86]

Harlan, J. R., Theory & dynamics of grassland agr. Van Nostrand Co. [this was posted in the top margin of the page. Starting with the first line we have things which I don't think are in the cited book:]

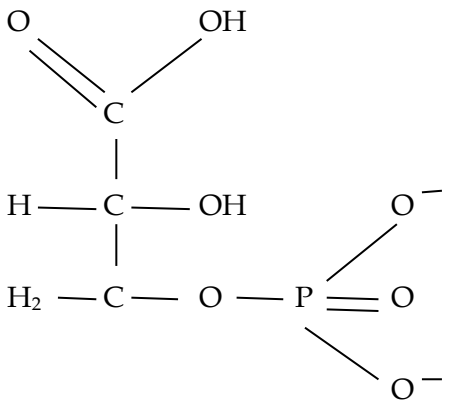
Light Reaction – light energy essential, temp relatively unimportant Dark reaction – does not require light but sensitive to temp.

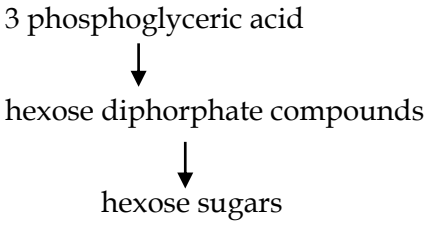
[now there are a page and a half full of chemical reactions and I just don't think this kind of thing is in "Theory & Dynamics", HVH2]



8-10 quanta for ea mol of CO_2 converted to a sugar unit, or 3-4 times the energy stored in each sugar unit.

$CO_2 + H_2O \longrightarrow$ C – C ? + O_2 ↑





Two points basic to metabolic processes:

1. Reactions are catalyzed by enzymes
2. Phosphate linkages are involved in the energy transfer of reactions involved.

Enzymes –

Proteolytic – all protein

Others proteins & non proteins prosthetic group – called coenzyme

Co-enzymes – single metal atoms or vitamine

Cu, Zn, Mg, Co, Mn, Fe

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D=dextro

L=levulose

[The above] refer to the direction of polarized light by the 2 stereoisomers. Enzymes which catalyze reactions of D forms very rapidly, may have little or no effect on L-forms. Naturally occurring sugars are usually D forms.

HC=O H-C=O aledhydic group

HCOH

HOCH

HC-OH

CH_2OH

D-glucose

Glycolysis – anaerobic

Degradation of hexose sugars to pyruvic acid

[page 88]

Goldschmidt, R. B. Theoretical Genetics 1955

The biochemists at present are in favor of the idea that DNA is the genetic material in the chromosomes. In favor of this view are (1) the constancy of the amount of DNA in all cells of a species, whereas the protein contents of the chromosomes vary; (2) the location of concentrations of DNA at points of the chromosome which experiments reveal to be genic (bands of salivary ch); (3) The facts of bacterial transformation via specific DNA and transduction via phase; (4) the role of nucleic acids in viruses; (5) the structure of the DNA molecule which permits visualizing self-duplication. Goldschmidt believes differently – thinks protein of the chromosoma is the genic material proper, but that it requires the linked DNA molecules for self-duplication.

Nucleoli = RNA

Heterachromatin – original meaning – existence of chromosomal regions differing from the others by their staining, according to the amt or conc of DNA in the chromomeres. These differences are specific at different times of the mitotic cycle.

Heteropykemsis – Interphase – Euchromatin invisible, heterochromatin stainable.

[page 89, Blank]

[page 90]

Winchester, A. M. Genetics, Shelton Univ. Mifflin Cl. Boston [This paper is about the evidence for DNA as the basic genetic material. It includes a diagram showing the basic structure of DNA, with all the components, but without the double helix. NEED TO GET THIS AND HAVE A LOOK – UNABLE TO FIND IT ON-LINE HVH2]

What is the evidence that has caused DNA to be considered as the basic genetic material?

1. Bacterial transformation

   [Here he has a little diagram with two circles representing Petri dishes. The one on the left has colonies of bacterial "Smooth colonies" and the right one has colonies of "Rough colonies". Below them is another Petri dish and there is an arrow from the Smooth colony Petri dish to the third one and it is labeled "Bact. Transferred." Another connects the Rough colony Petri dish with the third dish and it is labeled DNA transferred. From the third Petri dish is a line which is labeled, "24 hrs incubation" and the final Petri dish with both smooth and rough bacteria colonies. Under the final dish is written:] some rough colonies appear.

2. Evidence from virus research

   DNA of virus placed in bacterium & new particles produced

[Below this is a series of four Petri dishes showing something – I am not sure what, but below that is written:] Both DNA of viruses & genes retain their individuality through repeated multiplications.

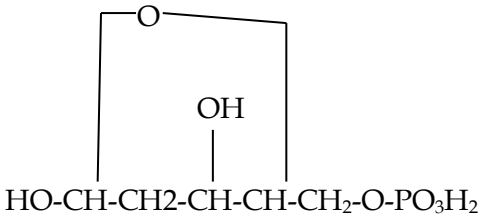
Bases in DNA

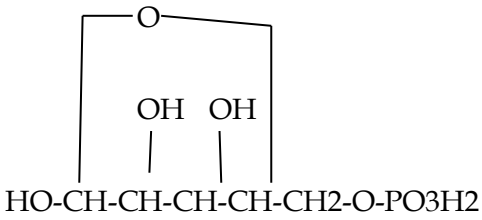
adenine
guanine — purines

thymine
cytosine — pyrimidines

[Then on the right he has a diagram of a DNA molecule showing how A always pairs up with T and C with G and on the sides of the ladder like structure are a series of D P D P , where D = deoxyribose, P=phosphate, A=adenine, C=cytosine, T=thymine, G=guanine, H=hydrogen bond. And, on the left is a chemical diagram which I will attempt to duplicate:]

Deoxyribose-phosphate





Ribos phosphate

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Cont'd Winchester

Recon – smallest element which can have recomb. Not more than 2 nucleotides

Muton " " " " give rise to a mutant form – 5 nucleotides

Cistron – functional unit (as a gene)

[page 92]

Goldschmidt – Theoretical Genetics 1955

Since ch remains intact in resting nucleus, the first step in genec action must take place at site of genic material.

Two possibilities:

1. Initial product of genic activity is a duplicate of geneic material or any part of it – if so this genic material itself is also its first active product.
2. Genic material may act as enzyme which catalyzes the first reaction product using surrounding materials as a substrate, different products occurring presumably along the length of ch.

Beadle's one gene – one enzyme theory. In the formation of a compound many reactions may take place: A→B → C→ D etc. In a mutant form the reaction may not go because the mutant prevented production of an enzyme to catalyze a particular step reaction - A→B, etc. By adding such an enzyme the reaction can go to completion. From this the conclusion was drawn that the normal gene produces this enzyme in a one-one relation. This one-one relation was interpreted to mean the following. The genes are permanent models in the image of which enzyme proteins are constructed. As each synthetic step requires a specific enzyme, and as each synthetic step is supposed to be [LOST AT BOTT OF PAGE 92] gene. Each specific enzyme

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has its master pattern in one gene. In the absence of a deficient function of the gene (mutation), the specific enzyme cannot be formed. Goldschmidt & others disagree at least in part w/ Beadle's theory. If a mutant prevents an enzyme from action, this does not mean that the normal locus produces the enzyme. If the normal locus controls any of the manifold physical & chemical conditions of an enzymatic synthesis, a mutant might prevent the latter by many indirect means (e.g. the control of pH).

Beadle faced with these objections and by further research changed the one gene – one enzyme idea into one gene – one function. This means the gene is connected to any function necessary for accomplishing one synthetic step.

As RNA is derived from DNA in the nucleus, we might think of RNA as the specific first product of genic action (assuming that DNA is the genic material). This would require that many kinds of RNA are dismissed into the cytoplasm as there are genic types.

[page not numbered, but should be **94]**

Morphogenesis

Wilde, C. E. The Urodele Neuroepithelium. The relationship between phenyl alanine metabolism and the differentiation of neural crest cells. J. Morph 97: 313-344, 1955.

The differentiation of neural crest derivatives, specifically pigment cells and ectomeseuchyme, is dependent upon a metabolic sequence localized in the presumptive region using phenyl alanine [phenylalanine] or tyrosine as a key substrate. Should this metabolism be sufficiently disturbed, differentiation of these cells from the neural crest would not occur.

[Next he has a drawing of a molecule of] phenyl alanine [and a note at the lower left corner of the benzene ring:] add OH to get tyrosine.

Analogues of phenyl alanine, when added to a culture medium that supports the differentiation of all neural crest components, give rise to 3 distinct classes of inhibitions. The inhibitory activity has a relation to structural differences between the various molecules and phenyl alanine or tyrosine.

Phenyl alanine (amino acid) is specifically assn with particular cell differentiations. The diff. of cells of urodele neural crest in tissue culture appears to be controlled by a special metabolism concerned with substrate phenyl alanine or tyrosine.

over

[page not numbered, but should be **95**]

The effects upon neural crest differentiation of the structural analogues used fall into 3 classes (1) U general effect on al cells, (2) a specific inhibition of neural crest ectimesenchyme diff., and (3) a specific inhibition of the differentiation of pigment cells and pigmentation.

Waddington, C. H. Genetic Assimilation of an acquired character. Evol 7:118-126 1953.

It has been suggested that if an animal is subjected to unusual circumstances to which it can react in an adaptive manner, the development of the adaptive character might itself become so far canalized that it continued to appear even when conditions returned to the previous norm. This mechanism provides a means by which an "acquired character" in the conventional sense could be "assimilated" by the genotype.

[Across the left hand margin aligned with the above paragraph was written:]

Stabilizing selection – differs from natural selection which eliminates deviants of an animal subjected to unusual environ conditions develops some abnormal phenotype which is advantageous under those conditions, selection will not merely increase the frequency with which this favorable result occurs, but will also tend to stabilize the formation of it even if returned to natural environ.

This (at 17-23 hrs after pupation) treated 4 hrs at 40°C produced crossveinless did not – no adaptive value.

[To the left of this statement Byrd wrote:] Only in 14th gen did control flies (not heated) show any crossveinless. These flies were of course descendants of treated individuals.

[Below the statement is a diagram with two descriptions joined together, as in a cross]

Crossveinless selection somewhat irregular 1st few gen.

Non-crossveinless

[Below all this is a graph with "%Cross-veinlessness" on Y-axis and "No. of Generations" on X-axis with the numbers 5 to 23 across the bottom. Across the top generally rising from 60% to 90% is a line called:] "Cross-veinless Selection Line" [and along the bottom, decreasing from 38% to about 10% is a dashed line labeled:] "Normal Selection line".

[to the left of this graph is written:] Above is not due to chance mutation since many genes are involved that are somewhat additive in effect. It is undeniable that such variability existed after the first generation of treatment since response to selection began immediately.

[page 96]

[Note: this is a very busy page. It looks like Byrd took notes on Waddington's paper and later put some other notes on it, class notes?]

[in top margin:] Ectoderm – skin & neural

Endoderm – gut

Mesoderm – muscles & skeleton

[another note:] Morphogenesis

591.33 W1180 Waddington, C. H. Principles of embryology

Evocation – a unitary process in which one single stimulus calls forth some response; wether the response is simple or complex is another matter.

- two neighboring parts of an egg or embryo may react with one another, in such a way as to change the capacity for development of one, or sometimes of both of the reactants. Takes place after period of cleavage – shiftings and folding of gastrulation bring together parts of embryo which were previously seprated. Interaction cause by assn of parts gradually increase the complexity.

Organizer – located in dorsal vegetative quadrant which contains blastopore. Blastopore region is essential for formation of an embryonic axis.

[Written to the left of all the above:] Individuation – process by which a structurally organized entity is built up and is essentially complex to a degree which corresponds with the number of elements involved in the organization.

Evocation is a straight forward biochemical process, individuation must always involve a biophysical element, since the organization of an embryonic rudiment is a matter of geometry as well as of chem. Nature of tissues.

[back to main page] Embryonic induction – grafting organizer region (near blastopore) from one embryo to another – getting an effect of organization. The organizer is at least as large as the region which will develop into the axial mesoderm (notochord & somites)

Fragments of early gastrula which have the power to induce always themselves develop into some neural, and even endodermal tissues.

By end of gastrulation, the action of primary organizer is over. The competent tissue (Stage of unstable equilibrium – can go either way – neural or epidermis)

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has been definitely swung into one or other of its possible types of development – neural or epidermis or mesoderm.

Continue on p 191

[page 98]

Leopold, A. Carl. Auxins and Plant Growth. Chapt IV & V

[The following is probably notes from Leopold's book about auxins: below this is a graph with on the Y-axis:] + Promotion [at the top and] inhibition – [at the bottom; and on the X-axis is a scale:] 10^{-11} 10^{-9} 10^{-5} 10^{-3} [and labeled:] Auxin Conc. (Indoleacetic acid) [There are three curves on the graph. Each curve begins at the midpoint and rises from left to right into the positive area, then dives down into the negative area. The first curve is labeled

"Roots" and it dives into the negative at about 10^{-9}. Next comes "Buds", which dives down about 10^{-5}. The third curve, on the right is for "Stems" and it dives down at about 10^{-3}.

Auxins can either stimulate or inhibit the various growth functions. Called dualism.

Auxins are transported laterally (more on dark than light side). Plant responds to light There is reason to believe that light causes desensitization of growing cells to a given amt of auxin. It has been estimated that as much as 50% of the curvature of Avena coleoptiles towards light may be a result of the reduced growth assn with the light reaction.

Is B carotene or riboflavin the phototropic pigment? Absorption spectrum of B carotene riboflavin like that of auxin.

Auxins participate in a general control of organ differentiation.

[At the bottom of this page is a horizontal V-shaped figure with the point at the left and it is labeled;] auxin / adenine ratio [and on the top of the expanding V-shape is written:] Buds Callus Roots

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Auxins increase ribose – nucleic acids and DNA following the addition of from 0.01 to 10 mg of undoleactric [?] acid.

[Beneath this are three more charts. These will be difficult to describe, so I will not attempt to do so. The first one, however, shows that with increasing responsiveness to auxins there is decreasing differentiation. The other two show the effect of auxins on various other variables.]

[page 100]

<u>Morphogenesis</u>

Bonner, J. T. Acrasin in Dictyostelium Jorn. Exp Zool,110:259-272 [1949, The demonstration of acrasin in the later stages of the development of the slime mold Dictyostelium discoideum.] Acrasin – active responsible subataner [substance?] for chemotaxis.

Main question that expts raise is the role of acrasin in the migrating & culminating pseudoplasmodia. Evidence to support the view that the first fruiting stage (aggregation) of the amoeloid slime mold Arctyostelium which involves the streaming together of the separate myramoebae, is controlled by a chemtoactically active substance tentatively called acrasin.

1. Acrasin continues to be produced by the appregated cell mass throughout its later development.
2. All the various regions of mig. Pseudo. Produce acrasin and especially active.

Bonner, J. T. Aggregation in Dictyostelium, Jour. Exp. Zool. 106:1-26

Dictyostelium is a member of that curious group of amaeloid slime molds, the acrasiales, which forms one of the numerous bridges between unicellular organisms and multicellular org. In its life cycle there is both a unicellular stage which subsequently develops by aggregation of cells to central collection points into a differentiated multicellular organism.

[To the left of this paragraph are four squares. The first has a bunch of dots in it, symbolizing a number of unicellular organisms. In the second and third boxes they are coming together and in the fourth box they form one big blob in the center. Below the paragraph it is written:]

Vegetative stage → O (Spore) vegetative stage → uninucleate myxamoeba

Aggregation → myxamoeba forms together a mass crawls during migration stage – this rises → culmination

[some words lost at BOTT page 100]

[page 101]

Bonner, J. T. and Slifka – Dictyostelium

It was found that in order migrating pseudoplaemoedia (those that had already migrated some distance) the anterior lip produced a large amount of acrasin while the whole remaining portion produced very little.

[Below this statement is a graph showing how the amount of acrasin is high at the anterior end but drops off steeply as you go towards the posterior end.]

Barth, L. G., Embryology, Dryden Press 1953

Presumptive values of a part is simply that structure or region which the part becomes in the course of development.

[At the bottom of the page is a large diagram: a circle with a number of parts inside it. It appears to be a blastula and the parts are named. Many of the parts are "presumptive" parts: presumptive head endoderm, presumptive endoderm, etc.]

[page 102]

Morphogenesis

Con't Barth

Presumptive eye when transplanted into brain area forms brain, epidermis, nasal placades. These are additional polemics for presumptive eye, others are otocyst, gills, forelimb & cartilage.

Ectoderm of early gastrula is truly undifferentiated tissue. Presumptive eye may form anything. Later the same tissue has only one potency – to form an eye.

The regions around the dorsal lip which normally invaginates to form the roof of the archenteron and which have the property of organizing the ectoderm into nervous system is called the "organizer" in amphibian egg. The region around the dorsal lip is dominant over the rest of the egg or exerts control over its development.

[Beneath this sentence is a diagram consisting of two egg shaped circles side by side. The one of the left is labeled:] amphibian gastrula [and the one on the right labeled:] chick primitive streak [there are some small figures in each and arrows connecting them one to another. Below this is a horizontal line across the page and below that is written:]

Organizer – region or structure which stimulates – or embryonic – process of stimulation – induction may be defined in its broadest aspect as the process by which one gourp of cells stimulates a second group of cells to differentiate.

Since the region of structure acts by contact, the stimulus is presumably chemical in nature.

[page 102]

Cont'd Barth –

Other tissues imitate to some extent at least the action of the organizer. Adult tissues do not have to be alive to stimulate. A variety of chem. were found to act as stimuli – fatty acids, sterols, protein extracts – especially nucleoproteins, etc. One of the best chemical inductors is tobacco mosaic virus. These chemicals only form neural tubes – a real organizer contains something also which changes neural tubes to specific parts of nervous system.

[Below this paragraph is a diagram of a rectangle with a larger circle in the top part and four smaller circles, with black dots in the center of them along the bottom of the rectangle. The four circles are labeled:] early gashulalim. The outside of one of the small circles is labeled:] blocking layer [and the dot on the inside of the small circles is labeled:] active substance [there is a label pointing to the inside of the rectangle which says:] living organizer [below the top rectangle is an arrow pointing down to the rectangle below which has a shaded circle towards the top, like the upper rectangle and below are four small circles which are all solid black and labeled:] liberated active substance [and the whole rectangle is labeled:] End of gastrulation.

[Below this is written:] Self-differentiation – the property of an organ to differentiate according to its presumptive value when transplanted after a presumptive structure has

been determined by the process of embryonic induction, it will self-differentiate even though it is transplanted to a foreign environment.

[page 103]

Siekevitz, Philip and Palade, George E., A Cytological Study on the Pancreas of the Guinea Pig. I & II Functional variations in Enzymatic activity of microsomes. Jour. Biophysical & Biochemical Cytology 4(3):309-319. 1958.

a. Zymogen granules – primarily composed of stored digestive enzymes & enzyme precursors (zymogens).
b. Endoplasmic reticulum becomes the micosome fraction in the usual cell fractionation procedure
c. Microsomes actively participate in the synthesis of new digestive enzymes and indicate that the intracisternal granules, are masses of segregated enzymes and enzyme precursors.
d. A large part of the trypsin - activatable proteolytic enzymes (i.e. mainly trypsinogen and chymotrypsinogea) produced by the pancreatic exocrine cell is localized in the zymogen granules.
e. Zymogen granules contain the 5 hydrolytic enzyme precursors, namely chymotrypsinogen, trypsmogen, procarboxypeptidase, amylase, and libase

[page 104] [Return to page 17]

Sat. Oct. 11 1958 [& 13 was added to this date; Oct. 11, 1958 is, indeed Saturday and Oct. 13 is the following Monday]

Allfrey V. C. & Mirsky, A. E.

The role of deoxyribonucleic acid and other polynucleotides in ATP synthesis by isolated cell nuclei.

Proc. Nat. Acad. Sci. 1957 589-598. [In this paper we can see how they are working on the DNA problem, but don't quite have it figured out. HVH2]

Nuclei deprived of their ATP lost ability to incorporate C^{14} alanim

Presented evidence that one function of DNA & of other polynucleotides in reconstituted nuclei, is to mediate the synthesis of adenosine triphosphate.

Used isolated nuclei from calf thymus. Pre-treatment of nuclei 2/deoxyribonuclease & removal of DNA, leads to a great reduction in subsequent AA uptake as measured by alanine C^{14}

!! in restoration expts do not need specific or homologous DNA. Other sources of DNA ok. DNA need not be intact molecule. Even ribonucleic acids will substitute for DNA in restoring AA incorporation into nuclear proteins.

In isolated nuclei, ATP synthesis requires oxygen and is inhibited by anaerobiosis, but 2,4-dinitrophenol, sodium azide, Na cynate, and antimycin A. In all these respects it resembles ATP synthesis by mitochondria. On the other hand several inhibitors of m itochondrial axidative phosphorylation, including carbon monoxide, Ca etc. have no effect on ATP synthesis by the nucleus.

The agents which block ATP synthesis in the nucleus also block amino acid uptake into its proteins.

Over

[page 105]

The evidence linking AA incorporation to ATP synthesis is not limited to inhibition studies. A more direct test was possible when it was discovered that acetate ions selectively remove nuclear ATP at pH values below 5.9.

Nuclei exposed to acetate buffer at pH 4.4 – 5.9 were far less active than control. Nuclei lost 77% of ATP & 90% of capacity to incorporate radioalamine.

Removal of DNA from nucleus impairs its capacity to synthesis ATP.

Capacity ATP synthesis can be restored by supplementing w/DNA actually increases ATP synthesis. Oxygen must be present for ATP synthesis.

One function of polynucleotides, including ribo- and deoxyribonucleic is to mediate the synthesis of ATP.

The fact that small relatively simple polynucleotides can function in ATP synthesis is of interest from evolutionary standpoint. Original role of polynucleotide structure and that the evol. of cell brought with it a parallel molecular evolution in which these nonspecific polysaccharide molecules were gradually branched and modified to take on a new complexity and assume a new function, therefore, a role in the transmission of heredity specificity.

[unnumbered page; should be 106]

Stern & Mirsky have shown that wheat germ nuclei possess the glycolytic enzymes necessary for generating ATP, and they suggest that the chromosomes probably function in an energy yielding environment. The nucleus thus possesses the ability both to reproduce itself and to supply the required energy.

Conclusion

Fundamental processes of carried out by mitochondria appear to be:

1. The terminal transfer of electrons
2. The coupling of energy – trapping mechanisms (phosphorytalions) to oxidantions, and
3. The Krebs cycle reactions.

The overall activity of the cell are the result of intiamate interactions among the various cellular components.

[page 107]

Hackett, David P. Recent studies on Plant Mitochondria. Int. Rev. Cytology 1955, p 143-196.

Mitochondria – the collection of variously shaped particles. 0.5 to 1 mm in dia. & up to 10 μ in length & composed largely of lipids & proteins.

Invertebrates, vertebrates & probably plants have similar pattern of organization of mitochondria.

It is generally accepted that mito. are self-dupl. elements which do not arise do novo but are formed by division of pre-existing particles. Plastids probably do not come from mitochondria.

Mito. Composition

30-40% proteins (dry wt) (Stafford) (Levcets)

RNA = 1-6% dry wt.

Vitamins & ascorbic acid

Phosphorylase ?

Function of mitochondria

1. Respiration ? Conversion of oxidative energy into a utilizable form.
2. Indirect role in regulating glycolysis (disappearance of glucose)
3. Possess an integrated enzyme complex capable of carrying out the reactions of the Kreb's Cycle
4. Reaction of aerobic phosphorylation – "power plants" of cell (ATP)

5. Centers of CO_2 production
6. Acetate activating enzyme is probably ass. w/mito.
7. Cytoplasmic water-pumping mechanism
8. Ion exchange across the cytoplasm.

Over

[page 108, blank]

[page 109]

[In the upper left corner is a diagram of a chemical with the following formula: $C_6N_4OH_7$

Schwartz, Drew Speculatons on gene action & protein specificity. Proc Nat. Acad. Sci 41:300-307, 1955.

Paper deals with the mode of action of a gene. Problem is how can a nucleic acid confer its specificity to a protein.

A hypothesis on the template mechanism of protein synthesis is discussed which proposes that the sequence of bases in nucleic acid determines the positions of aromatic amino acids in the protein molecule.

[page 110]

1. Albert Einstein

   The story of Albert Einstein by Mae Blacker Freeman, 178 pgs Random House

2. Richard Goldschmidt Biologist Sci. 128 (3331)1069-1-7-, 1958

[page 111]

Definitions

Photon – a quantum unit of radiation

Exclusion principle – spin around nucleus only one direction at a time

Neutrino – a neutron ejects a beta particle which turns into a proton[9]

Nucleon – force that neutrons & protons together

- Emits & absorbs pions
- Pion & meson – Particle of intermediate weight = 2 photons

[page 112]

Gell-Mann & E. P. Posenbaum

Elementary Particle Sci. Amer. 197(1) 72-88, 1957

Some 30 yrs ago physicists thought the theory of the atom stood virtually complete; nearly all the properties of ordinary matter could be mathematically deduced in terms of motion of neg. charged electrons around a charged nuclei. The trouble began when the physicists began probing the interior of the nucleus. When a nucleus is shattered, entirely new matter types are created – a bewildering variety of short-lived particles which do not exists within the atoms of ordinary material.

+ch 1836.1 (1) Protons Inside nucleus

no ch 1838.6 (2) Neutrons Inside nucleus

[Byrd has a line connecting the two weights and leading down to point 3]

Times mass of (3) electrons – around nucleus

(4) Photon – building black of electromagnetic field.

[9] This is in error. A beta particle is an electron which has been ejected by a decaying nucleus. **Neutrinos** are subatomic particles produced by the decay of radioactive elements and are elementary particles that lack an electric charge, or, as F. Reines would say, "...the most tiny quantity of reality ever imagined by a human being".

Virtual process – photon is emitted and reabsorbed so fast that the gain in energy cannot be detected

(4) Antiparticles

[page 113]

Sept. 26, 1958

Crafts, et al, Water in the physiology of plants. Chronica Bolonica Co.

Physical & thermal Properties of water and other liguids

	Surf. Tens.		Internal Press	Heat Cap.	Dielectic Const. E.	Temp
Water	75.6	0	16,400	18.1	81.00	17
Mg	47.6	20	13,050		_____	____
Carbon	35.3	0	5,400		2.600	0
Benzene	31.6	0	4,050		1.002	100
Carbon Tet	29.0	0	3,640		1.003	110
Hexane	20.5	0	2,020		1.874	20
Eth	24.0	0	7,200		1.006	100

Water stands out, having a very high heat of evap. & fairly high heat of fusion. It has high surface tension, internal pressure and dialectic constant.

Max. density at 4°C & greatest expansion at solidification.

Early theories of structure

1. Composed of spheroid molecules, heterogeneously arranged.
2. Raoult pictured association of water molecules into groups of four.
3. Röntgen proposed that liquid water is made up of a saturated soln of ice in some other form of water.

[page 114]

The Hydrols:

Sutherland proposed that water vapor is H_2O (hydrol), ice pure $(H_2O)_3$ (trihydrol), and liquid water a mixture of $(H_2O)_2$ (dihydrol) and $(H_2O)_3$ in proportions dependant on temp.

[Below this is a diagram of a hypothetical water arrangement with three oxygen atoms in a triangle and two hydrogen atoms on the outside of each oxygen. Below the diagram it says:]

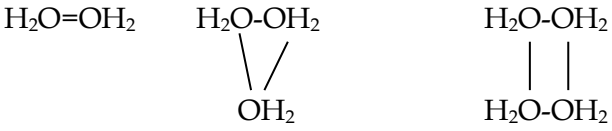
Trihydrol (polymerization on a tetrad O_2valence)

[To the right of that is a little table:]

Fraction of $(H_2O)_3$ in water

Temp C°	%
0	37.5
20	32.1
40	28.4
60	25.5
80	23.4
100	20.3
4	33.3

Armstrong Dihydrone Trihydrone Tetrahydrone



The Faraday Symposium

The association theory predominated and most papers concerned estimation of degree of assn and diff. cond.

Guye – used polyumerization

Bousfield & Lowry – used hydro theory

[page 115]

Kamen, Martin D., A Universal molecule of living matter Sci. Amer. 199 (2):77-82, 1958

The tetrapyrrol ring, a chemical structure made up of four smaller rings, occurs in the chlorophyll of plants, the hemoglobin of blood and many enzymes which, like hemoglobin, take part in respiration. This basic structure with small modifications perform an amazing vaiety of living functions; namely, distributing oxygen to an animal's tissues, converting food into energy, conducting the photosynthesis of plants.

[There is a diagram whithc is going to be too hard to do in Word.]

Tetrapyrrole ring

(porphin) over

[page116]

Hemoglobin carries O_2 as baggage & not as chemically bonded. Somehow the protein attached to the iron cools off the usual warm affinity between iron & oxygen.

Cytochromes – carry out oxidation of foods in a series of finely controlled steps to ATP. (adenine triphosphate) in plants & animals both.

Hill's researches & Kamens show that chlorophyll & Cytochromes always go together in the same part of the cell.

[Note: in the scanned copies of these pages there is a second copy of 115 between 116 & 117]

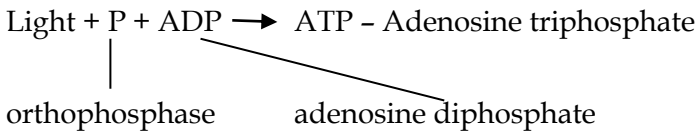
[page 117]

Arnon, D. I. Whatley, F. R. & Allen, M. B.

Assimilatory Power in Photosynthesis, Science 127 (3305): 1026-1034. 1958

The concept is firmly established that adenosine Triphosphate (ATP) is a universal "energy currency acting as a link between energy-yielding and energy-consuming metabolic reactions. Carbohydrates, the main products of photosynthesis, are formed by a series of reactions in which phosphorylation steps with ATP are essential. What has remained obscure was the cellular site at which the special phosphorylation occurred and the mechanism by which it was accomplished – special light – driven assimilation of inorganic phosphate catalyzed by enzymes closely bound to the chlorophyll system or, in mitochondria, by the mechanism of oxidative phosphorylation. CHLOROPLASTS

When conditions were so arranged that CO2 assimilation was excluded, chloroplasts used light energy to esterify inorganic phosphate in accord with the over-all reaction:



phosphorylation can occur in broken plastids providing the water soluble portions (Vit. Etc.) are re-added. Enzymes for this reaction are insoluble.

[Here are some organic compound formulas which are too hard to duplicate. HVH2]

Over

[page 118]

It appears that in all photosynthetic organisms the cytoplasmic particles which contain the chlorophyll pigments also contain a phosphorylating system. The phosphorylating system differs from the CO_2 – fixing enzymes are water-soluble.

Phosphorylation is apparently independent of O_2.

Beneath this is a graph. On the X-axis is Minutes from 0 to 40 and on the Y-axis is labeled micromoles Pestisfied from 4 to 16. There are some experimental points: some are open circles:] =aerobic [and closed circles:]=anerobic. There is two curves, one rising to the right to about 16 and then leveling off is labeled:] light [the other is very close to the X-axis and is labeled:] dark.

[Below this graph is written:] Independence from molecular O_2 means: the synthesis of ATP by illuminated chloroplasts occurs (I) when absorption of molecular O_2 cannot be detected either by manometric techniques or by a mass spectrograph or (II) in an atmosphere of N or organ when O2 is eliminated.

The same light quanta which accomplish the reduction of TPN also bring about the synthesis of ATP and generate the assimilatory power needed for the conversion of C O_2 in Carbo etc. of photosynthesis.

$$\text{Light} + A + H_2O \longrightarrow H_2A + 1/2\ O_2$$

[page 119]

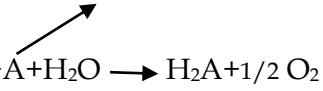
Cont'd Arnon Sci 127 (3305) May, 1958

[Having tried and failed to reproduce the diagrams on this page I will attempt to describe them:]

[Starting with hv acting on chlorophyll this breaks down water into OH and H. The OH goes to Oxygen and the H is taken up by ADP with a Phosphorous atom and TPN. ATP and the TPN goes to $TPNH_2$. These last two go to an X and CO_2 comes in from the left reacts with X and what results is sugar phosphates which go to starch.]

Scheme for photosynthesis by isolated chloroplasts. Photolysis of water results in the evolution of O_2 and the generation of "assimilatory power" comprising two components: reduced triphosphopyridine nucleotide ($TPNH_2$) and ATP. Assemlatory[?] power is then used for the assimilation of C O_2 in reactions independent of light. The same light quanta which accomplish the reduction of TPN also bring about the synthesis of ATP and generates the assimilatory power needed for the conversion of C O_2 in carbohydrates, etc. of photosynthesis.

Hill Reaction ferrecy amite or benzoguinone



Isolated chloroplasts are known to evolve oxygen when they are illuminated in the presence of an artificial electro [Can't read bottom line]

[page 120]

Cyclic photophosphorylation – the conversion of light energy into ATP without the "water-splitting" reaction. Under these conditions, when CO_2 assimulation did not occur, the hydrogen atoms which would have been used in the reduction of CO_2 became a part of the reconstituted water molecule instead of a newly formed sugar molecule.

[page 121]

Goldschmidt, R. B. et al Podoptera effect in Drosophila. Calif U. Pubs. in Zool 55(3):67-294. 1951

1. Podopters is a collective name for a group of different hereditary strains in which the wings are transformed into leg-like, 3-jointed appendages of great variability indetail, including transitions to almost normal wings.

2. Podoptera group of mutants is so widely spread that it appears to be unbiquitous. The usually very low * → penetrance, even in hormozygous condetion, is responsible for the little attention paid it.

   Tetraltera – simple mutant – entire wing transformed into halter like structure
   In all pod types only the costal part of the wind is transformed into a wingleg.

Pod G	1% penetrance
Pod H	2.5% "
" K	30%
M	15%

[to the left of the above list:] all pod lines show pleistropic astrons – lobersting scalloped & un-expanded wings & anomalie of the legs.

Sterility increased with increase in penetrance

**********End Transcript/Discussion of Harlan's Mechanics of Evolution Course 1958*********