

AN OUTLINE OF "THE SYNTONIC PRINCIPLE" ©1941

by Dr. Harry Riley Spittler

Outlined by Dale A. Fast, O.D., F.C.S.O.

Syntonic (adj.) to indicate a balanced, integrated autonomic nervous system where there exists a state of dynamic antagonistic tension between its two systems, the *Sympathetic* and *Parasympathetic*. When these two tensions are equal the nervous system is said to be in a syntonic state. [p3]

Why do individuals react differently to the same environment and the same stimulus?

1. Heredity - twins often react differently to the same stimulus.
2. Structural - some functional differences can be interpreted in terms of recognizable structural differences.

An axiom of biological phenomena is "structure governs function" - not 100%. [P5]
"Heredity governs function in terms of genus and species but we find wide variation in structure, behavior and function within the same species." [P6]

Does the environment alter or prevent instinctive structural manifestations of function, either physiologic or pathologic? Spittler says that environment only alters the drive or urge and does not alter structural instinctive function.

Common Environmental Factors

1. Heredity - varies between families, but not within same family.
2. School and family environment.
3. Endocrine differences - many differences- individuals vary from day to day.
4. Food.
5. Forms of radiant energy absorbed:
 - a) Hertzian waves
 - b) Infra-red waves
 - c) Photic or visible range of spectrum
 - d) Ultraviolet waves
 - e) Grenz and X-rays
 - f) Cosmic rays

Is it possible by altering or controlling the frequency of the photic range of the electromagnetic spectrum incident into the eye and as a result of these changes to predict altered function and to what extent and in what manner? [P9]

History

The 46th word in the Bible is "light".

Ancient Egyptians make frequent references to the sun as source of light and life.

Hindu philosophies abound in references to the use of colored light for the attainment of the contemplative attitude.

In 1871 Pleasanton wrote of using blue light to stimulate the glands of the body for a therapeutic effect. [P13]

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activity thus showing that colored light thrown into the eyes does alter systemic functions of the body. [p17]

A good, easy-to-understand explanation of the electromagnetic spectrum can be found in Dinshah's "Spectro Chrome Encyclopedias".

The therapeutic effect received from water irradiated in colored bottles appears to be due to change in the organic matter in the water, as no therapeutic effect is received with irradiated distilled water. [p25]

Living Cells Ch. IV

1. Ability to make change of form, structure, shape or position as a result of changes in its environment. [P31]
2. Ability to repair themselves and maintain cellular integrity.
3. Continue life requirement of a cell is that it be in an aqueous solution containing its necessary food; and its waste products, which are passed out through the cell wall, shall be removed from the immediate vicinity of the cell. (Carrel's experiment: chicken heart tissue lived for over 25 years until someone forgot to change the solution.)

Osmosis can be varied by:

1. Externally applied pressure.
2. Existence of difference of electrical potentials.

Living cells work best with a 60:1 ratio of potassium to sodium.

Animal cells have increased activity due to the following environmental factors:

1. Increase in oxygen supply.
2. Food in solution.
3. Increased rate of waste removal.
4. Presence of an optimum amount of heat (varies with different types of animals; human 98.6° F).
5. Externally applied source of pressure may increase absorption of food and elimination of waste.
6. Acid/base status of the aqueous environment of the cell:
 - a) Human body optimum acid/base status is 7.4.
 - b) 7.6 is alkaline (predisposes to the allergic diseases).
 - c) 7.2 is acidic.
7. Any change in local electrical charge may alter cell activity.

Stimulus (n) "Any change in environment which produces an active reaction in the cell." There are many stimuli: heat, radiant energy, solution, mechanical contact, chemicals, cold, electrical, etc. In any given cell there can only be one response regardless of the stimulus used.

The *biological triangle*, whose three sides are *environment*, *heredity* and *response to environment* applies to cells and also to complex organisms.

The only clue to an anticipation of possible reactions by a given human being is the objectively observed structure. Types of structures are classified, called *Biotypes*.

Reaction characteristics of all:

1. Normal cell structure is essential to normal function. [P36]
2. Continued abnormal function results in abnormal structure. [P37]
3. A normal cell environment is essential to normal function.
4. A cell or tissue, given a choice between two acts, always does the one requiring the least expenditure of its own energy. (The greater the enforced departure

- from the normal, as it pertains to function, the greater is the tendency for the cell or tissue to revert to its normal status)
5. Nothing of value can be added to the normal environment of the cell. [P38]
 6. Nothing better than the normal environment can be provided for injured or abnormally functioning cells. [P39]
 7. After the cell's reserves are exhausted, continued activity for an expenditure of energy takes place at the expense of the cell structure itself.
 8. Abnormal function indicates either abnormal structure or abnormal environment, usually the latter.
 9. Symptoms exhibited during departures from normal are merely evidence of efforts to continue to live under these circumstances.

Neurology Ch. V

Two nervous systems which interlock, interact and are mutually supportive despite the fact that these two systems have distinctly different classes of functions to perform.

1. *Cerebrospinal System* (brain, cerebellum, spinal cord)
 - a) Quickly reactive to stimuli.
 - b) Extero-fective system.
 - c) Effector system is striated muscles - quick acting.
2. *Autonomic System* (not affected by conditioning or cerebrum)
 - a) slow responses.
 - b) Two dynamically antagonistic divisions.
 - 1) *Sympathetic*
 - 2) *Parasympathetic* (more specialized but less continuous in its effective responses)
 - c) Intero-fective system.
 - d) Effector system is smooth muscles.

Neuromere ≡ receptor; an ingoing conducting fiber; a nerve cell center (reflex arc); an outgoing conducting nerve fiber; something to respond to the receipt of the stimulus. [P42] Millions of these units make up the entire nervous system. Interaction between the neuromeres is very important.

Postural reflexes are integrated and correlated in the cerebellum.

Integration of action is the all-important function of the nervous system. [P44]

Light reflex of the pupil is an autonomic response: light enters by way of CNII to brain and then back by way of CNIII to pupil.

The extero-ceptive paths reach consciousness on two levels: first in the thalamus where a crude integration takes place (survival); second in the cerebral cortex where conscious perception takes place.

From the two maculae of the eyes, in addition to the sensory optic nerve fibers, we have two sets of other fibers distributed to the vestibulocerebellar nucleus, to the lateral nucleus and to the vestibulospinal nucleus. [P51]

Stimulation of the vestibular end-organ in the ears causes impulses to pass to the five vestibular nuclei and spread into the medial longitudinal fasciculus, and to enter the 3rd, 4th and 6th nuclei resulting in nystagmus. May even go to the 10th and cause nausea or 11th and cause abnormal head posture.

Glands and plain muscle are under the control of the autonomic system.

Central Gray Ch. VI

Central gray has the control of maintenance of and expression of life. [P54] Skin and nervous system develop from the ectoderm. The lens, cornea and iris of the eye develop from the epidermis. Corpus striatum controls the muscle tonicity of skeletal muscles throughout the body, and any failure or involvement in this region results in nystagmus, agitations and other incoordinate and involuntary motions, which is controlled by the thalamus. [P56]

The sensory paths of the retina go to three places:

1. Thalamus.
2. Anterior colliculus or superior corpora quadrigemina (reflex center of the eye) mediated through the tectospinal tract.
3. Lateral geniculate body. [P57]

Central Gray Function Centers

1. Respiratory center which controls rate and depth of respiration but is chemically controlled by the carbon dioxide in the blood.
2. Temperature control.
3. Glycogenic or glycometabolic center (diabetes association). [P59]
4. Cardiac center; oculo-cardiac reflex.
5. Vasomotor center.

Central Gray Center for the Eyes [p60]

Diencephalon proper

Sub-thalamus

Thalamus

Epithalamus

Hypothalamus

(Faults of the extrinsic eye muscles, optic radiations and optic chiasm)

Midbrain

Faults of lid muscles

Faults of pupils

(?) Faults of accommodation

Hypothalamus = controls oxygen consumption of the body involved in schizophrenia. [P61]

Neuro-physiological processes of the cerebral cortex are geared to those of the thalamus, and through it to the entire nervous system, to the endocrine glands and to the whole animal. Simultaneous stimulation of the sense of smell was an aid to seeing. Oil of citronella gave a maximum increase in acuity discrimination, while turpentine decreases acuity. [P62]

Corpus striatum does govern muscle tonus of somatic muscles. The striatal bodies themselves are under the control of the thalamus.

Faulty action of the striatal body may result in muscular atony, tremor, nystagmus and clonic spasms of striated muscles. [p63]

The superior corpora quadrigemina control the well-known parasympathetic act of pupillary contraction. [P64]

Autonomic Centers located in the lower part of the diencephalon [p65]

Function of these centers are (* = of concern to optometrists):

1. Thyroid gland stimulation.
2. Lachrymal gland stimulation*.
3. Sugar metabolism regulation.

4. Adrenal gland stimulation.
5. Salivary gland stimulation.
6. Kidney regulation.
7. Sweat gland stimulation.
8. Vasomotor control.
9. Fat metabolism regulation.
10. Possibly uterus control.
11. Possibly bladder control.
12. Temperature regulation.
13. Sebaceous gland stimulation*.
14. Protein metabolism regulation.
15. Pupil regulation*.

Maintenance of the normal body functions (vital functions) and normal ocular functions is the particular duty of the thalamus and central gray. [P66]

Vital Functions

1. Mental.
2. Motor.
3. Reflex.
4. Sensory.
5. Trophic.
6. Vasomotor.
7. Secretory.
8. Hormonal.
9. Body temperature control.

The eyes are known to have a direct connection with the central gray and may be used to exert a powerful influence thereon.

Autonomic Ch. VII

The act of living is roughly described by the word *metabolism*. [P67]

Anabolism ≡ the upbuilding process (vital phase). P[68]

Catabolism ≡ destructive or downtearing process.

Metabolism is under the control of the autonomic nervous system.

Anabolism = parasympathetic or craniosacral division.

Nerve trunk origins in central gray surrounding the 3rd ventricle: parasympathetic outflow by way of 3rd, 7th, 9th, 10th (most important) and maybe 11th. [P69]

Parasympathetic activates some visceral functions while slowing others. The sympathetic always antagonizes the action of the parasympathetic, for any given viscus.

Vagotonic ≡ entire parasympathetic is dominant.

Sympathicotonic ≡ sympathetic division is dominant.

Archipallium or area of hypothalamus is the "seat of elementary vital and vegetative functions of life."

Sympathetic consists of two gangliated chains within the trunk which receives white rami communications from all the dorsal spinal segments and usually the first three lumbar nerves.

Anabolic Functions

Is dominant when in horizontal position.

Parasympathetic dominance or stimulation causes [p70]:

1. Contracts pupil.
2. Widens eye slit.
3. Increases lachrymation.
4. Upper lid ptosed, puffy.
5. Intra-ocular hypotension.
6. Increases accommodation.
7. Esophoria reflex.
8. Low abduction tendency (base in)
9. Activates intrinsic eye muscles.
10. Increases secretions of nose, mouth and pharyngeal glands producing catarrh.
11. Increases salivary secretion.
12. Hypersecretion and hypermotility of intestines leading to colicky pains and either spastic constipation or diarrhea.
13. Slows heart.
14. Dilates arteries.
15. Decreases blood sugar.
16. Stops sweating: palms, soles, under arms.
17. Decreases respiration rate.
18. Irritable bladder.
19. Decreased adrenaline presumptively.
20. Increases bronchial secretion.
21. Produces asthma.
22. Hypermotility and increased secretion of stomach with an excess of hydrochloric acid.
23. Activates:
 - Parathyroids
 - Adrenal cortex
 - Stomach
 - Liver
 - Pancreas
 - Spleen
 - Duodenum
 - Intestines.
24. Drugs increasing parasympathetic:
 - Pilocarpine
 - Aspirin
 - Coal tar drugs.

Catabolic Functions

Is dominant in vertical position. [p73]

Sympathetic (braking system)

dominance or stimulation causes [P72]:

1. Dilates pupil.
2. Protrudes eyeball.
3. Lessens lachrymation.
4. Upper lid retracted, lagging.
5. Intraocular hypertension.
6. Lessens accommodation.
7. Exophoria reflex.
8. Low adduction (base out) tendency.
9. Inhibits ocular activities.
10. Lessens mucous secretions of nose and throat.
11. Lessens salivary secretions.
12. Slows peristaltic wave producing the common type of constipation.
13. Increases pulse rate.
14. Contracts arteries, raising blood pressure.
15. Increases blood sugar.
16. Increases perspiration: palms, soles, under arms.
17. Goose flesh and cold sweating hands, feet, under arms.
18. Increases body heat because:
 - a. Increased chemical action.
 - b. Decreased radiation through the skin.
19. Diminished quantity of urine.
20. Contracts uterus.
21. Hyposecretion and Hypomotility of stomach; stops digestion.
22. Activates:
 - Thyroid
 - Adrenal medulla
 - Pituitary
 - Gonads
 - Muscles.

Enervation of the Iris [p77]

1. Parasympathetic - Edinger-Westphal nucleus in oculomotor nerve to ciliary ganglion. Function: contraction of the pupil and accommodation.
2. Sympathetic. Function: dilation of the pupil, protrusion of eyeball.

Fatigued striated muscles or contracted somatic muscles may be quickly restored to normal or above functional activity by stimulation of the sympathetic. [P79]

Disease conditions due to lack of sympathy in the autonomic system:

1. Rheumatism.
2. Arthritis.
3. Asthma.
4. Angina pectoris.
5. Osteomalacia.
6. Poliomyelitis.
7. Raynaud's and Burger's diseases.
8. Epilepsy.
9. High blood pressure. [p80]

Sympathetic releases or secretes a chemical compound named sympathin; parasympathetic mediates a chemical effector known as acetylcholine. Response of sympathetic is an entire system integration. [P81] Stimulation of the sympathetic causes instant eradication temporarily or permanently of conditioned vision. [P82] Practically all of the associated functions of vision fall in this class, which functions temporarily disappear or are considerably lessened in their power for continued function:

1. Accurate convergence.
2. Stereopsis.
3. Depth perception.
4. Accurate binocular fixation.
5. Maintenance of single binocular vision.

The parasympathetic keeps the animal alive, operating its vital mechanism. [P83]

The sympathetic protects the animal in danger by activating its defense reactions.

Stimulating or depressing the thalamus alters the state of equilibrium existing between the two divisions. [P84]

Biotypes Ch. VIII

Asthenic

Narrow head
Slender bodied
Short or tall

Syntonio

Square head & face
Athletic type body
Medium height

Pyknic

Wide head
Wide body
Short or tall [p88]

Personality and temperament are inherent hereditary qualities. [p88]

Character is the reaction of an individual's fixed hereditary qualities to the environment in which that person is reared.

Structural development of an individual is basically a function of the thalamus and corpora quadrigemina.

Diseases associated with the biotypes: [p91]

Asthenic

High incidence of influenza
Colds
Tuberculosis
Melancholy
Thyroid involvements
Ocular problems [p92?]

Syntonie

Pyknic

Stomach troubles
Tropsy
Apoplexy
Kidney diseases
Cancer
Heart trouble
Arteriosclerosis
Diabetes

Two different phases of personality are represented in the face: the right side represents conscious reactions of the individual; the left side reflects one's unconscious and emotional life. [p94-95]

Endocrines Ch. IX

Endocrinologists use the relative size and shape of teeth in the upper jaw (front six teeth) in determining early developmental states of the endocrine system. [P101]

1. Central incisor = early development of pituitary gland (anterior).
2. Lateral incisors = hormonal secretions of gonads.
3. Canines = activity of adrenal glands (medulla).

Hypothalamus controls the major activities of the endocrine glands. [P102]

Each gland is dependent upon the autonomic system plus the secretion of the other glands into the blood stream. [P103]

Pituitary

Regulation of all other glands.
Not immediately necessary for life.

Anterior Portion

Slightly toxic extracts
General growth
Extracts which activate gonads
Extracts which activate thyroid
Extract which controls fat metabolism
Prolactin which activates secretions of mammary glands
Decreases ability of smooth muscle to contract and hold contractions

If overactive before puberty: [p104]

Excessive growth of bones
Excessive growth of genitals
Excessive growth of voluntary muscle size

After puberty:

Affects bones of head and face (acromegaly).

If underactive before puberty:

Results in short stature, small bones, underdevelopment of voluntary muscles
Anterior lobe stores bromides if administered medicinally, lessening synaptic response.

Posterior Portion

Highly toxic extracts
Pitressin, a vasoconstrictor and controls blood sugar level
Oxyptosin causes contraction of plain muscle
Deficiency results in:
Marked obesity
pelvic and shoulder girdles
upper arms and thighs

1. Blood vessel walls
2. Heart
3. Intestinal tract
4. Interior of eye

Adrenal Gland

• Medulla (inner) activated by the sympathetic; secretes adrenaline and greatly increases under emotional stress of anger, fear, rage. [P107] Acids and calcium in blood increase and activate adrenaline; alkaloids and potassium decrease adrenaline activity [p108]. Blood Ph must remain below 7.6 for adrenaline to be activated.

Adrenaline physiological responses are:

1. Rise in blood pressure.
2. Releases sugar in the blood.
3. Goose flesh.
4. Blanching of skin.
5. Dilation of pupils.
6. Occasionally tremors.
7. Relaxes spasms in bronchioles (asthma).
8. Increases metabolic rate (burns up stored body fat).

A powerful adrenal medulla is a necessity for strong skeletal muscles, muscle response plus recovery of fatigued skeletal muscles. [P109]

Adrenal medulla and thyroid are synergistic glands and antagonistic to pancreas and duodenum.

Cortex

Cortex activates the parasympathetic.

Immediately necessary for life.

Affects oxygen utilization.

Maintains a vital blood volume.

Secretes choline which may decrease blood pressure.

Aids utilization of vitamin C and metabolism of sulfur.

Overactivity in children causes precocious sexual development.

Thyroid Gland

Not immediately necessary to life.

Releases thyroxin = contains iodine and mediates metabolism.

De-iodothyronin = antagonistic to thyroxin.

An absolute vegetarian diet decreases size of thyroid, reduces its functional power.

Basal Metabolism Test (BMT) = measures rate at which oxygen is utilized by body tissues in the fasting state. [P110] BMR is closely associated with pulse pressure and pulse rate.

$BMR = (.683)(\text{sum of pulse rate}) + (.9)(\text{pulse pressure}) + (-71.5)$. Safe range ± 15 .

Results of increased thyroid secretion: [p111]

1. Increased utilization of oxygen.
2. Increased blood sugar mobilization of water and chlorides.
3. Increased pulse rate.
4. Increased elimination of calcium and phosphorus.
5. Increased tonus of striped and smooth muscles.
6. Increased tonic tension of the sympathetic.
7. Increased nervous irritability with extensive reflex responses.

Ocular functional anomalies may be:

1. Focusing.
2. Convergence.
3. Binocularity.

Thyroid acts synergistically with adrenals, pituitary, gonads, liver; antagonistically with thymus, pancreas, parathyroid.

Thymus

Gland of childhood and normally undergoes atrophy at puberty. Injection of thymus extract causes increased growth of external genitalia. Thymus has a compensatory relationship with the adrenals. An individual with a small thymus has a large and massive adrenal and vice versa. [P111]

Parathyroids

Controls calcium metabolism. *Lack of calcium in blood may:*

1. Result in tetany (tonic spasm of somatic muscle.
2. Cause irritation of autonomic nervous system.
3. Cause trophic changes of teeth, nails, loss of hair.
4. Senile type cataracts (deposit of calcium on lens). [P112]

Pituitary

Governs behavior of the individual. The eye must be taken into account not only for sensory visual perception but as a highly complicated organ eliciting nervous reflections in close interrelationships with both components of the autonomic nervous system, with oculocardiac reflex as one connection between eye and parasympathetic.

In hyperpituitism the middle incisors are large and widely separated.

In overlapping of incisors there is a tendency toward uterine malposition or fibroids in the female and to prostatic hypertrophy in the male.

Determining the present status of the endocrine system: [p114]

1. Distribution of fat, and whether the fat is hard or soft.
2. The quantity and distribution of facial hair in women.
3. The dermatograph, which is a peculiar vasomotor response of the skin to friction.
4. Findings about the eye and bodily proportions.

Symptom findings about the eye embrace the following conditions which are attributable to the endocrines:

1. The ability of the pupil to contract to light, with an inability to hold the contraction in the same light intensity for longer than approximately fifty seconds. (*Alpha-omega pupil*) These findings indicate a lack of proper adrenal function.
2. A sluggish reaction of the pupil to light or convergence is also an adrenal anomaly.
3. Exophthalmus is an accompaniment of thyroid over-activity.
4. Ptosis may be interference with the cervical sympathetic, closely associated with thyroid and adrenal function.
5. Nystagmus may be a parathyroid involvement by reason of altered calcium metabolism with tetanic clonic contraction of extraocular muscles.
6. Convergent or divergent strabismus may be due to pituitary involvement.

Fat distribution: [p115]

1. Hypothyroid
 - a. Upper back pad of fat from 7th cervical to 4th dorsal.
 - b. Buttocks are well overlaid with fat; usually extends to thighs.
 - c. Breasts are large and soft.
 - d. Facial expression is puffy and listless.
 - e. Hair dry.
 - f. Skin dry and sealy.
2. Hypopituitary
 - a. Fat distributed around midline and hips.
 - b. Lower abdomen often overhangs.
 - c. Round facial formation with massive double chin.

- d. Males have female breast distribution.
- e. Ankles and wrists are thin within six inches.
- 3. Hypogonadism
 - a. Upper 1/3 of thighs with large fat pads over the trochanteric ("saddlebag") region.
 - b. Very slender fingers and wrists.
 - c. Long bones, usually longer than normal for the height of the individual.
- 4. Hypoadrenia
 - a. Full trunk as a whole with a full, puffy face but expression is alert as contrasted with the dull expression in hypothyroid.
 - b. Upper arms and thighs have fat "chicken drumstick" appearance.
 - c. Hands and feet are usually warm and dry.
- 5. Central gray dysfunction
 - a. Causes a fat distribution similar to hypopituitary with additional masses of fat over the buttocks.

Autonomic disturbance of ocular structure: [p116]

	<u>Sympathetic</u>	<u>Parasympathetic</u>
Upper lid	Retarded lagging	Ptosed - puffy
Conjunctiva	Vasomotor constriction	Vasomotor dilation
Cornea	Complicates conditions only	Dystrophic changes
Pupil	Dilated	Contracted
Palpebral fissure	Widened	Narrowed
Lachrymation	Increased	Decreased
Position of eye globe	Exophthalmus	Enophthalmus
Intraocular tension	Hyper	Hypo

Increased activity of sympathetic may be caused by:

1. Overactive thyroid.
2. Overactive adrenal medulla with blood Ph below 7.6.
3. Overactive posterior lobe of pituitary.
4. Overactive anterior lobe of pituitary.

Increased activity of parasympathetic may be caused by: [p116]

1. Overactivity of parathyroid with increases of calcium metabolism.
2. Increase of interstitial hormones by gonads.
3. Overactive pancreas, if insulin is increased, radically lowers blood sugar.
4. Overactive adrenal cortex.

Intracranial pressure symptoms:

Usually causes impairment of fundus as seen by the ophthalmoscope, or from and color fields as checked by perimetric or campimetric methods.

<u>Where</u>	<u>Nerve Affected</u>	<u>Degree of Pressure</u>	<u>Sympathetic</u>	<u>Parasympathetic</u>
Intracranial	Oculomotor	Slight Great	Relaxant Unopposed	Stimulant Destroyed
Cervical	Sympathetic	Slight Great	Stimulant Destroyed	Relaxant Unopposed

Metabolic effects on eyes due to endocrine dysfunction: [p117]

A. Abnormal muscle functions - abnormal findings

B. Lids

1. Lid lag - Von Graefe sign.
2. Stare - Gifford sign.
3. Slow winking - Stellway sign.
4. Lack of fixation convergence - Moebius sign - seemingly due to mechanical pressure on eyeball in exophthalmus or excess tension of oblique muscles. (Items 1-4 related to thyroid)
5. Also, sympathetic action does the same.
6. Paresis, ptosis, nystagmus, look for possible pituitary involvement.

C. Corneal and Conjunctival Changes

1. Degenerative changes in hyperthyroid - due to exophthalmos.
2. Keratoconus - adipose genital dystrophy, usually pituitary in origin.
3. Keratitis - diabetes; hypothyroid; phlyctenular type - hypo-ovarian. Conjunctival dryness.

D. Cataract

1. Parathyroid perinuclear and lamellar, usually parathyroid, sometimes following thyroidectomy.
2. Diabetic - begins as fine, punctate, milky, white spots which soon coalesce to complete cloudiness - 3-4% of all cases.
3. Senile - hypothyroid - usually begins as cortical. Some say gonadal - controversial.

E. Eye Grounds

1. Simple atrophy in pituitary in 50% of cases.
2. Choked disc in pituitary in only 10% of cases.
3. Optic Neuritis in pituitary in only 20% of cases.

F. Nerve

1. Enlarged blind spot.
2. Bitemporal hemianopsia. Often tumor, pituitary.
3. Unilateral hemianopsia - unusual.

G. Fields

1. Pregnancy and menstruation may show some field changes due to pituitary enlargement.

H. Tension/Glaucoma

1. Depending on structure to cause glaucoma - contributory causes:
 - a. Flat anterior chamber.
 - b. Hyperopia.
 - c. Large lens.
 - d. Hypothyroid - erratic.
 - e. Dished iris - convexly forward.
2. Some producing causes:
 - a. Emotional stress.
 - b. Fatigue.
 - c. Cold.
 - d. Thyroid - hyper.
 - e. Climacteric women - old men - gonadal.
 - f. Sympatheticotonia - extirpation of superior cervical ganglion.

I. Pigmentation, abnormal location of, in the eye or its surrounding tissues.

Body Potential, Brain Waves and Action Currents Ch. X [p119]

Electrolyte = A chemical compound that ionizes when dissolved or molten to produce an electrically conductive medium.

Diffusion potential = the difference in electrical energy between two solutions separated by a semipermeable membrane.

Living cell potential difference between its interior and its environment may result from:

1. A difference in the solutions on the two sides of the cell membrane.
2. Certain increased activities within the cell which take the form of chemical action necessary to its metabolism, which causes the interior of the cell to become electrically negative to its external environment. The nucleus of the cell is positive to the cell protoplasm. From 10 to 20 millivolts of electrical potential is generated by the living processes of metabolism within the cell. [p120] By irritating the cell electrically, chemically, mechanically or by use of certain stimulating drugs it is found that the potential difference between interior cell and environment is markedly increased.

Brain is positive and liver negative under anesthesia.

Conscious brain is negative and liver positive.

Tops of plants are positive and roots negative.

To maintain life and adequate function it is necessary to maintain an optimum potential difference between the brain and other organs and tissues. [p123]

Stimulus = any change in environment which produces an active reaction in a cell.

Life = the power to react to varying environmental conditions. [p124]

Female-producing spermatozoa carry negative charges.

Emotion, worry and fear produce action currents in the nervous system.

Anterior of eye shows a positive charge and back of eye a negative charge.

The chemico-physical change responsible for the transmission of a nerve impulse is an increased utilization of oxygen by the fiber; the stimulus travels along the fiber as a wave of depolarization of the difference in potential between center of fiber (negative) and external surface (positive). [p127]

In cerebrospinal system the depolarization wave travels between 28 and 100 meters per second; in autonomic between 0.3 and 5 meters per second.

The effectivity of a stimulus depends upon its rate of change as well as the intensity of its application. [p128]

Refractory period = Twenty-two to twenty-three thousandths of a second is the shortest interval between two stimuli which may be applied to a nerve fiber and get about 95% of a normal reaction. [p129]

The intensity of the response of the effector in any efferent path is not the result of the intensity of the variation of intensity of the nerve impulse, but is a function of the frequency of the volley of the impulse.

There is a lag of 1/20 of a second for ordinary sensory reception between the incidence of the stimulus and appearance of impulse in the nerve fiber. [p128]

*The functional response is determined by the frequency of the impulse. [p130]

*Intensity of the light stimulus plus the frequency of the light has an effect upon the frequency of the nervous impulses from the eye.

*The higher frequencies are more capable of ionization of the photochemical substances in the retina than are the lower frequencies.

*Variation of light frequency directly varies nerve impulse frequencies.

It takes 37,000 calories per gram molecule to produce visible red while it takes 71,000 calories per gram molecule to produce violet light.

The character of the nervous impulses over the optic nerve from the retina is not different from the character of nerve impulses from other sensory receptors. The interpretation of impulses from the eye must lie within the brain itself. [p131]

Control of the wavelength of the absorbed emission controls protoplasmic tissue during oxidation.

Chief organs involved in systemic oxidation are the brain, thyroid and the adreno-sympathetic system first. [p132-35]

Photochemical effects are reversible in darkness.

Retina

Cones - form perception in high degrees of illumination; color perception.

Rods - motion perception in low degrees of illumination.

Choroid

Has some function to play in the act of seeing.

Hydrogen carries a positive; oxygen negative.

Scotopic retina has an alkaline chemical reaction; photopic retina acid.

The measure of acidity chemically is determined by the mobile hydrogen ions in solution. [p136-137]

Alpha rhythm = 9-10/second. Berger Index factor is the sum of the alpha waves that are recorded in 30 seconds.

Beta Wave = 20-24/second.

Alpha rhythm disappeared when eyes were used to view some object or light was thrown into the eyes.

Intensity of light is not a factor in ocular sensations as a result of light, the real factor being the state of the receptor and the conduction paths. [p138]

Very definite correlation between temperature and alpha rhythm.

Increasing body temperature 6° F increases alpha rhythm 35%.

Epileptic seizure increases voltage of brain waves 3,000%.

Surface potential changed in very definite locations of the brain when light was thrown into the eye. [p139]

Anesthesia merely inhibits perception of impulses.

Motor cells were found to discharge rhythmically at about 40/second. Optic pathways from eye to brain have rhythmic discharge rate of about 10/second. This discharge completely dominates the brain. [p140]

Cortex is highly dependent upon adequate blood supply. [p141]

Physics of Light Ch. XI

White Light = consists of trains of irregular pulses of energy in space. [p143]

Aperiodic energy = energy which consists of a continuous flow of an irregularly pulsating energy.

Periodic energy = energy in which pulsations follow at definite recurring intervals.

The changes in space relationship, number of electrons and their grouping about the nucleus are the distinctive differences among the atoms of the several elements. [p145] Under a number of stresses - electrical, heat, chemical or radiant energy - it is possible for an atom to lose an electron from one of its orbits, usually an electron having high energy in an outer orbit. Upon these phenomena of gain or loss of an electron - *ionization* - depend all known chemical reactions, nerve transmission and the process of metabolism of the living unit. [p146]

All energies of the electromagnetic spectrum travel at a constant velocity of 186,000 miles per second.

Light carries chemical potentialities just as do other chemicals which may be purchased by weight. [p148]

* The ability of an electron to do work is a function of its velocity squared. [p149]

* The chemical structure of the cell may be caused to vary by the light incident upon and absorbed by it.

* The degree of chemical change becomes a function of the frequency of the absorbed light.

* Intensity does not cause a variation of electron velocity, but does determine the number of electrons released.

Photon or Quantum = unit amount of light energy absorbed by an emitted electron and which energy caused it to leave its orbit. [p151]

The unit of energy possessed by each quantum is calculated by the formula

$$E_q = Fh$$

where F is the frequency of light and h is Planck's constant.

The sun emits about 1.98 calories/minute/cm² = 5,000,000 hp/square mile.

Area of human pupil = 0.5 cm² = in clear sunlight the human eye absorbs one calorie/minute.

Almost any atom can be made to emit light by adding energy to it, but the light emitted by the atom of any given element is always the same frequency. [p152]

Also, the excited atoms of any given element always absorb the same frequency of light that they would emit if in a state of excitation. The best radiators are also the best absorbers of energy = black body. A perfect black body = merely a hole = pupil = may radiate or absorb energy simultaneously. [p153] * Imperfect type = choroid = absorbs all frequencies of light (heat) which is carried by the vascular system.

Light waves of low frequency are dispersed less by prisms or lenses than are light waves of high frequency = *chromatic aberration*. [p155] Human eye has 1.8 D. focal interval between red and blue for a light source 1/3 meter from the nodal point of the eye.

Ocular Phenomena in Response to Light Ch. XII

Two types of photoreceptors: [p163]

1. Rods - scotopic; peripheral; functions best at low intensity illumination; 60-100 rods per nerve fiber. [p159]
2. Cones - photopic; macular; function best in high intensity illumination; one cone for each nerve fiber.

Light incident upon the cone sets up a wave of depolarization in the photoreceptor which when it reaches the nerve fiber normally increases polarization; at that point the nerve polarization starts a nerve impulse down the fiber en route to the brain, which has synapses. (Show *Scientific American* article)

Continuous incidence of light on the photoreceptors elicits a series of impulses in the optic nerve tract, thalamus and finally the cortex. The interpretation of these impulses constitutes the conscious act of vision. [p160]

Properties of synapses

1. Synaptic delay ≈ 0.002 ".
 - a. Chemical mediator theory.
 - b. All-or-none theory.

2. After discharge = a kind of repetition of the impulse in the absence of a further impulse stimulus. [p161]
3. Unidirectional transmission of impulses through the synapse.
4. Temporal summation.
5. Spatial summation.
6. Inhibition by the synapse.

Sensitivity of the retina for color:

1. Green is smallest field, then red, and blue is the largest. [p164]

Rate of regeneration:

1. Photopic eye = relatively complete after two to three minutes of darkness.
2. Scotopic eye = takes about 30 minutes of dark adaptation. [p165]
3. There are about 150,000 cones/mm² in the foveal region; each cone \approx 40" arc at the nodal point.
4. A cone must receive and transmit an impression in 1/250 of a second. [p166]

Range of perception:

1. Cones = 10⁻⁴ to 10⁴ foot candles per square foot.
2. Rods = 10⁻⁸ to 10⁻¹ foot candles per square foot.

In the photopic state the maximum sensitivity is in the yellow-green, while in the scotopic state is in the blue-green. [p167]

Under low intensity illumination in long periods nystagmus often develops and may be nature's method of enhancing vision of the subject.

The sensitivity of the eye to flicker is increased by increasing the intensity of the light in its surroundings.

Any system of illumination which provides high intensity in one position without at the same time lessening the illumination of all its surroundings is bad, and results in lessened acuity with consequent eyestrain. Good ocular hygiene then requires a high intensity of illumination in an entire room, but for fine detail work an additional intensity should be cast upon the work at hand. [p168]

There are about 80,000 fibers of varying cross sectional sizes in the optic nerve. Those of larger diameter are easier to stimulate electrically and carry impulses at a higher velocity than the fibers of smaller size. [p172]

The optic nerve has a minimum of three functions: two correspond to potential waves of the first order following stimulation of the retina, which have to do with the act of seeing; third is the motor visceral function control possibly affecting the general health. [p173]

It seems probable that the activity of the cortex, spontaneous as well as due to nerve stimulation, is largely controlled by the thalamus. [p176]

Functional Control by Eyes Ch. XIII

The function of the organism as a whole depends upon the maintenance of an electrical potential difference. [p179] Cellular and tissue function are a part of the generally metabolic processes which aid in the maintenance of potential differences.

Only when a condition of nervous syntony exists will it be possible to have an adequate and normal endocrine status in the individual.

The central gray and the thalamus act as a central nervous organization or distributing center for the maintenance of syntonic function between the two divisions of the autonomic. [p180] Another connection between central gray and endocrine system

is the portal circulation arrangement existing between the central gray and the pituitary. The pituitary is the controlling gland of the endocrine system. [p182] Diencephalon or central gray is the portion of the brain which dominates the autonomic.

Sympathetic system is necessary for instantaneous integration of the body in the presence of danger.

There are several experiments which indicate a relationship between the absorption of radiant energy and pituitary function. [p183]

1. The length of exposure to light.
2. The intensity of the light.
3. The wavelength or frequency of the light.
 - a. Greatest under red light.
 - b. Least under blue.

A weak stimulus over a longer period was equivalent in effect to a strong light stimulus over a shorter period of time. [p185]

If the products of intensity multiplied by time are the same, then the physiological response would be identical.

The eyes alone are the sole receptors of light energy which resulted in the physiologic changes. [p186]

Bodily Health Ch. XIV

In epilepsy there is too much water stored in the body in similar fashion as with too much sugar in diabetes. [p191]

Gault found that increasing room light actually increased *hearing acuity*. [p192]

Bodily health depends upon syntony of all functions; the degree of stability and the degree of irritability of the autonomic division of the nervous system are the determining factors in the maintenance of health or the cure of disease.—

Continued abnormal function may and often does result in structural changes which are not reversible. [p193]

Hereditary dominance of one division of the autonomic over the other would result in the development of rather definite structural biotypes. One of the environmental factors responsible for altering the biotype away from the hereditary tendency is undoubtedly the light environment in early life.

Functional disorders or diseases from dominance or overactivity of the parasympathetic: [p194-5]

1. Visceral hypermotility.
2. Spastic constipation.
3. Intestinal stasis.
4. Mushy stools.
5. Incontinence of urine or stools.
6. Excessive hunger.
7. Chordee = painful erection of penis in gonorrhea or Peyronie's disease, with curvature resulting from lack of distensibility of the corpus cavernosum urethrae.
8. Bradycardia = excessively low pulse = slow heart beat, usually under 60/minute.
9. Hyperchlorhydria = presence of an abnormal amount of hydrochloric acid in the stomach.
10. Eyestrain accompanied by nausea headache.
11. Hay fever.

12. **Asthma.**
13. **Excessive bodily sweating.**
14. **Increased contraction of muscles of the uterus.**
15. **Hypotension.**
16. **Hypothyroid.**
17. **Spasmodic laryngitis.**
18. **Croup = any infection of the larynx in children.**
19. **Eczema.**
20. **Enuresis = Involuntary passage of urine, usually occurring at night or during sleep.**
21. **Migraine.**
22. **Glaucoma.**
23. **Cystitis = inflammation of urinary bladder.**
24. **Diabetes.**
25. **Rheumatoid arthritis.**
26. **Urticaria = hives; nettle-rash; an eruption of itching wheals usually of systemic origin.**

Functional disorders or diseases from dominance or overactivity of the sympathetic:

1. **Acute diseases with: fast pulse, rapid respiration & increased temperatures.**
2. **Hypertension before arteriosclerosis.**
3. **Hypothyroid.**
4. **Chronically dilated pupils.**
5. **Uterine cramps, due to os contraction.**
6. **Retinal hemorrhage.**
7. **Osteoarthritis = inflammation of the articular extremity of a bone, involving the contiguous joint structures resulting in erosion and fibrillation of the cartilages.**
8. **Hypertensive myocarditis.**
9. **Catarrhal gastritis**
10. **Angina pectoris.**
11. **Gastric ulcer.**
12. **Atonic constipation.**
13. **Dysuria = difficult and painful urination.**
14. **Dysmenorrhea = difficult and painful menstruation.**
15. **Tachycardia = rapid beating of heart, usually over 100 beats per minute.**

(definitions from Stedman's Medical Dictionary)

Light effects: [p196] (During departures from normal)

1. **Low frequencies (red) stimulate the pituitary, decrease the leak in potential and tend to stimulate the sympathetic, producing physiologic activity of the defensive type.**
2. **High frequencies (blue) depress the pituitary, increase the leak in potential and tend to stimulate the parasympathetic producing physiological rest or the vital type activity.**

Ultimate Control of Ocular Functions Ch. XV

Function of *accommodation* is controlled by the *parasympathetic* division. [p197]

One would expect a more active accommodative function in a *pyknic* type, where *parasympathetic* is over-active.

More *pyknics* are *myopes*.

Bernstein finds that the amplitude of accommodation is a rough measure of life expectancy. [p198]

Function of *convergence* is commonly accepted to be under control of the *cerebrospinal* system.

Size of pupil is controlled by the *autonomic*:

1. Dilated by *sympathetic*.
2. Contracted by *parasympathetic*.

A high percentage of cataracts can be favorably affected by the blue-green range. [p202]

The ability of striped muscle to recover from fatigue is a result of adrenal activity, and the ability of smooth muscle to have contractions is due to blood chemistry and secretions from the posterior lobe of the pituitary. [p201]

In some toxic states, especially those which stimulate the *sympathetic*, there is an over-response of convergence as associated with the act of accommodation. [p204]

Those *phorias* which are a direct resultant solely of the association of the *internal recti* with the act of accommodation uniformly respond to irradiation of the eye by some one or more of the deep blue transmitted filters.

When *sympathetic* is overactive there is a tendency towards *exophoria* and *exotropia*. [p205]

The mechanical and functional status of the upper four thoracic segment of the spinal cord can affect the ocular functions through quantitative anemic responses, which give fatigue effect.

Night Blindness: [p206] usually can be helped with:

1. Vitamin A.
2. Red-orange filter.

Amblyopia is believed to be due to an *excessive synaptic delay*. [p207] Can be helped by filters which decrease ionization in the retina.

Use of cross-hatched fixation target and frequencies such as transmitted by cobalt glass is good on accommodative problems.