V - ALTERATIONS IN BODY DEFENSES
V.A. STRESS & ADAPTATION

A.a. GENERAL

Even when diseased (stressed), many body functions go on as normal, a fact worth pointing out to your client.

A.b. STRESS

A.b.A. GENERAL PATHOLOGY

stress ⇒ <disease> (hypertension, heart disease, peptic ulcer)
stress ⇒ behaviors (smoking, alcohol abuse, overeating) => <disease>

Path VA-1. General Pathology of Stress

A.b.B. CATEGORIES OF STRESS

A.b.B.a. PHYSIOLOGICAL~ADAPTIVE~EUSTRESS

often
1) highly predictable
2) specific
3) turns off when no longer needed (e.g. ↑ temp –> ↑ **HBR**)

A.b.B.b. PSYCHOLOGICAL~MALADAPTIVE~DISTRESS

1) not predictable
2) nonspecific

(Hans Selye, endocrinologist): ["Nonspecific response of the body to any demand made on it."]; nonspecific [logically inappropriate, nonadaptive]

3) continues beyond removal of stress

A.b.C. STRESSORS [sources of stress] (Δ in stressor {intensity or type} => Δ demand on body => stress response)

A.b.C.a. CLASSIFICATION

1) according to the source of stressors

Endogenous arise w/in the body
Exogenous arise outside the body

2) according to the timing/sequencing of stressors (1,2,3, below, where each different number represents a different stressor)

Acute Time-Limiting	1
Event-Sequencing	1 2 3
Chronic Intermittent	1 1 1
Chronic Sustained	111111111

A.b.D. GENERAL ADAPTATION SYNDROME (**GAS**)

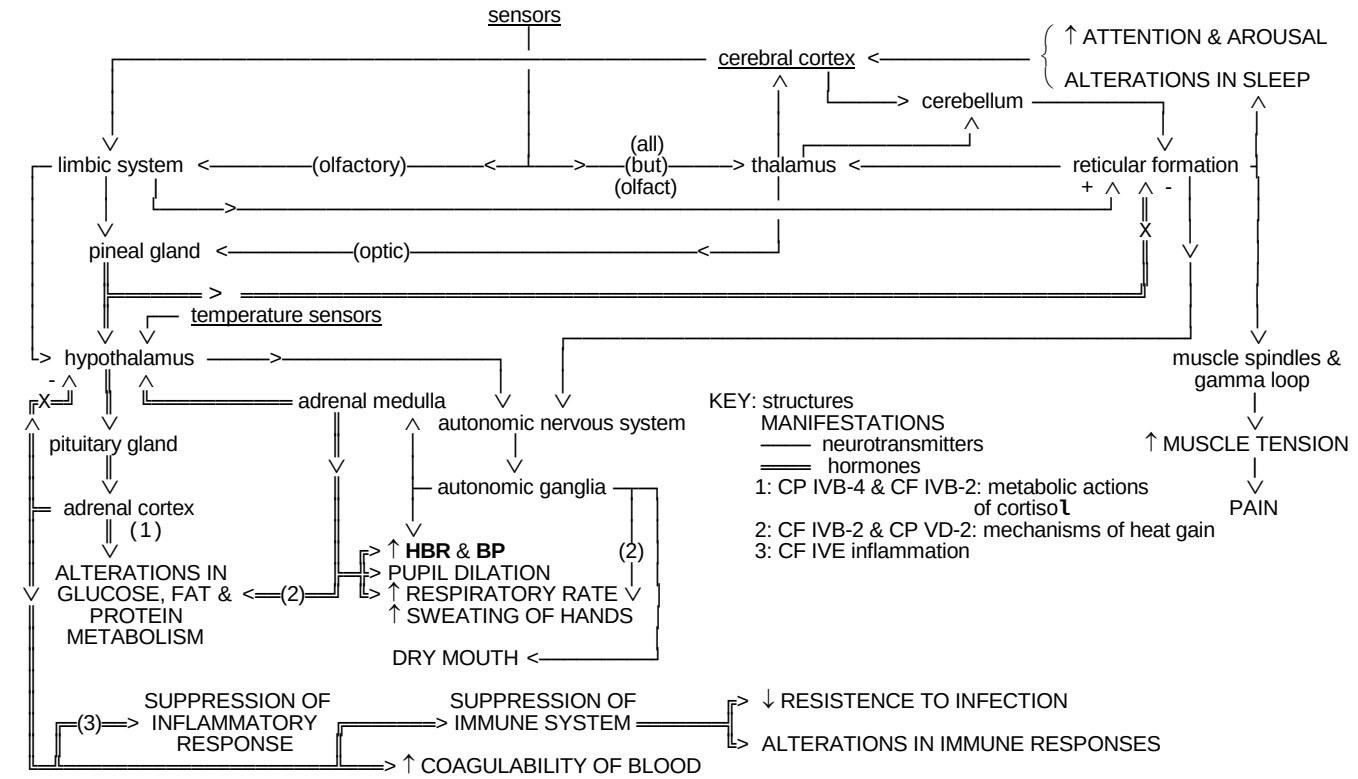
Adaptation [responses to changing conditions likely to promote survival]

1) Three stages
1) Alarm Stage: ↑ hypothalamus-pituitary-adrenal (**HPA**) axis –> mobilization of energy & ↑ efficiency of circulatory system –>
Selye's triad: adrenal enlargement, thymus atrophy & gastric ulcers
2) Stage of Resistance: ↓ **HPA** Axis + ↑ system best able to deal w/ stressor
3) Stage of Exhaustion: all systems worn out, especially those in stage 2

2) In first two stages, homeostatic responses [responses –> a constant condition for some physiological process in the body] commonly occur. These responses can regulate some physiological aspect ↑ or ↓; each homeostatic response mechanism has the following four components:

physiological aspect	sensor	comparator	effector system
variable that is measured = ?	measures value of *variable* = ?	compares measured value to an established **set point**	some body system that brings measured value to **set point**
( )	( )	( )	( )

HWA
Figure VA-1. The Four Components of a Homeostatic Response TP VA-1



Critical Figure VA-2. Stress Pathways. =X=>⁻ represents negative feedback-inhibitory effect; adopted from 32, p 147) TP VA-2 HWA

1) Auto\nomic {G self\G law} Responses
↓ para\sympathetic {G along side of\} division (routine homeostatic)
↑ sympa\thetic {G together\G squeeze} division (emergency homeostatic):
1) activate emergency survival mechanisms (pupils dilate, ↑ heart BR, ↑ respiratory rate)
2) partition limited supply of blood to where it will do most good
3) Table 21.1, p 591, TP VA-3 4) involves HPA Axis

2) Hypothalamic-Pituitary-Adrenal Responses (Axis)

stress =(1)=> / activity of hypothalamus => / corticotropin (**CT**) **RH** => anterior pituitary => / **ACTH** => 1)
stress =(1)=> / activity of adrenal medulla => / epinephrine (a catecholamine)

KEY: 1: F VA-2: stress pathways
2: CP IVC-4: metabolic effect of cortisol & metabolic acidosis
3: S V.E & S V.G: inflammation & immune response

1) zona fasciculata of adrenal cortex => / cortisol
(2)=> / gluconeogenesis
=> / secretion of gastric juice (how relate to / gluconeogenesis?) => gastric ulcers
(2)=> / neutral fat cata\bolism {G down\G throw}
??=> / vascular & cardiac responsiveness to catecholamines => ALARM STAGE
(1)=> - feedback to hypothalamus
(1,3)=> suppression of inflammation & immune responses => atrophy of thymus

Path VA-2. Path from Stress Through the **HPA** Axis to the Alarm Stage (9, → p 260) TP VA-4

3) Limbic System-Pineal Gland-Hypothalamic Axis

KEY: 1: F VA-2: stress pathways
[a]hydroxylase 0-methyl

stress –(1)–> limbic system: / activity of –> 1)
/ darkness –> eye –(melanopsin)–> hypoT TP VA-4b
1) –> / (L-tryptophane => serotonin)
=> pineal gland: / (serotonin ⟹ melatonin) / **HOMT**[a]
=> / melatonin =(1)=> / inhibition of reticular formation => 2)
=> / serotonin =(1)=> / stimulation of pleasure centers in hypothalamus => 3)

2) => TIREDNESS 3) => DEPRESSION

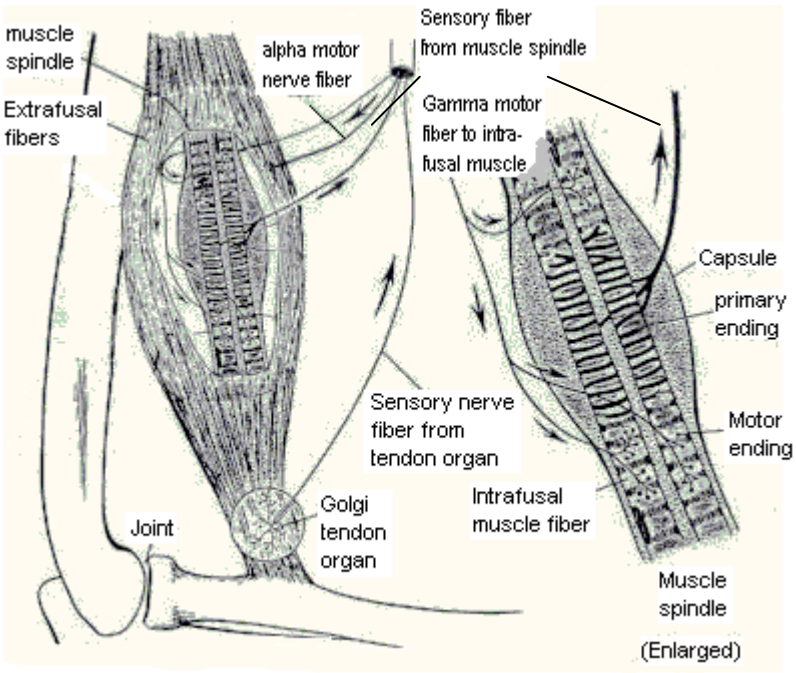
Key: –>: nerve pathway: neurotransmitters
=>: blood pathway: hormones
hypoT: hypothalamus

Path VA-3. Path from Stress Through the Pineal Gland to the Hypothalamus TP VA-4a

4) Musculoskeletal Responses (muscluloskeletal tension = stiff neck, backache, headache, knee ache)

KEY:
A = α-motor nerve fiber~α-motoneuron
B = extra\fusal muscle fiber
{G outside of\G spindle}
C = stretch sensor in muscle spindle
D = sensory fiber from muscle spindle
E = γ-motor nerve fiber~γ-motoneuron
F = intra\fusal muscle fiber
{G within\}

A -> B
C -> *D*
E -> F



Critical Figure VA-3. The Structure of Muscle Spindles & Their Relationship to Muscle Fibers (3, p 186) TP VA-5

TP VA-6
resting muscle: F is always contracted > B, so *C* is always actively stretched

contracting muscle: ↑ stimulation of *A* –> / contraction of B –> / stretch of *C* –> / impulses in D –> / impulses on *E* –> / contraction of F–> 1)
(shortening of muscle)

1) –> / stretch of *C* so *C* maintains its active stretch status

relaxing muscle:
(or muscle being stretched by contraction of antagonist) (↓ stimulation of *A* –>) / contraction of B –> / stretch of *C* –> / impulses in D –> 2)
(elongation of muscle)

2) –> / impulses on *E* –> / contraction of F –> so *C* maintains its active stretch

stress =(1)=> / stimulation of (**SO**) cerebral cortex =(1)=> / **SO** limbic system =(1)=> / **SO** reticular formation => / impulses on *E* => 3)

3) => / contraction of F => too much (/) stretching of *C* => / impulses in D => 4)

4) => / reflexive stimulation of *A* => / contraction of B
- => / stretch of *C* => *C* maintains its active stretch
- => compression of blood => / blood flow => hypoxia =(2)=> PAIN (vessels in motor unit)
- => / MOBILITY => STIFFNESS/TIGHTNESS

(e.g.) STIFFNESS/TIGHTNESS
- a=> in rectus capitis posterior minor muscle (TP VA-7)
- b?=> pulling on dura mater / stimulation of stretch receptors in dura mater –> HEADACHE
- => STIFF NECK

KEY: 1: F VA-2: stress pathways
2: CP IIIA-9: severe hypoxia –> / lactic acid –> / stimulation of pain receptors
a: (41, pp 2484-2485)
b: (42, p 2486)

Critical Path VA-4. Path From Stress to Pain & Stiffness

5) Immunologic & Hematologic Responses (S V.F & V.G: white blood cells & immunology; S V.I: hemostasis)

6) Blood-brain Barrier Responses (43, p 375) involves CRH, the immune system, cytokines (IL-1) and nerve cell death (BIODOTS)