



BIOLOGY OF HUMAN AGING LECTURE 1

Gerontology: Relatively new health care specialization

- “*Geron*” “old man”
 - Is a branch of **science**
 - Deals directly with the broad study of the aging process
 - Usually is from the onset of maturity to death
 - Is a **multidisciplinary field** (includes biological, sociological, psychological and economical perspectives)

Gerontologist: utilize multidisciplinary concepts and approaches in an attempt to understand ALL aspects of complex aging process

Geriatrics is:

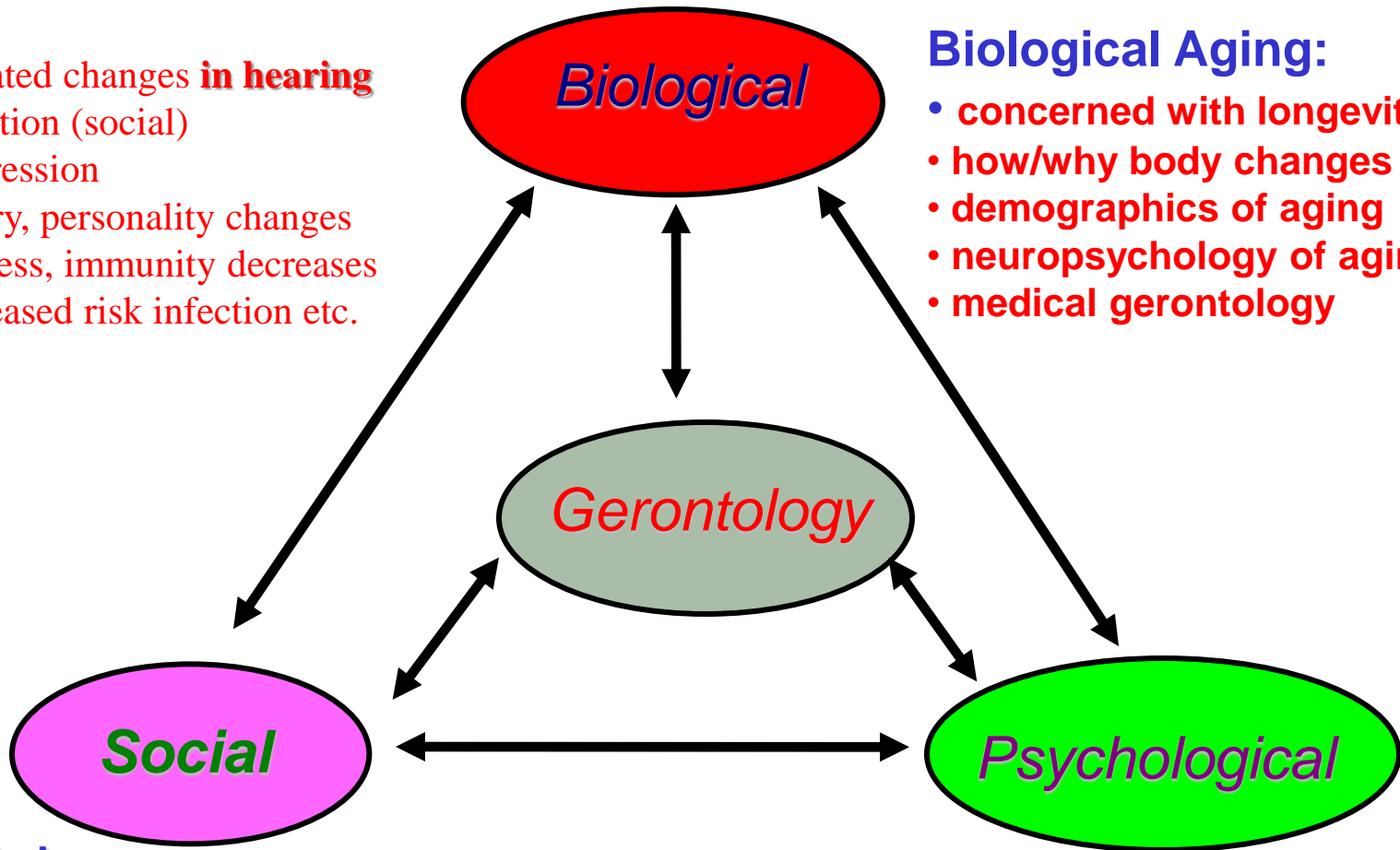
- “*Geras*” “old age”
 - Branch of specialized **medicine (health care)**
 - Deals with medical care and treatment of elderly
 - Relies heavily on field of Gerontology (can't practice without understanding process)

Geriatricians: Primarily concerned with the health, care, diseases, and treatment of older adults (holistic approach that takes into many factors of the elderly patient (health, comfort, treatments, living condition etc.)

3 main academic areas (below) have contributed to Gerontology

Age-related changes in hearing

- Isolation (social)
- Depression
- Angry, personality changes
- Eat less, immunity decreases
- Increased risk infection etc.



Biological Aging:

- concerned with longevity
- how/why body changes with age
- demographics of aging
- neuropsychology of aging
- medical gerontology

Social

Psychological

Social Aging

- Concerned with social roles and expectations of society
- births, deaths
- retirement
- societal roles

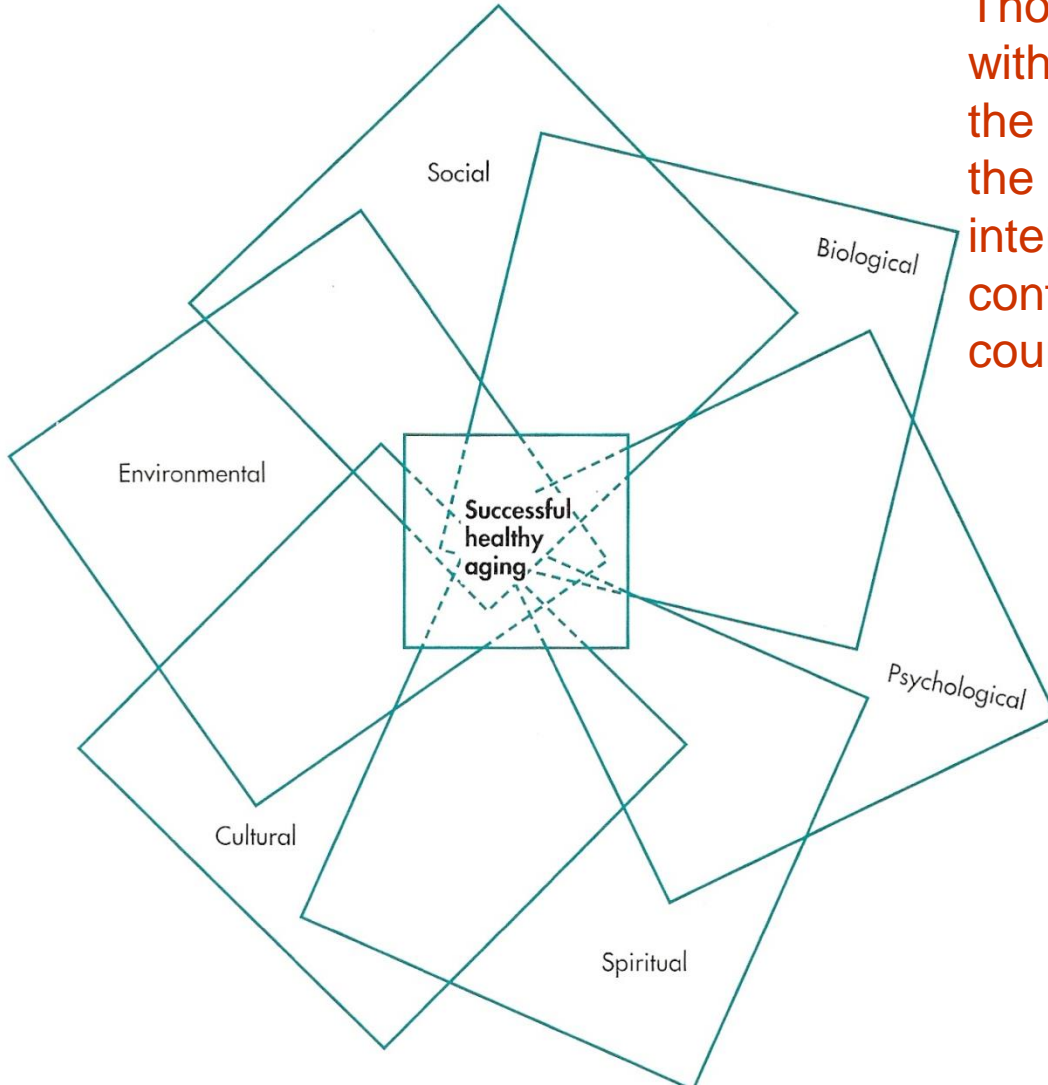
Psychological Aging

- concerned with adaptive capabilities i.e. memory
- Behaviour:**
- attitudes, motivation, emotions

- **Gerontology is an interdisciplinary and multidisciplinary field**

Holistic Approach to Aging

Though this course will primarily deal with **biological aspects** of aging, each of the other aspects are equally important in the aging process of an individual **AND** interaction of all these processes will contribute to shape an individual's aging course or path



•BUT none can impact or alter chronological aging

**Aging unique combo of ALL processes combined
This is what makes elderly so difficult from a medical perspective**

Biogerontology:

• the scientific investigation of biological mechanisms of how and why we age

• Became an independent field of research in early 1940's

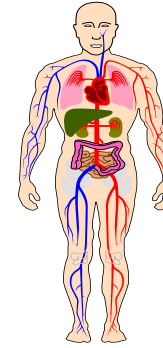
• looks at **physical changes** in body structure that occurs with increased age

• these normal physical changes could lead to changes in

- 1) appearance
- 2) functional capacity

→ **Wrinkles**
gray hair
↓ **Height**
↓ **mobility**

anatomical



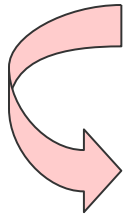
Tissues
Organs
Systems

Biogerontology

cellular



DNA,
Proteins
Lipids
Carbohydrates
Cells, Organelles



MAY Lead to...

Abnormal age-related changes



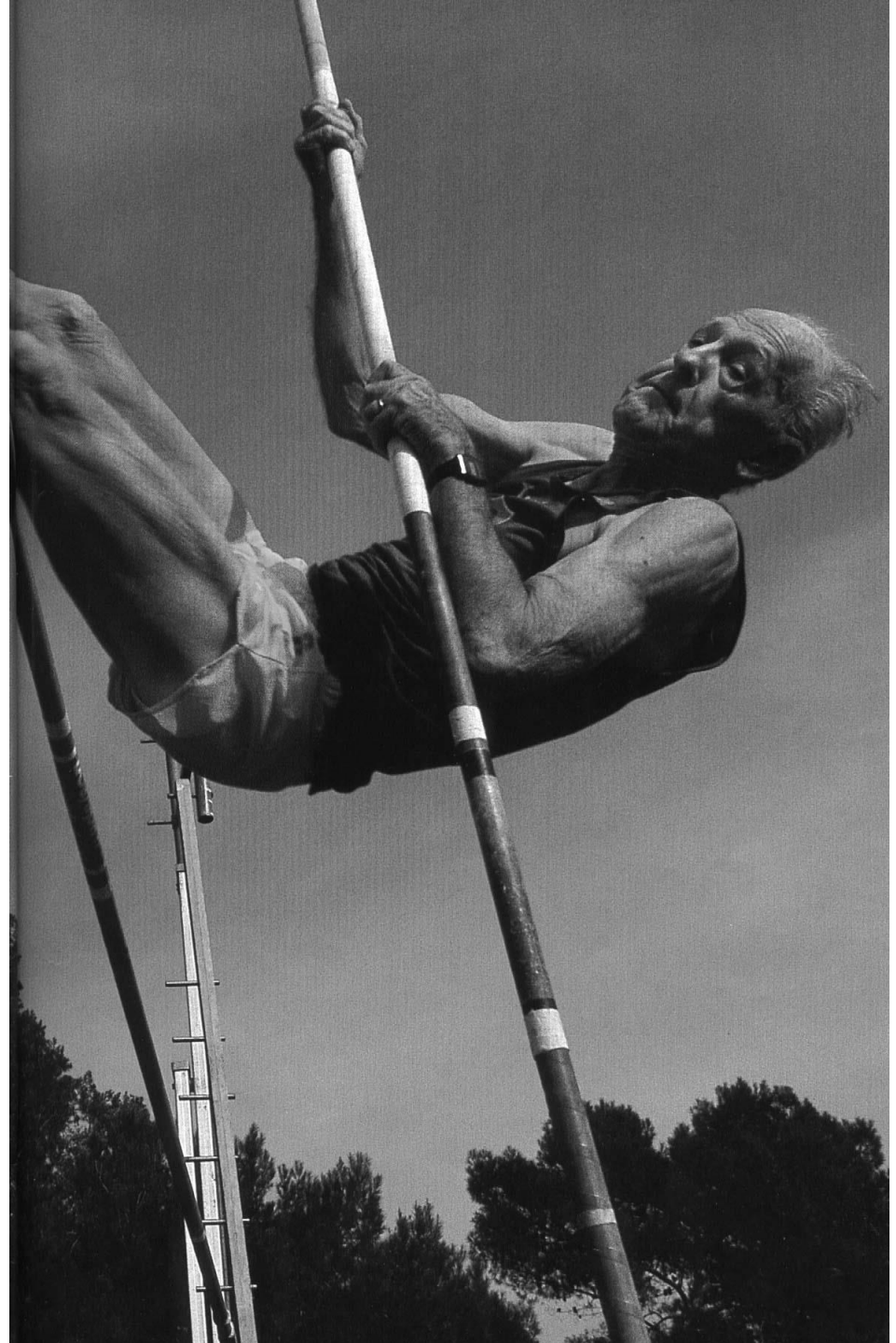
Geriatrics

• also includes any **functional restrictions and impairments** often associated with advanced age

Aging: New answers to old questions

What are our limits?

**Defying his 85 years as
well as gravity, Carl
Johnston held the world
record -7' 6" !**



How is Aging Defined?



How would you define aging?

Difficult to define:

- aging has diverse meanings for different people
- Simplest way is by their **chronological age**

Defined as: the passage of time from birth for that individual

Poor Indicator of Elderly Persons Biological Age Status Because:

- Subjective since it is based on time only
(does not reflect tremendous biological tremendous amount variation in how individuals age, based on numerous exposure to many conditions)
- arbitrary (cohort effect, elderly grow up in different times/places),
- relative (Survivorship effect, where you are in own lifespan-genetics)

Factors above are different for each individual, also the magnitude and type of factors

No good biological markers have been found that coincide exactly with a precise chronological age (or even age category)

CHRONOLOGICAL VERSUS BIOLOGICAL AGING



➤ Chronological age categories are useful for populations but are not useful for expressing aging of individuals

Why? Because: **biological aging \neq chronological aging**

Biological age is based on person's **functional capacity**, not just their age in years

Functional capacity is a direct measure of the ability of our cells, tissues, and organ systems to function properly/optimally

Biologically human individuals are extremely diversified in their physiological aging process in terms of:

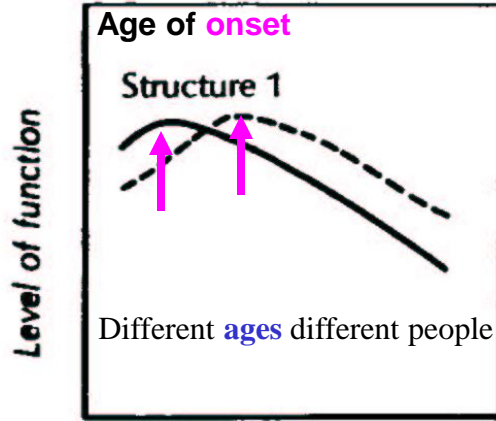
- The **ONSET** of the aging process
- The **RATE** at which it progresses
- The **EXTENT** to which it progresses

- People become more unique as they grow older, not more alike

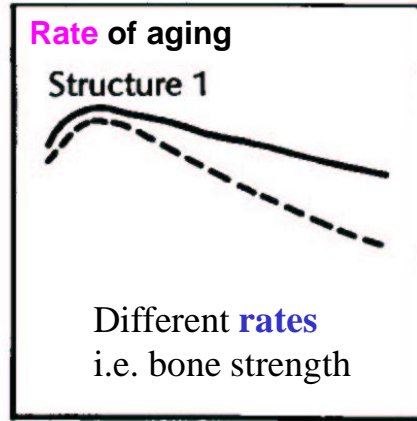
WHO: Terms (Labels)

- young/old 65-74
- middle-old 75-84
- oldest-old over 85

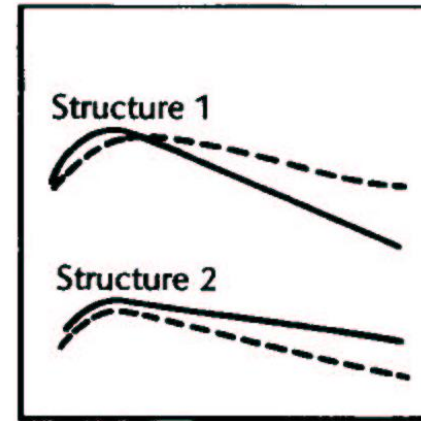
FIGURE 1.13 Aging variables: (solid line = person A, dashed line = person B) (a) Age at onset. (b) Aging rate of the same structure. (c) Aging rate of different structures. (d) Average aging rate. (e) Aging rate in the same person.



(a)

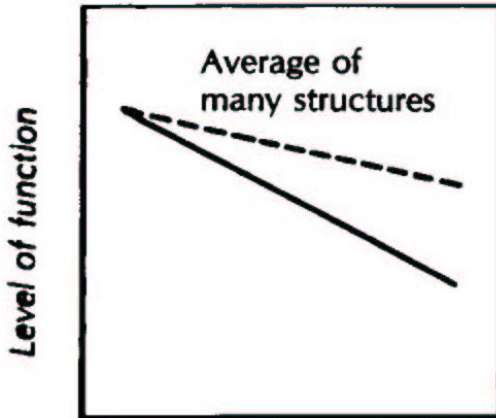


(b)

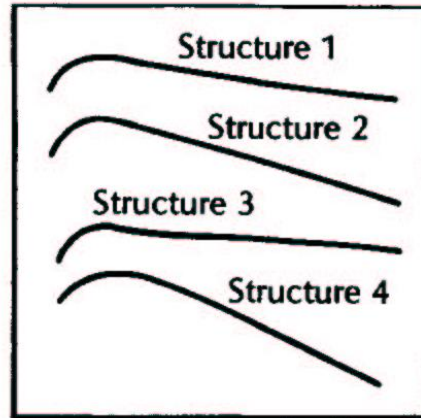


(c)

Variability in structures
between people
Heart vs lungs



(d)



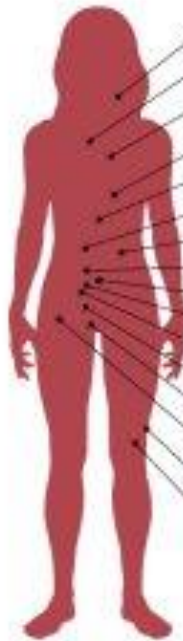
(e)

Do to considerable environmental
influences, genetics.

YOUR BODY PARTS AREN'T ALL THE SAME AGE

A new study found that certain body parts age faster than others. Steve Horvath, a geneticist at UCLA's medical school, found age-related features of DNA that allowed him to type the different relative age of tissues in the body. He looked at tissue samples from one woman and one man, whose ages he didn't know. He found these relative ages of their body parts:

AVERAGE AGE: 44.4



LYMPH NODE / AGE: 39
LUNG / AGE: 48
AORTA / AGE: 53
BREAST / AGE: 67
DIAPHRAGM / AGE: 43
ADRENAL / AGE: 39
SPLEEN / AGE: 48
GALL BLADDER / AGE: 44
PANCREAS / AGE: 42
DUODENUM / AGE: 48
URETER / AGE: 34
OVARY / AGE: 31
BLADDER / AGE: 46
ADIPOSE / AGE: 42
SKIN / AGE: 45
SKELETAL MUSCLE / AGE: 39

AVERAGE AGE: 47.8



LYMPH NODE / AGE: 48
LUNG / AGE: 44
AORTA / AGE: 46
HEART / AGE: 42
DIAPHRAGM / AGE: 48
ADRENAL / AGE: 42
SPLEEN / AGE: 39
STOMACH / AGE: 58
PANCREAS / AGE: 39
URETER / AGE: 36
COLON / AGE: 34
BLADDER / AGE: 31
PROSTATE / AGE: 43
ADIPOSE / AGE: 45
SKELETAL MUSCLE / AGE: 55

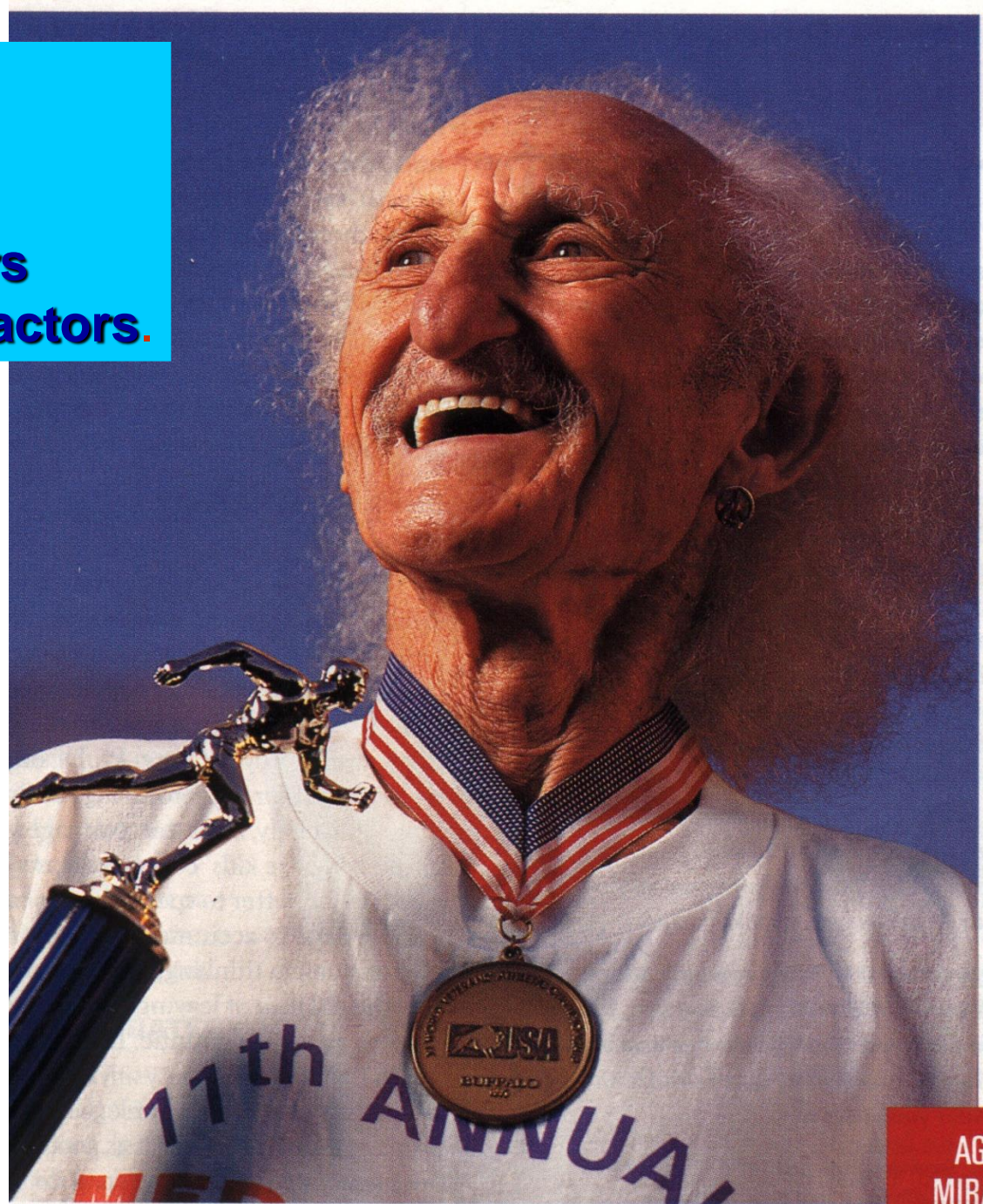
8,000 samples of 51 different cells and tissues.

WHY?

Biological aging is influenced by many other factors

- greatly by **extrinsic factors**
- lesser extent by **intrinsic factors.**

Sam Gadless



When Sam Gadless was in his 70s, his body was a mess and a doctor told him he might not last much longer. He decided it was a good time to start life over again. On Sunday, at 91, he's competing in his seventh New York City Marathon, along with his son and grandson. This year, as the 26.2-mile (42.16-kilometer) marathon's oldest entrant, the Boca Raton, Florida, resident hopes to beat his 1997 time of 8 hours, 10 minutes. It would be a triumph of mind over body, since Gadless missed six weeks of training this year recovering from being hit by a car

If the Einstein lookalike with the flying white hair makes it, he'll cross the finish line in Central Park Sunday wearing a peace-and-love ring in his left ear. "I had one ear pierced for my 90th birthday. There was so much killing in my life that we need to run for love and peace," said Gadless, his English thick with the Yiddish he spoke as a child in his native Poland. He survived German attacks in World War I and escaped the Holocaust by boarding a ship in 1939 and landing in Cuba. He spent nearly two years there before sailing to New York. Later, as an immigrant tailor in California, he chain-smoked his way through hard times until an ulcer forced him to have more than half his stomach removed.

"I was very unhealthy all my life and I don't have good genes," he says. "My father died when he was 42." When he moved to Florida during the 1970s, he had arthritis so severe he couldn't lift an arm and had to have the bones in his big toes replaced with artificial ones. His cholesterol and blood pressure were high and he was a borderline diabetic. The future looked bleak, a doctor told him.

Then Gadless started reading "Prevention" magazine and other health publications. He entered his first New York City Marathon at 85, and has since completed races in Los Angeles, Buffalo, Miami and Orlando. His secret?

He cooks his own meals, skipping meat, dairy products, sugar and white flour, and eating fruit, vegetables and grains - with some red wine. He also eats red salmon, sardines and white tuna.

"I don't eat the bad stuff, like milkshakes, or the (matzo ball) soup my wife used to cook," with butter or chicken fat.

He's replaced it with a 16-bean soup.

"And I eat garlic by the pound. It's an antibiotic," he said. Gadless trains by doing aerobics, stretching and swimming, as well as light weightlifting. And he walks up to 40 miles (60 kilometers) per week, alternating among 10 pairs of shoes.

"Age is just numbers," Gadless said. "When I was younger, I was sick as could be. I'm living my youth"



Posted: January 13, 2005

Athletics: Marathoner Gadless Dies At 98

Sam Gadless, who didn't run his first marathon until he was 85 years-old, died on 04-Jan, according to his son, Louis Gadless. He was 98 years-old and lived in Boca Raton, Fla.

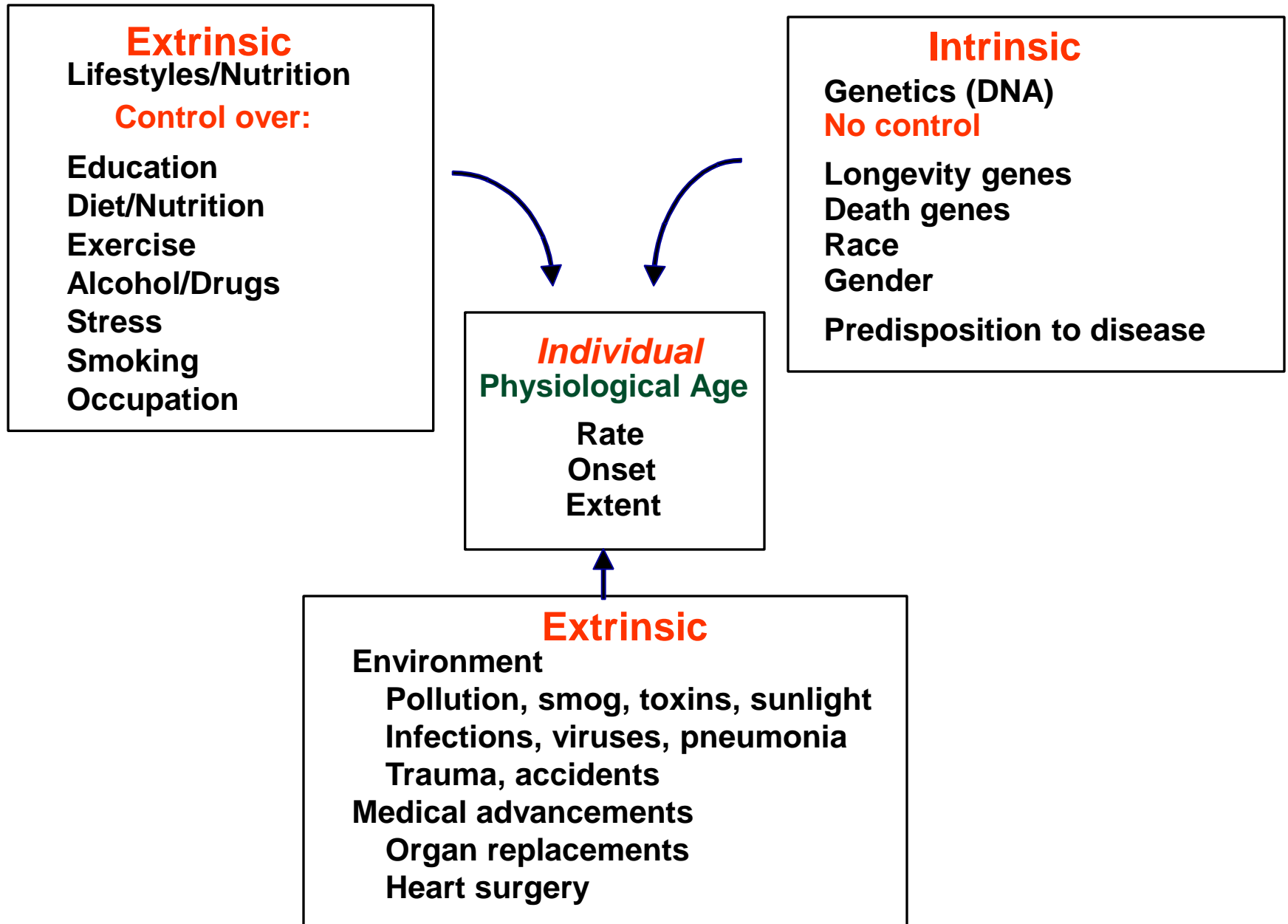
In 1992, Gadless entered the ING New York City Marathon and finished in 6:44:32 at age 85. He went on to run the race eight consecutive times, and was honored with the Abel Kiviat Award for each of those performances as the oldest finisher of the race. He last ran the ING New York City Marathon in 1999 at the age of 92, finishing in 9:28:05. His best time came in 1993 when, at age 86, he ran 6:04:47.

"Sam loved the New York Marathon and he treasured the memories of his eight marathon experiences," said his son, Louis, in an e-mail message sent to the New York Road Runners. He made many friends through his participation and he had many fans among the people of New York."

In 1998, when Gadless was 91, he ran the race just two months after being hit by a car. He finished in 8:26:00.

"It's like he always says: His goal is to be the healthiest man in the cemetery," his son Louis told Outside magazine at the time.

Some factors which effect the time of onset, rate and extent of biological aging



3 major lifestyle factors that have a major impact on the manner in which we age are:
Regular exercise, proper nutrition, stress management.

Yoga teacher, 96, sets world record

Sarah Ratchford

TORONTO — Ida Herbert stands with her feet wide apart, takes a deep breath, and bends her body to one side to touch her left foot, settling into a triangle pose.

Herbert is 96, an age not many reach — and she has been named the oldest yoga teacher in the world by the Guinness World Records.

She has been practising the ancient discipline since the late 1940s — long before Lululemon started making workout clothing, and well before it was a trend in western society.

“Yoga’s wonderful for your body, and it’s also wonderful for the interior. You can be so quiet and peaceful as you exercise,” Herbert says.

“I don’t think I talked about it to anyone. If I did, I would just say ‘I’m going to the health club.’”

The four-foot-ten instructor wears vintage cat-eye glasses, has tidy white hair and looks about 25 years younger than she is.

Herbert attributes her good health and generally happy attitude largely to her years of practising yoga. “It’s made me very phys-

ically very flexible, and inside, it’s made me look at circumstances in a peaceful way,” she says. “Things won’t make me quite so angry as they used to.”

Herbert rises at 5:30 a.m. to perform her poses and says her day isn’t quite the same if she forgoes her routine.

Herbert got started practising yoga when she was at a health club in Toronto. One of the women who worked there taught her the poses — and that got her hooked.

Now, Herbert helps other women find that same peacefulness. She retired last year from teaching at the YMCA in Orillia, Ont., after 25 years. She now teaches in the Bayshore Village area, near Orillia, with classes that range from five or six up to about 17 people per class. Her students tend to be women ranging in age from their 50s up to their 80s.

“And I’m the oldest one there, of course,” she says, adding she doesn’t plan to stop teaching after doing it for about 30 years.

“It’s very complimentary to know that you can get into the book of records,” she says.

The Canadian Press



MICHELLE SIU, THE CANADIAN PRESS

Ida Herbert, the 96-year-old yoga instructor who has been named the oldest yoga teacher by the Guinness World Records, poses for a photo in Toronto.

Overview of Normal Biological Aging Process

Extrinsic Factors

Lifestyle: diet, stress, exercise

Intrinsic Factors

Genetics: Fixed
positive or negative



Extrinsic Factors

Environmental Factors:
temp, drugs, trauma,
toxins, radiation

Aging of Organism

- decline of functional properties
- loss of homeostasis
- decreased ability to adapt to internal/external stimuli
- increased vulnerability to disease and mortality

Definition of Normal Biological Aging

- Aging is defined as the decline and deterioration of **functional properties** at the cellular, tissue and organ level
 - *structural elements within the body deteriorate*

- Loss of functional capacity with age results in a decreased ability of the elderly to adapt to both **internal and external** stressors

- The reduced capacity of elderly to respond to changing internal and external environments makes it difficult for them to maintain stable chemical and physical states within body (*homeostasis*)

- In absence of homeostasis, dysfunction of cells, organs and systems is more likely with age, which increases likelihood of *disease and death*



Step 1:

Loss of Functional Capacity of Cells, Tissues and Organs

↓ F.C. with age due to deterioration of structural elements (usually cells)

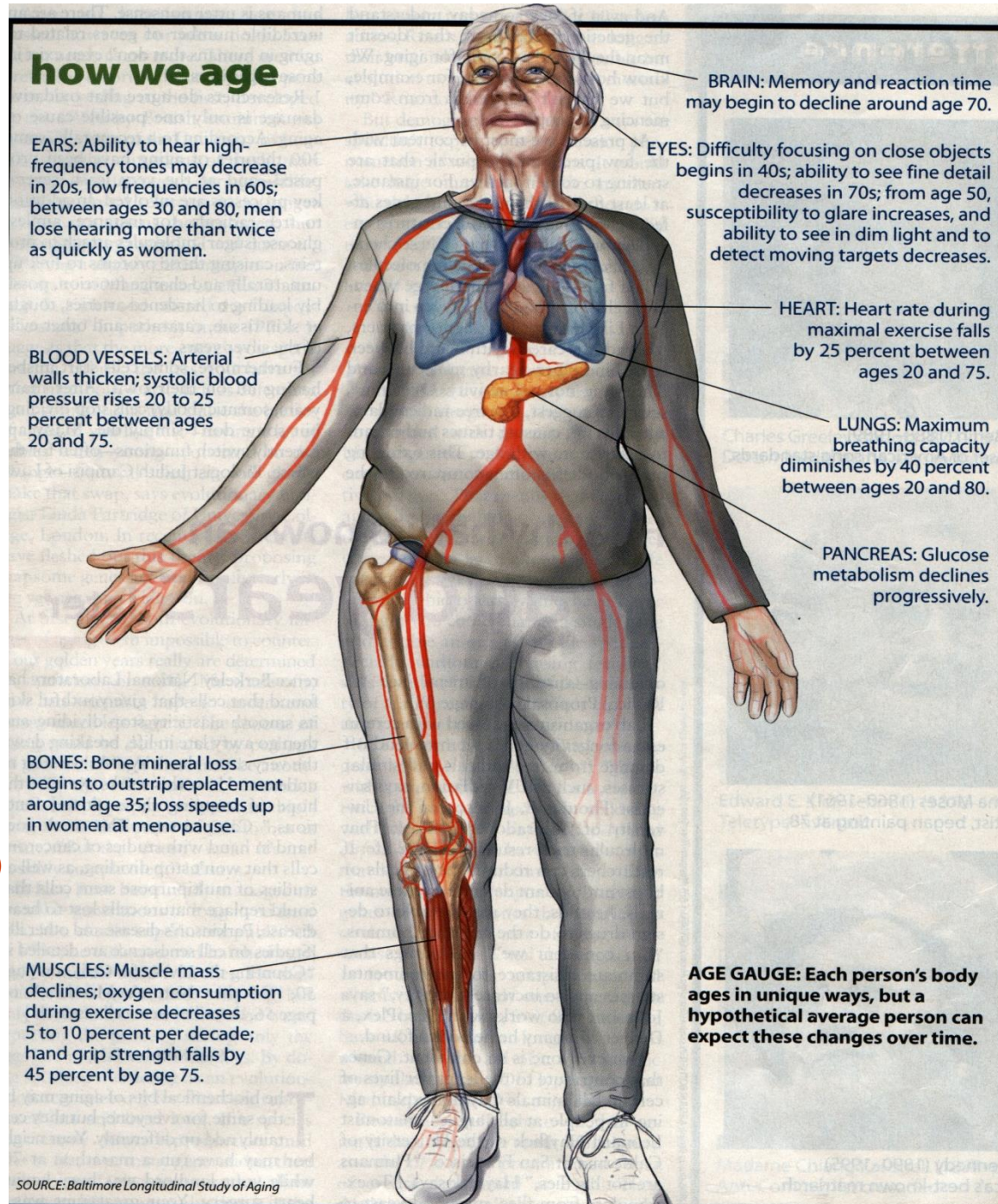
Brain weight ↓ by about **15%** by the age of 80

Basal metabolic rate by about **20%**

Cardiac output (ability of the heart to work) is about **30-35%** less functional by 80

Respiratory capacity (lung functioning) is about **45%** between 40-70

Liver weight declines by about **35%**, while liver blood flow about **50%** by age 80



Flagging Cell Repair Leads to a Gradual Decline

BRAIN

Memory and reaction time may begin to decline around age 70.

EYES

Difficulty focusing on close objects begins in 40s; ability to see fine detail decreases in 70s; from age 50, susceptibility to glare increases, and ability to see in dim light and to detect moving targets decreases.

LUNGS

Maximum breathing capacity diminishes by 40 percent between ages 20 and 80.

HEART

Heart rate during maximal exercise falls by 25 percent between ages 20 and 75.

SPINAL DISKS

Years of pressure on the spongy disks that separate the vertebrae can cause them to slip, rupture or bulge; then they, or the vertebrae themselves, can press painfully on nerves.

BONES

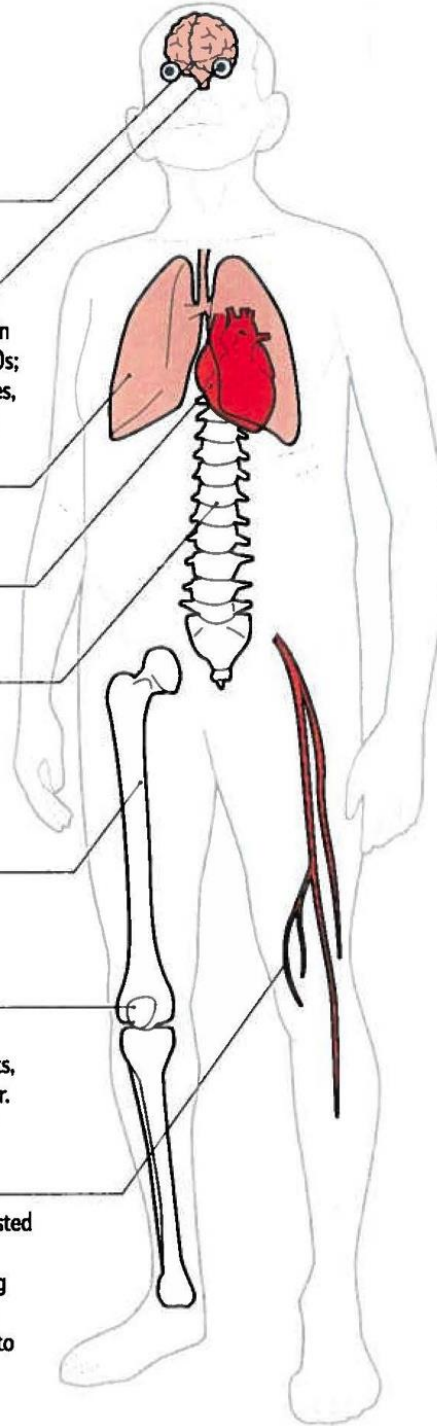
Bone mineral loss begins to outstrip replacement around age 35; loss speeds up in women at menopause.

JOINTS

Repetitive motions through the years thin the slippery protective coverings over joints, causing bones to grind against one another. The resulting pain may be exacerbated by osteoarthritis and other disorders.

VEINS

Veins in the legs become enlarged and twisted when small valves that should snap shut between heartbeats (to keep blood moving up toward the heart) malfunction, causing blood to pool. Severe varicosities can lead to swelling and pain and, on rare occasions, to life-threatening blood clots.



Loss of Functional Capacity of Cells, Tissues and Organs

Step 2: Decreased ability to handle stressors

- **Stress** is the body's reaction to harmful forces (stressors) which are capable of disturbing homeostasis
- Individual responses depend on many factors
 - Age
 - General health
 - Type of stressor
 - Persistence of stressor

Homeostasis dependent on adequate response to stress by:

- Mobilizing energy
- Activating defense mechanisms
- Repairing any damage

Inadequate response to stress results in destruction of cells

Step 3: Loss of Homeostasis: What is homeostasis?



- Survival relies on cells of the body performing thousands of physiological processes and do it without mistakes... if cells were not functioning properly then most body activities would cease

- To function properly cells in body must have proper set of internal conditions which remains virtually **constant or balanced** all the time (i.e. internal stability)

Homeostasis = Homeo similar + stasis condition. When these internal conditions are met and cells are functioning optimally then we are in *homeostasis*

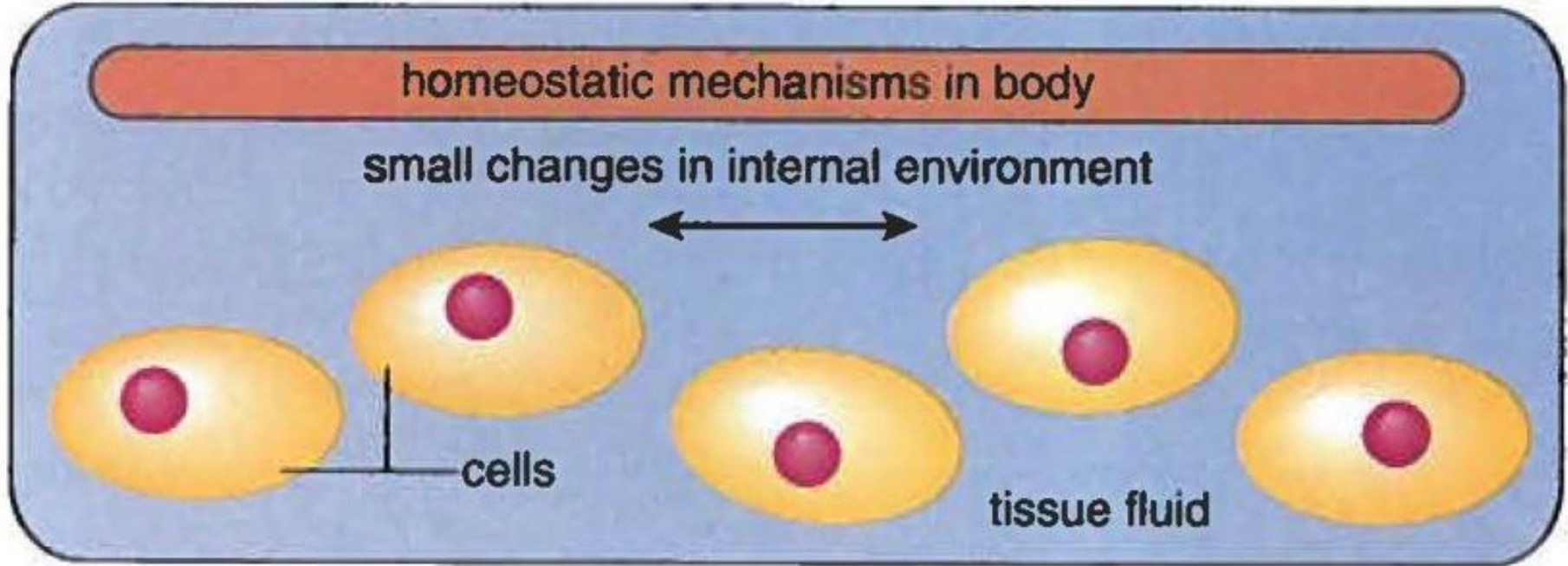
This could be either external to body or within body but exterior to cells

large variations in external environment



homeostatic mechanisms in body

small changes in internal environment



Described as the ability to maintain relatively **stable internal conditions** even in the face of **large continuous changes in the outside environment** “unchanging”

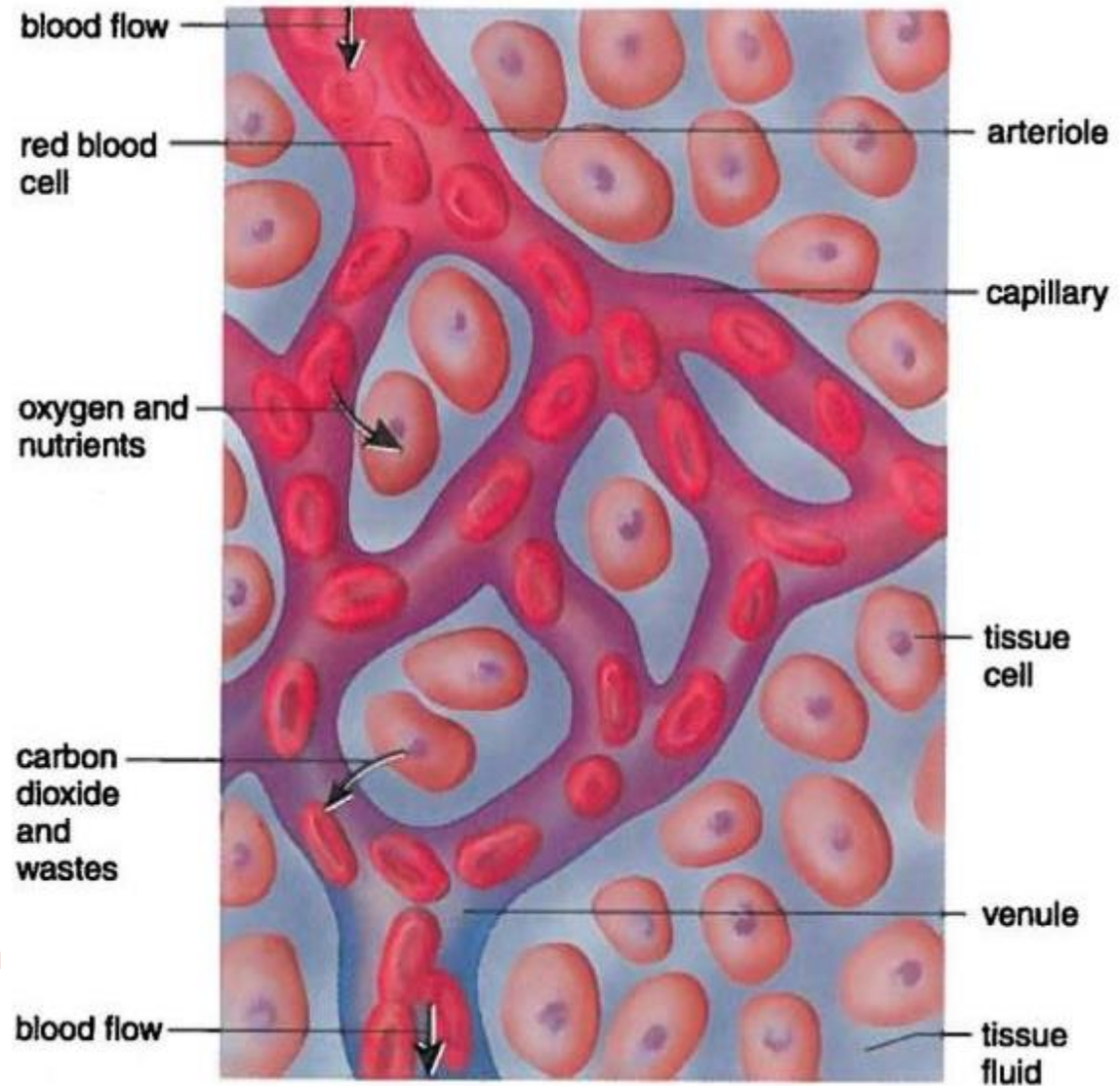
When cells are outside homeostasis for too long or are out too far from normal they die –this will contribute to the generalized loss of functioning of that tissue, organ or system

Variables under homeostatic control that affect cells:

1) Environmental
osmolarity, temperature, pH

2) Materials cells need
Nutrients, water, sodium, calcium inorganic ions, oxygen, hormones, chemicals for signalling

All of this is in blood/lymph



The fluid environment that cells reside in is very important to their function. i.e. lymph, blood or extracellular tissue fluid between cells. Fluid inside the cell (intracellular) is important. Both of these fluids must be regulated (amount and composition) at all times for cells to function

Examples of Important functions that must be maintained by homeostasis

1. nutrients: blood sugar levels (glucose -pancreas)

- i.e. sugar in blood is about 0.1%

2. water content (dehydration)

3. pH (gas exchange of CO₂ and O₂)

i.e. no matter how acidic your blood pH usually kept around 7.4

4. body heat (body temperature)

- i.e. body temp always around 37°C regardless of how hot or cold outside

5. sodium, calcium, ionic balance -kidneys

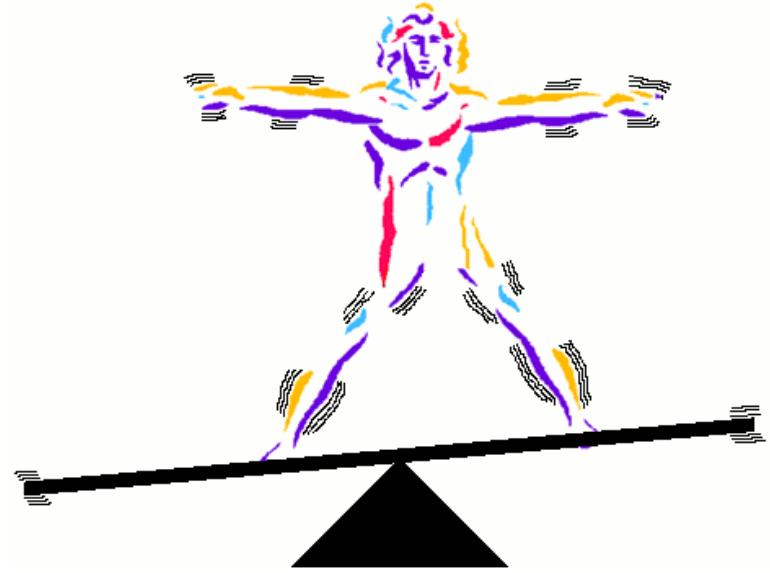
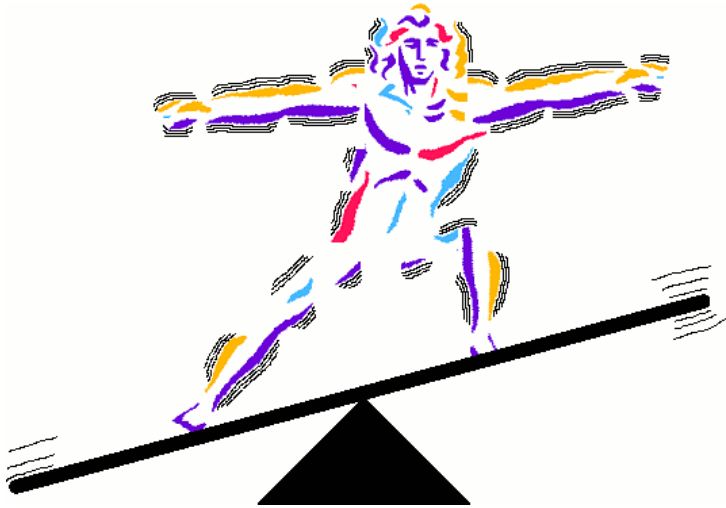
6. blood pressure

Other systems:

1. immune, nervous, endocrine, renal (wastes) etc.

Homeostasis:

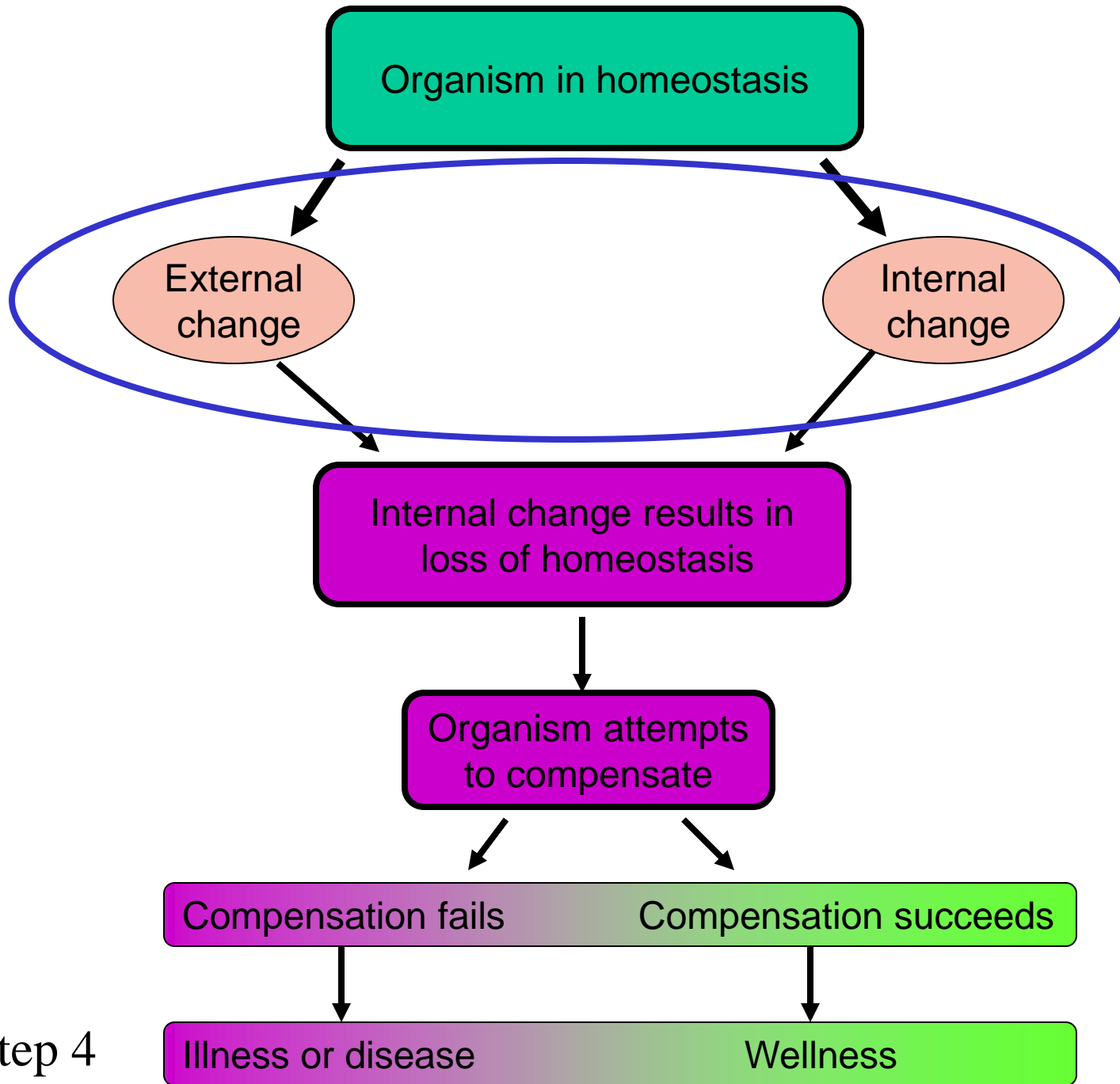
- Conditions in bodies must change from time/time
- To be alive we must move, grow and utilize substances



The body constantly monitors its internal state and takes action to correct disruptions that threaten its normal function.

Everytime we alter body conditions, we alter homeostasis

Quickly and efficiently brought back to homeostasis



Step 4

Exposure to **stress** reveals age differences not otherwise detectable under steady-state conditions (**basal**)

Elderly are less capable of withstanding stress compared to young

Ie. Fasting blood sugar values are minimally affected by aging (except in adult onset diabetics where they are elevated).

However even in the non-diabetic elderly, when challenged with a sugar load (stress) the efficiency with which they are capable of maintaining levels within normal limits and the rapidity with which these levels return to normal are significantly reduced in old compared young adults