HAND-OUT MATAKULIAH

ILMU GIZI DAN KESEHATAN

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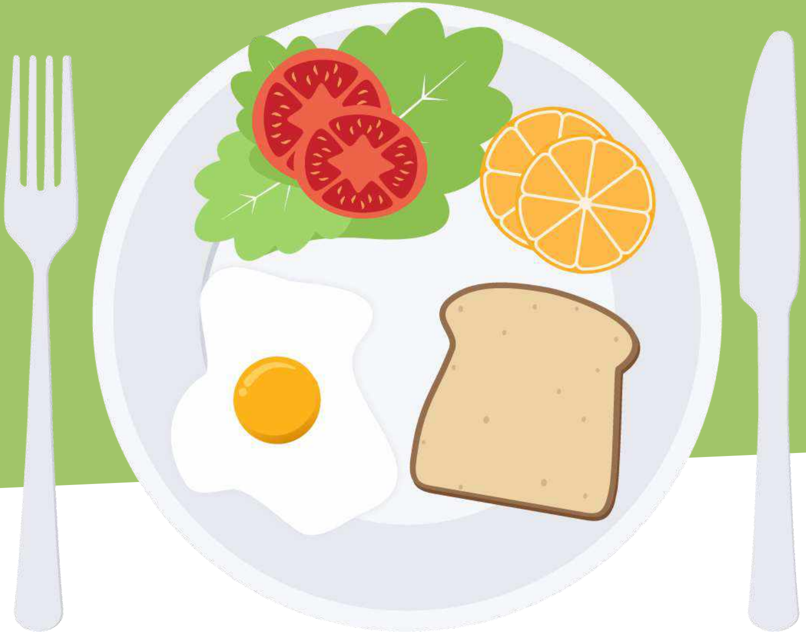
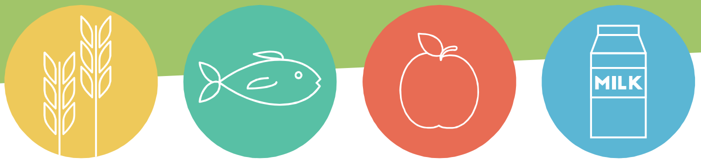


ILMU GIZI DAN KESEHATAN:

PENGUKURAN STATUS GIZI



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Tujuan perkuliahan

- **Setelah perkuliahan ini, mahasiswa diharapkan dapat**
- Mengetahui berbagai metode yang dapat digunakan untuk mengukur status gizi
- Memahami teknik pengukuran antropometrik dasar, aplikasinya, & standar referensinya

STATUS GIZI

- Status gizi/nutritional status seringkali merupakan hasil dari berbagai faktor yang saling berkaitan.
- Dipengaruhi: jumlah & kualitas konsumsi makanan & kondisi kesehatan → bioavailabilitas zat gizi dan kemampuan penyerapan → usus
- Secara umum, spektrum status gizi → obesitas hingga malnutrisi parah

Mengapa dilakukan pengukuran status gizi?

- Identifikasi resiko malnutrisi individual atau populasi
- Identifikasi tingkat malnutrisi individu atau populasi
- Pengembangan program kesehatan yang dapat memenuhi kebutuhan gizi masyarakat → kebutuhan ditentukan oleh status gizinya
- Pengukuran efektivitas program penangangan gizi & intervensi bagi masyarakat

Metode pengukuran status gizi

- METODE LANGSUNG

→ Pengukuran langsung terhadap individu menggunakan kriteria objektif

- METODE TIDAK LANGSUNG

→ Mengukur status gizi kelompok masyarakat tertentu yang secara tidak langsung menunjukkan status gizi individu di dalamnya

METODE LANGSUNG

DISINGKAT ABCD

- **A**nthropometric methods.
- **B**iochemical, laboratory methods.
- **C**linical methods → metode klinis
- **D**ietary evaluation methods.

Anthropometric Methods

- Anthropometry → pengukuran tinggi – berat badan & proporsinya.
- PENTING PADA BAYI, ANAK-ANAK, dan wanita hamil → mengevaluasi kelebihan dan kekuranga gizi
- ANGKA menunjukkan status gizi sewaktu → tidak menunjukkan perbedaan kondisi akut & kronis.

Other anthropometric Measurements

- Lingkar pertengahan lengan
- Lingkar kepala
- Rasio ukuran kepala dan dada
- Rasio pinggang/panggul

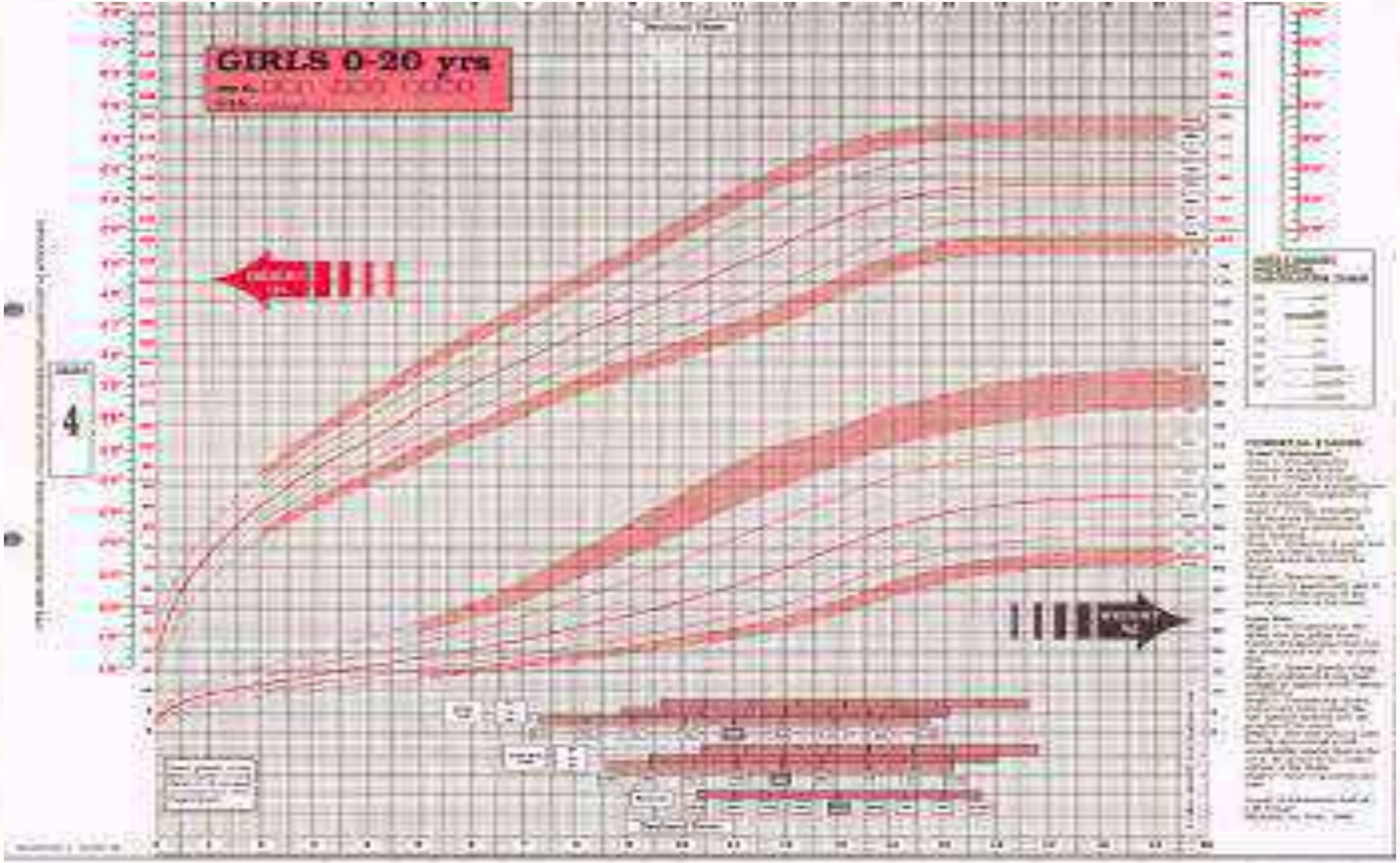
Antropometri anak-anak

- Pengukuran tinggi dan berat yang AKURAT → sangat penting untuk mengevaluasi pertumbuhan anak sesuai usia.

- Dibandingkan dengan standar *growth charts* → dibandingkan dengan *international standards* (WHO)

Growth Monitoring Chart

Percentile chart



PENGUKURAN PADA ORANG DEWASA

TINGGI BADAN:

- Subjek berdiri tanpa alas kaki pada stadiometer

BERAT BADAN

Diukur dengan timbangan yang dikalibrasi, subjek menggunakan pakaian yang “ringan”, tanpa alas kaki, diukur hingga 0.1 kg.

INDIKASI GIZI PADA ORANG DEWASA

- The international standard → body mass index (BMI).
- BMI is computed using the following formula: BMI = Weight (kg)/ Height (m^2)
- **BMI TINGGI** (obesitas) → type 2 diabetes & resiko tinggi penyakit kardiovaskular, kematian

BMI (WHO - Classification)

- BMI < 18.5 = Under Weight
- BMI 18.5-24.5 = Healthy weight range
- BMI 25-30 = Overweight (grade 1obesity)
- BMI >30-40 = Obese (grade 2 obesity)
- BMI >40 =Very obese (morbid or grade 3 obesity)

Rasio Pinggang/Pinggul

- Lingkar pinggang diukur pada pusar, subjek berdiri dalam keadaan perut rileks, lengan di samping, kaki dilekatkan, dalam keadaan nafas keluar.

LINGKAR PINGGANG

- LINGKAR PINGGANG dapat dipergunakan untuk memprediksi **angka harapan hidup** lebih tepat daripada faktor antropometrik lain → mengukur obesitas, dan berbagai **resikonya**

	PRIA	WANITA
LEVEL 1	> 94cm	> 80cm
LEVEL2	> 102cm	> 88cm

LINGKAR PINGGANG

- Level 1 → **maximum acceptable** pada usia berapapun → tidak boleh naik berat badan lagi.

- Level 2 → **obesitas** → harus mengatur berat badan melalui konsumsi pangan seimbang & peningkatan aktivitas fisik yang rutin → untuk mengurangi resiko type 2 diabetes & komplikasi kardiovaskular.

LINGKAR PANGGUL

- Diukur pada panggul dan tengah pantat.
- The subject should be standing and the measurer should squat beside him.
- Both measurement should taken with a flexible, non-stretchable tape in close contact with the skin, but without indenting the soft tissue.

Interpretation of Waist Hip Ratio

- High risk WHR= >0.80 for females & >0.95 for males i.e. waist measurement >80% of hip measurement for women and >95% for men indicates central (upper body) obesity and is considered high risk for diabetes & CVS disorders.
- A Waist Hip Ratio below these cut-off levels is considered low risk.

ADVANTAGES OF ANTHROPOMETRY

- Objective with high specificity & sensitivity
- Measures many variables of nutritional significance (Ht, Wt, HC, skin fold thickness, waist & hip ratio & BMI).
- Readings are numerical & gradable on standard growth charts.
- Readings are reproducible.
- Non-expensive & need minimal training

Limitations of Anthropometry

- Inter-observers errors in measurement.
- Limited nutritional diagnosis.
- Problems with reference standards, i.e. local versus international standards.
- Random statistical cut-off levels for what considered as abnormal values.

CLINICAL ASSESSMENT

- Esensial
- paling simpel dan paling sering dipergunakan
- gejala fisik (specifik & nonspecific) → penanda malnutrisi dan defisiensi vitamins & mikronutrien

CLINICAL ASSESSMENT

- Good nutritional history should be obtained.
- General clinical examination, with special attention to organs like hair, angles of the mouth, gums, nails, skin, eyes, tongue, muscles, bones, & thyroid gland.
- Detection of relevant signs helps in establishing the nutritional diagnosis.

CLINICAL ASSESSMENT

- **ADVANTAGES**
  - Fast & Easy to perform
  - Inexpensive
  - Non-invasive
- **LIMITATIONS**
  - Did not detect early cases

Clinical signs of nutritional deficiency

HAIR

Spare & thin	Protein, zinc, biotin Deficiency (rare disease, it part of Vit. B family)
Easy to pull out	Protein deficiency
Corkscrew Coiled hair	Vit C & Vit A deficiency

Clinical signs of nutritional deficiency

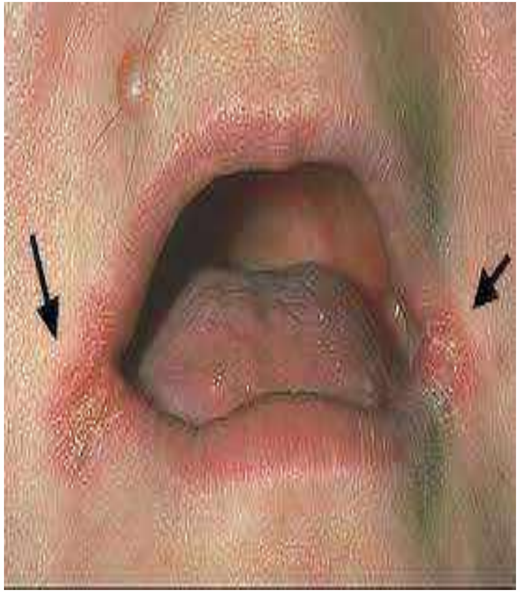
MOUTH

Glossitis	Riboflavin, niacin (vit. B3), folic acid, B12.
Bleeding & spongy gums	Vit. C,A, K, folic acid & niacin
Angular stomatitis, cheilosis & fissured tongue	B 2,6,& niacin
leukoplakia	Vit.A,B12, B-complex, folic acid & niacin
Sore mouth & tongue	Vit B12,6,c, niacin ,folic acid & iron

Clinical signs of nutritional deficiency

Leukoplakia

cheilosis



Clinical signs of nutritional deficiency

EYES

Night blindness, exophthalmia	Vitamin A deficiency
Photophobia-blurring, conjunctival inflammation	Vit B2 (Riboflavin) & vit A Deficiencies

Clinical signs of nutritional deficiency

NAILS

Spooning 	Iron deficiency
Transverse lines 	Protein deficiency

Clinical signs of nutritional deficiency

SKIN

Pallor	Folic acid, iron, B12
Follicular hyperkeratosis	Vitamin B & Vitamin C
Flaking dermatitis	Vit B2, Vitamin A, Zinc & Niacin
Pigmentation, desquamation	Niacin
Bruising, purpura	Vit K ,Vit C & folic acid

Follicular hyperkeratosis

Flaking dermatitis

Pigmentation, desquamation

Clinical signs of nutritional deficiency

Thyroid gland

- In mountainous areas and far from sea places Goiter is a reliable sign of iodine deficiency.

Clinical signs of nutritional deficiency

Joins & bones

- Help detect signs of vitamin D deficiency (Rickets) & vitamin C deficiency (Scurvy)

DIETARY ASSESSMENT

- Nutritional intake of humans is assessed by **five** different methods. These are:

1. 24 hours dietary recall.
2. Food frequency questionnaire.
3. Dietary history since early life.
4. Food dairy technique.
5. Observed food consumption.

24 Hours Dietary Recall

- A trained interviewer asks the subject to recall all food & drink taken in the previous 24 hours.
- It is quick, easy, & depends on short-term memory, but may not be truly representative of the person's usual intake.

Food Frequency Questionnaire

- In this method the subject is given a list of around 100 food items to indicate his or her intake (frequency & quantity) per day, per week & per month.
- Inexpensive, more representative & easy to use.

Food Frequency Questionnaire

Limitations:

- Long Questionnaire.
- Errors with estimating serving size.
- Needs updating with new commercial food products to keep pace with changing dietary habits.

DIETARY HISTORY

- It is an accurate method for assessing the nutritional status.
- The information should be collected by a trained interviewer.
- Details about usual intake, types, amount, frequency & timing needs to be obtained.
- Cross-checking to verify data is important.

FOOD DAIRY

- Food intake (types & amounts) should be recorded by the subject at the time of consumption.
- The length of the collection period range between 1-7 days.
- Reliable but difficult to maintain.

Observed Food Consumption

- The most unused method in clinical practice, but it is recommended for research purposes.
- The meal eaten by the individual is weighed and contents are exactly calculated.
- The method is characterized by having a high degree of accuracy but expensive & needs time & efforts.

Interpretation of Dietary Data

1. Qualitative Method

- Using the food pyramid & the basic food groups method.
- Different nutrients are classified into 5 groups (fat & oils, bread & cereals, milk products, meat-fish-poultry, vegetables & fruits)
- Determine the number of serving from each group & compare it with minimum requirement.

Interpretation of Dietary Data

2. Quantitative Method

- The amount of energy & specific nutrients in each food consumed can be calculated using food composition tables & then compare it with the recommended daily intake.
- Evaluation by this method is expensive & time consuming, unless computing facilities are available.

Initial Laboratory Assessment

- Hemoglobin estimation is the most important test, & useful index of the overall state of nutrition. Beside anemia it also tells about protein & trace element nutrition.
- Stool examination for the presence of ova and/or intestinal parasites.
- Urine dipstick & microscopy for albumin, sugar and blood.

Specific Lab Tests

- Measurement of individual nutrient in body fluids (e.g., serum iron, urinary iodine, vitamin D).
- Detection of abnormal amount of metabolites in the urine (e.g. urinary creatinine/hydroxyproline ratio) (done to children with short structure)
- Analysis of hair, nails & skin for micro-nutrients.

Advantages of Biochemical Method

- It is useful in detecting early changes in body metabolism & nutrition before the appearance of overt clinical signs.
- It is precise, accurate and reproducible.
- Useful to validate data obtained from dietary methods e.g. comparing salt intake with 24-hour urinary excretion.

Limitations of Biochemical Method

- Time consuming
- Expensive
- They cannot be applied on large scale.
- Needs trained personnel & facilities.

METODE TIDAK LANGSUNG

TERDIRI DARI 3 KATEGORI:

- VARIABEL LINGKUNGAN

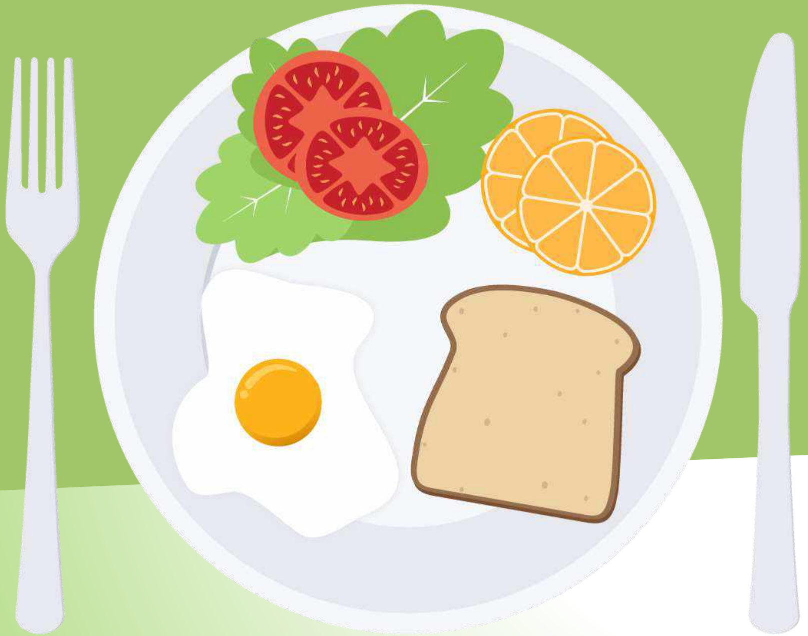
Misalnya tingkat produksi pangan suatu daerah.

- VARIABEL EKONOMI

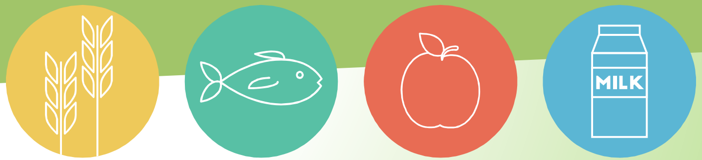
Misalnya pendapatan per kapita, kerapatan populasi & kebiasaan umum → konsumsi makanan manis

- STATISTIK VITAL KESEHATAN

Terutama tingkat kematian bayi – balita & indeks fertilitas



ENERGI



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Energi

- Kebutuhan energi seseorang merupakan jumlah energi dari makanan yang sesuai dengan pengeluaran energinya dengan komposisi dan ukuran tubuh tertentu, derajat aktivitas fisik, konsisten dengan kondisi sehat dalam jangka panjang; dan memungkinkan untuk menjaga kebutuhan ekonomi dan sosialnya. Pada anak-anak dan wanita hamil atau menyusui, energi yang diperlukan termasuk energi yang diperlukan untuk pertumbuhan dan produksi ASI dengan laju konsisten dengan kesehatan (WHO, 1991).

WHO, 1991. *Energy and Protein Requirements*. Report of a Joint FAO/WHO/UNU Expert Consultation, Geneva.

The most commonly used

Calorie

Equivalensi nilai energi

kcal

- 1 kilocalorie adalah jumlah panas yang diperlukan untuk menaikkan suhu 1 kg air sebesar 1°C

kjoule

- Satu kilojoule menunjukkan energi yang terlibat untuk memindahkan 1 kg berat sepanjang 1 m dengan daya 1 Newton

- Internasional unit energi adalah joule (J)
- 1 kcal = 4,184 kJ
- 1 kcal = 3.086 foot-pounds
- 1 kcal = 427 kgm

HOW TO COUNT CALORY FROM HUMAN AND FROM FOOD

Calorimetry

- Menghitung panas yang dilepaskan dari metabolisme

Calorimetry

Direct

Measuring the heat produced by metabolic processes

Indirect

Measuring respiratory gases

Pedometer

Accelerometer

Burnt calorie per day

Direct method

Measuring the heat produced by metabolic processes

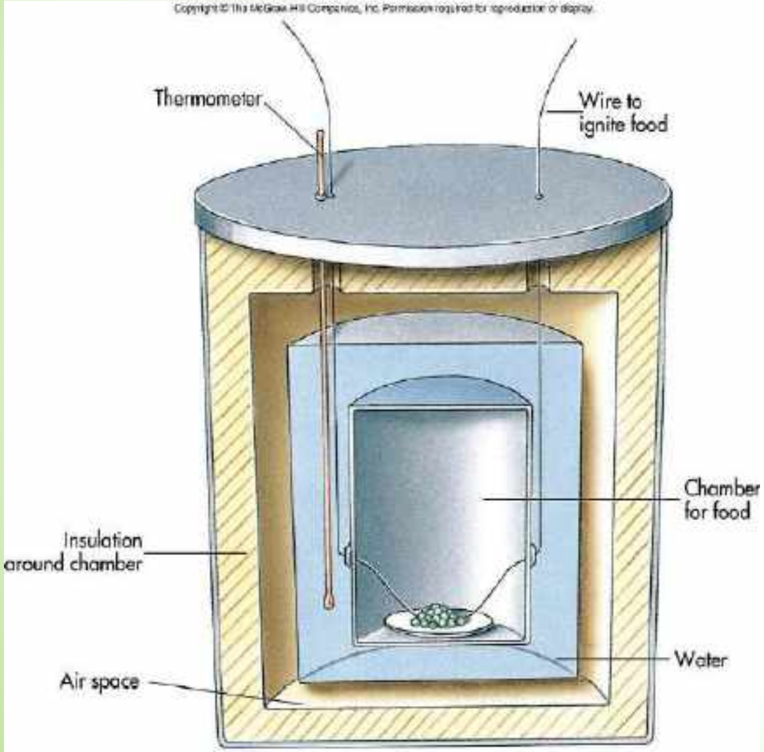
Indirect Calorimeter

- **Indirect calorimetry** calculates heat that living organisms produce → measuring from their carbon dioxide production and nitrogen waste or from their oxygen consumption

- Indirect calorimetry → in vivo ESTIMATION of the type and rate of substrate utilization, and energy metabolism starting from gas exchange measurements → **carbon dioxide production** and **oxygen consumption** during rest and steady-state exercise.

- This technique provides unique information, is noninvasive, and can be advantageously combined with other experimental methods to investigate numerous aspects of nutrient assimilation, thermogenesis, the energetics of physical exercise, and the pathogenesis of metabolic diseases.

From Food → Bomb Calorimeter



- Burns food inside a chamber surrounded by water
- Heat is given off as food is burned
- The increase in water temperature indicates the amount of energy in the food

How we estimate daily calorie requirement?

First step

Calculate your Basal Metabolic Rate.

Our bodies are like engines that are constantly running. They're always burning fuel or calories (even during sleep).

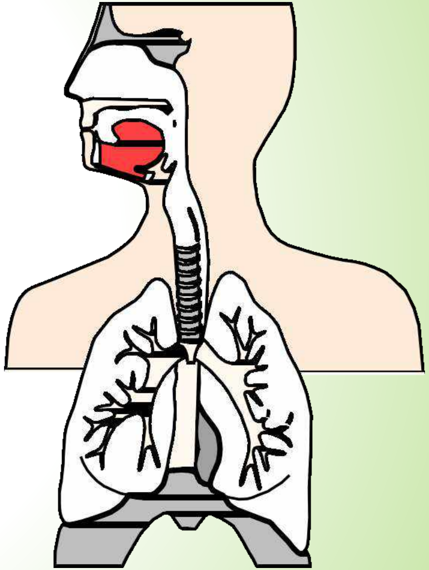
BMR → the number of calories you burn each day simply by being alive.

Your Basal Metabolic Rate (BMR) can vary based on your age, sex, size, and genetics.[1]

Metabolisme Basal

(Basal Metabolic Rate, BMR)

- the sum total of the minimal activity of all tissue cells of the body under steady state conditions
- 50-70% of total energy expenditure
- The resting metabolic rate
- Mostly for driving the osmotic pumps that maintain the differences between extracellular and intracellular fluids, and for the synthesis of proteins and other macromolecules.

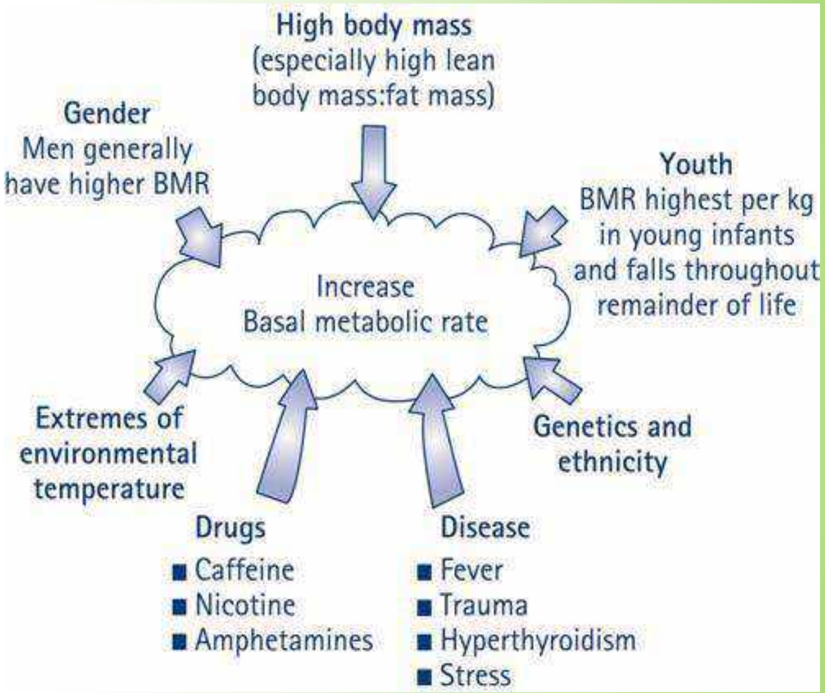


- Only about 10% is used for internal mechanical work, including the functioning of the heart, respiratory system and digestive tract.

BASAL METABOLISM

The factors:

- Body size
  - A taller, larger person → higher BMR
  - Reflects total amount of lean tissue
- Age
  - The number of kcalories used for basal processes increases during the growth years
- Gender
  - Male >> female
- Health status
  - Physically fit >>
- Thyroid hormone level
  - Thyroid hormone thyroxin is a metabolic accelerator
- Reproductive status
  - Pregnancy >>
- Individual variation



Formula to count BMR: The Harris-Benedict Equation / Rumus Harris Benedict

Men:

$$(13.75 \times \text{weight}) + (5 \times \text{height}) - (6.76 \times \text{age}) + 66$$

In kg

In cm

Women:

$$(9.56 \times \text{weight}) + (1.85 \times \text{height}) - (4.68 \times \text{age}) + 655$$

After BMR?

Step 2
Adjust your BMR to include physical activity.

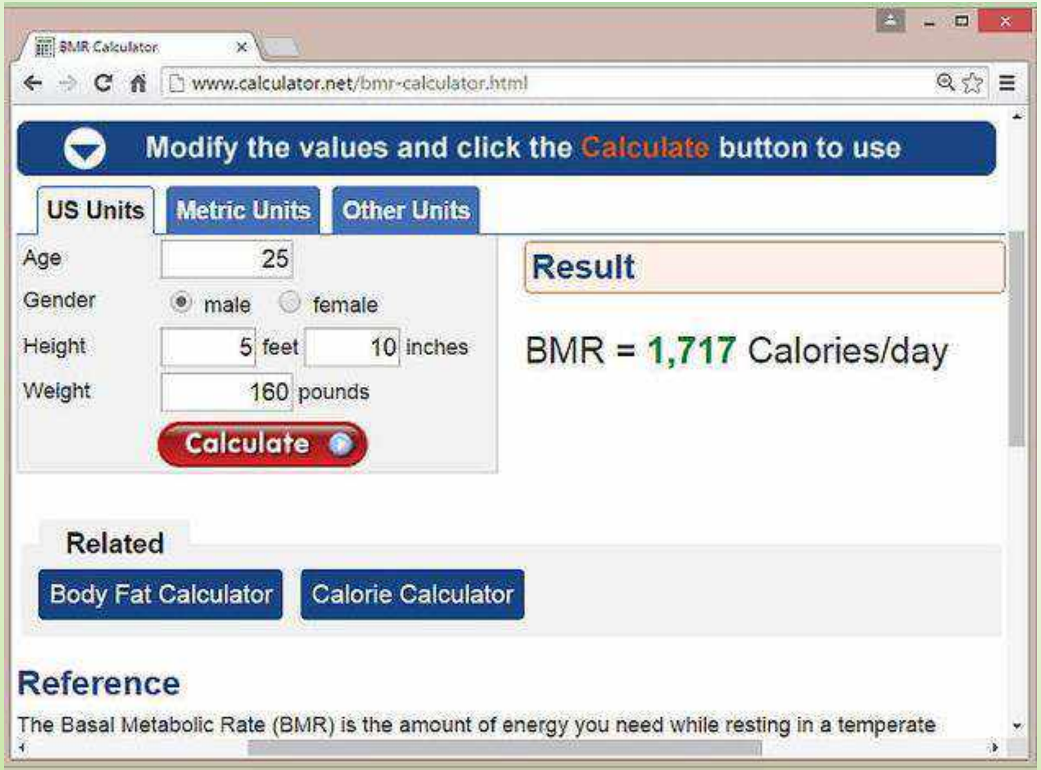
To get an accurate count for your daily expenditure→include the calories burned from physical activity.

People need different calorie levels depending on their activity level and energy expenditure from exercise.


No exercise = BMR x 1.2
1-3 days/week = BMR x 1.375
3-5 days/week = BMR x 1.55
Most days = BMR x 1.725
Every day = BMR x 1.9
wikiHow to Calculate Calories Burned in a Day

- **Use an online BMR calculator.**

Automatically find your BMR based on age, gender, height, and weight → online calculator → easier and more simple



Lalu?

Hitunglah kebutuhan kalorimu.

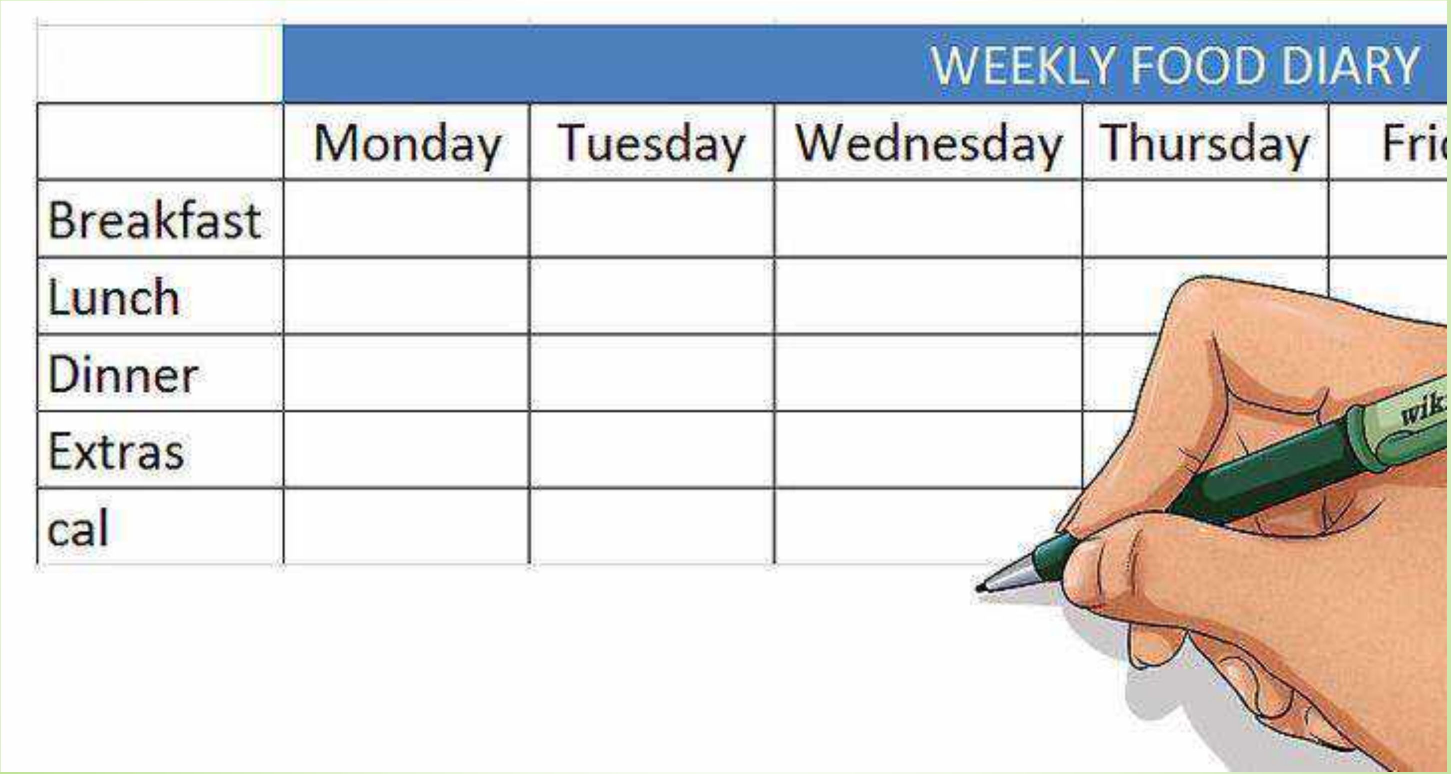
Kurangi 300 Kal jika ingin mengurangi berat badan

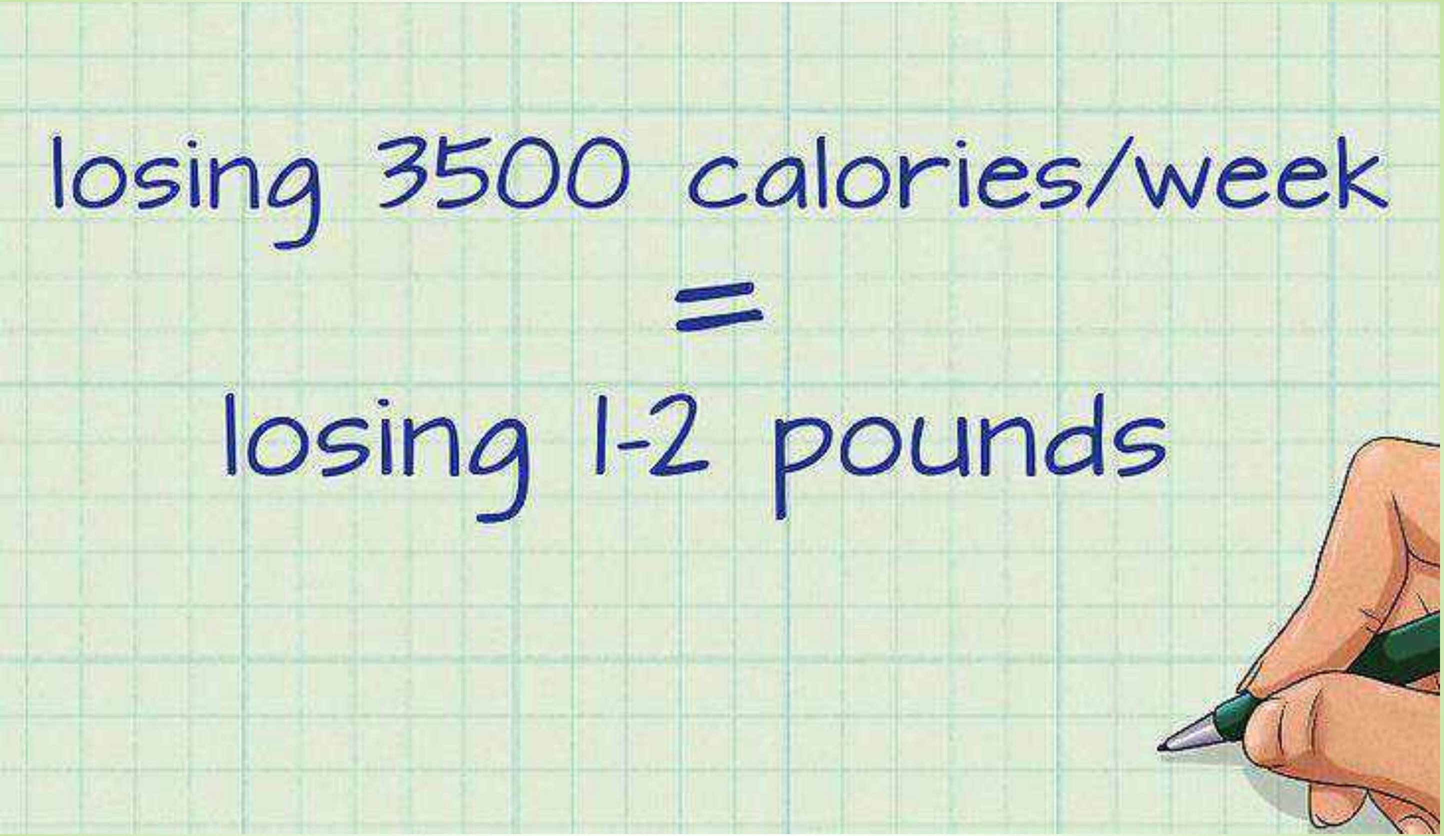
Tambah 300 Kal jika ingin meningkatkan berat badan

Garmin Forerunner 610 **Apple Watch**

- **Start a food journal.**
- It will be useful to track your total calorie intake using a food journal, food journaling app or website. This will help you manipulate your predetermined caloric goal to result in any desired weight changes. It can also help keep you accountable to your diet plan. Food journals are also a great way to get insight into what you currently eat and how that compared to your determined caloric goal.
- Food journals will be able to give you an idea of where you're eating most of calories during the day.
- Lastly, journaling will be able to help you track and successful gain, lose or maintain your weight.

Caloric Information → Food Diary




losing 3500 calories/week
=
losing 1-2 pounds

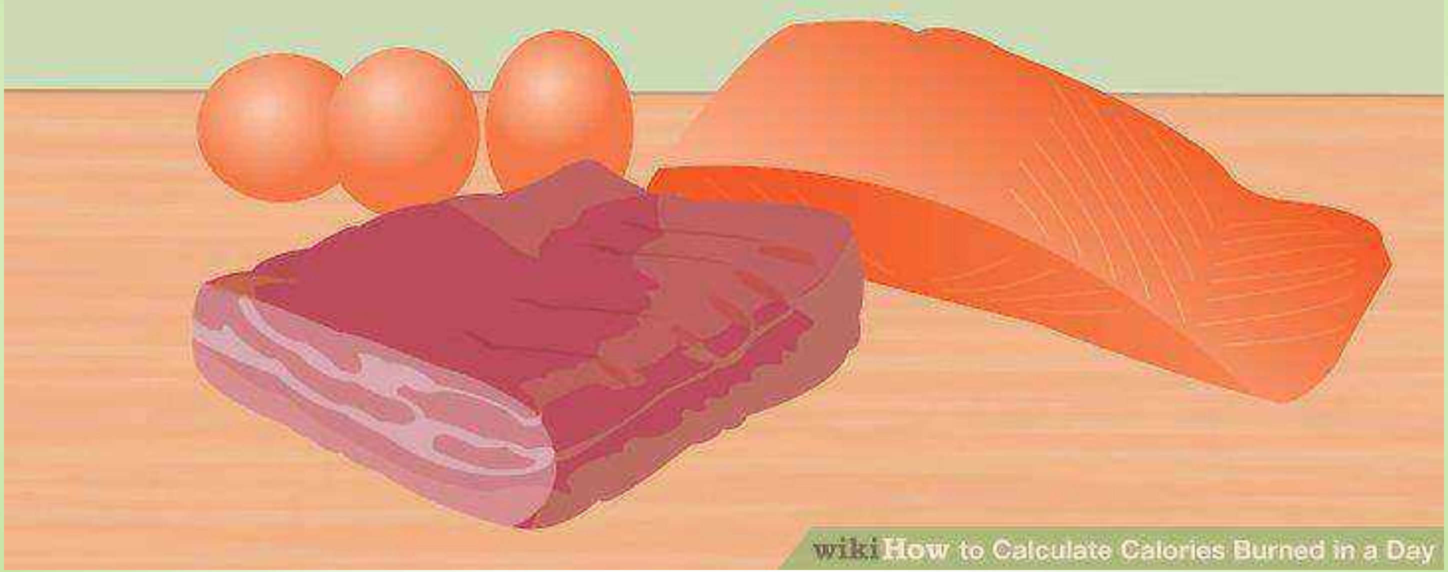
- **Cut calories to lose weight.**
- Lose weight → you MUST consistently have a net negative calorie intake each day by reducing the number of calories you eat, burning more calories through exercise, or both.
- In general → losing 3500 calories per week = TWO kilograms body weight. Cutting out 500 calories daily will help you reach this weekly deficit.
- Don't lose weight too quickly or cut out too many calories. Most reputable sources recommend losing no more than about 2-4 kg per week. This can be dangerous and may leave you feeling weak, tired and low in essential nutrients.

How many calories do you need to burn to lose 1 kg?

- Burn 7700 calories to lose 1 kg.
- Burn 3500 calories to lose 0,5 kg

- A study conducted by the American Council on Exercise determined that a typical Tabata workout can burn an average of **15 calories per minute, or 450 calories per half hour** (workouts usually don't last longer than 20 to 30 minutes).
- Swimming **burns** between 300 and 450 **calories** in 30 minutes
- Conclusion: IF you want to lose 1 kg per week, you need to workout at least once per week for 30 minutes.

Try to gain w8?



- **Increase calories to gain weight.**
- Take in more calories than you burn through daily activities and exercise to help you gain weight. You can do this by increasing the number of calories you eat or decreasing the amount of calories you spend through exercise or with a combination of both.
- Regardless of your reason to gain weight, choose healthy, yet high calorie foods to help you meet a higher calorie goal.
- Choosing fried, processed or other unhealthy foods isn't ideal!!
- Note that some exercise is necessary to maintain good health. Don't discontinue exercise unless instructed by your doctor.
- Though everyone's physical activity needs are different, most medical sources recommend about two and a half hours of moderate aerobic exercise with strength training on two days out of the week (or one and a half hours of intense aerobic exercise)

Energi dari makanan

Komponen	***Values***
Karbohidrat	4,1 kcal/g
Lemak	9,45 kcal/g
Protein	5,65 kcal/g (4,3 kcal/g)
Alcohol	7,00 kcal/g

Cofficient of digestibility

Komponen	**Koefisien**	***Physiological fuel values***
Karbohidrat	98%	4 kcal/g
Lemak	95%	9 kcal/g
Protein	92%	4 kcal/g

Komposisi proksimat

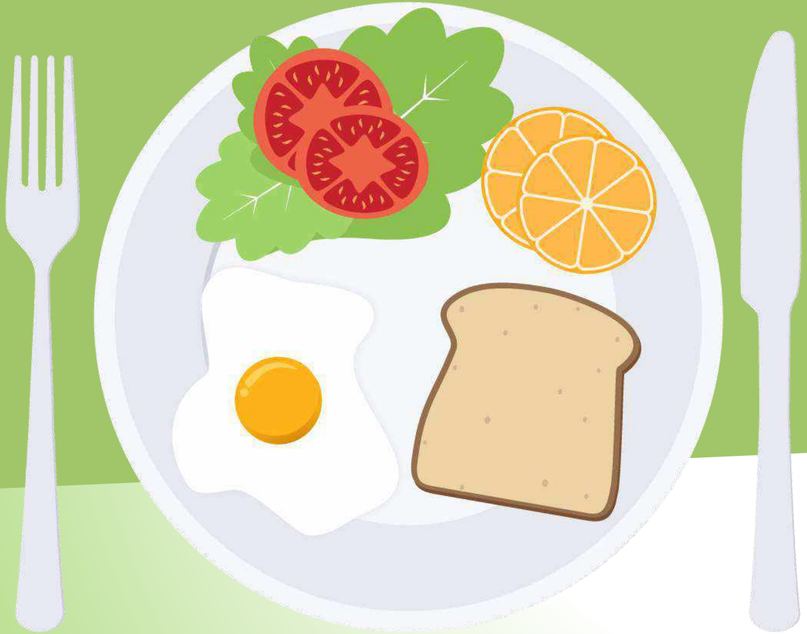
- Prosentase karbohidrat, lemak, protein, dan air padapangan

Komponen	Persen dalam makanan	Jumlah per 100 g	Nilai energi/g (kcal)	Nilai energi per 100 g (kcal)
Karbohidrat	21,4	21,4	4	85,6
Lemak	9,2	9,2	9	82,8
Protein	5,5	5,5	4	22,0
TOTAL ENERGI				**190,4**

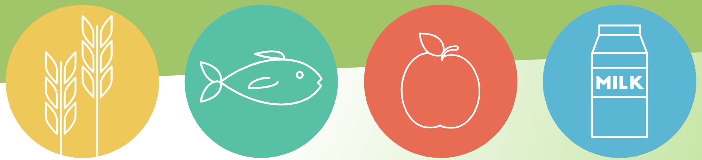
PERKIRAKAN JENIS MAKANAN YANG DIKONSUMSI

Percentage of energy from carbohydrate, protein and fat in selected foods				
Food	Total energy content of 100 g serving (kJ)	Energy (%) from		
		Protein	Fat	Carbohydrate
Wholemeal bread	922	17	10	73
Cornflakes	1601	8	2	90
Boiled rice	587	8	8	84
Milk, semiskimmed	195	30	32	38
Cheese, Cheddar type	1725	25	75	0
Butter/margarine	3042	1	99	0
Low-fat spread	1519	7	91	2
Egg, boiled	612	35	65	0
Beef stew	570	45	42	13
Chicken, roast	742	63	37	0
Baked beans	355	25	6	69
Peanuts	2491	17	79	5
Peas	291	35	11	54
Potatoes, boiled	306	10	1	89
Chocolate	2177	6	52	42

Barasi ME, 2003. *Human Nutrition – A Health Perspective*, 2nd edition. Hodder Arnold, London



ENERGI



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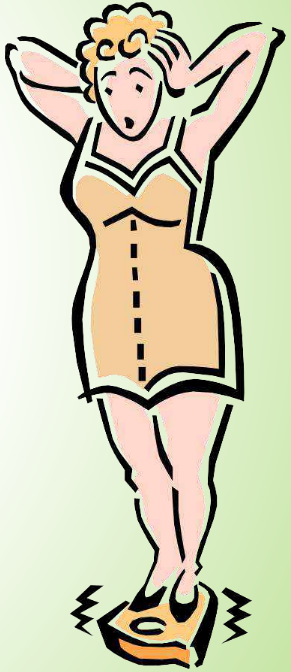
WEIGHT MANAGEMENT

What is a Healthy Body Weight?

- Based on how you feel, weight history, fat distribution, family history of obesity-related disease, current health status, and lifestyle
- Current height/weight standards only provide guides



Weight-Related Conditions

- Hypertension
- Type 2 diabetes
- Metabolic syndrome
- CHD
- Stroke
- Sleep apnea
- Cancers
- Osteoarthritis

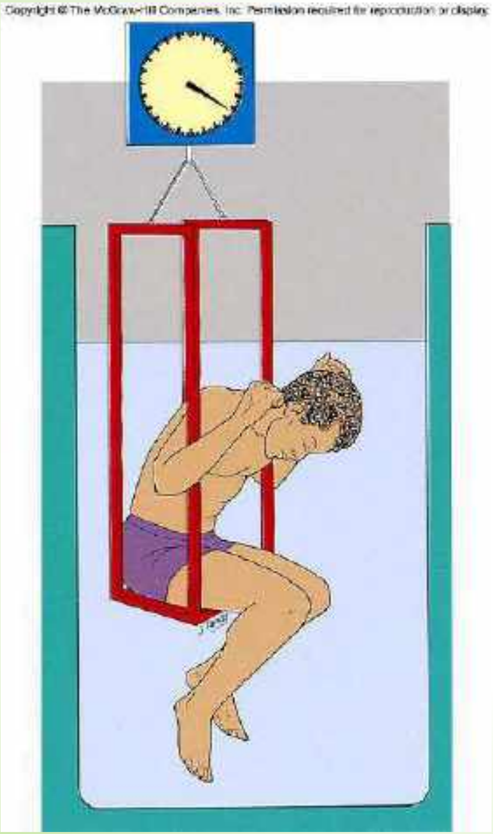
In addition

- **Depression**
- **Eating disorders**

Obesity

- Excessive amount of body fat
  - Women with > 35% body fat
  - Men with > 25% body fat
- Increased risk for health problems
- Are usually overweight
- Measurements using calipers

Estimation of Body Fat

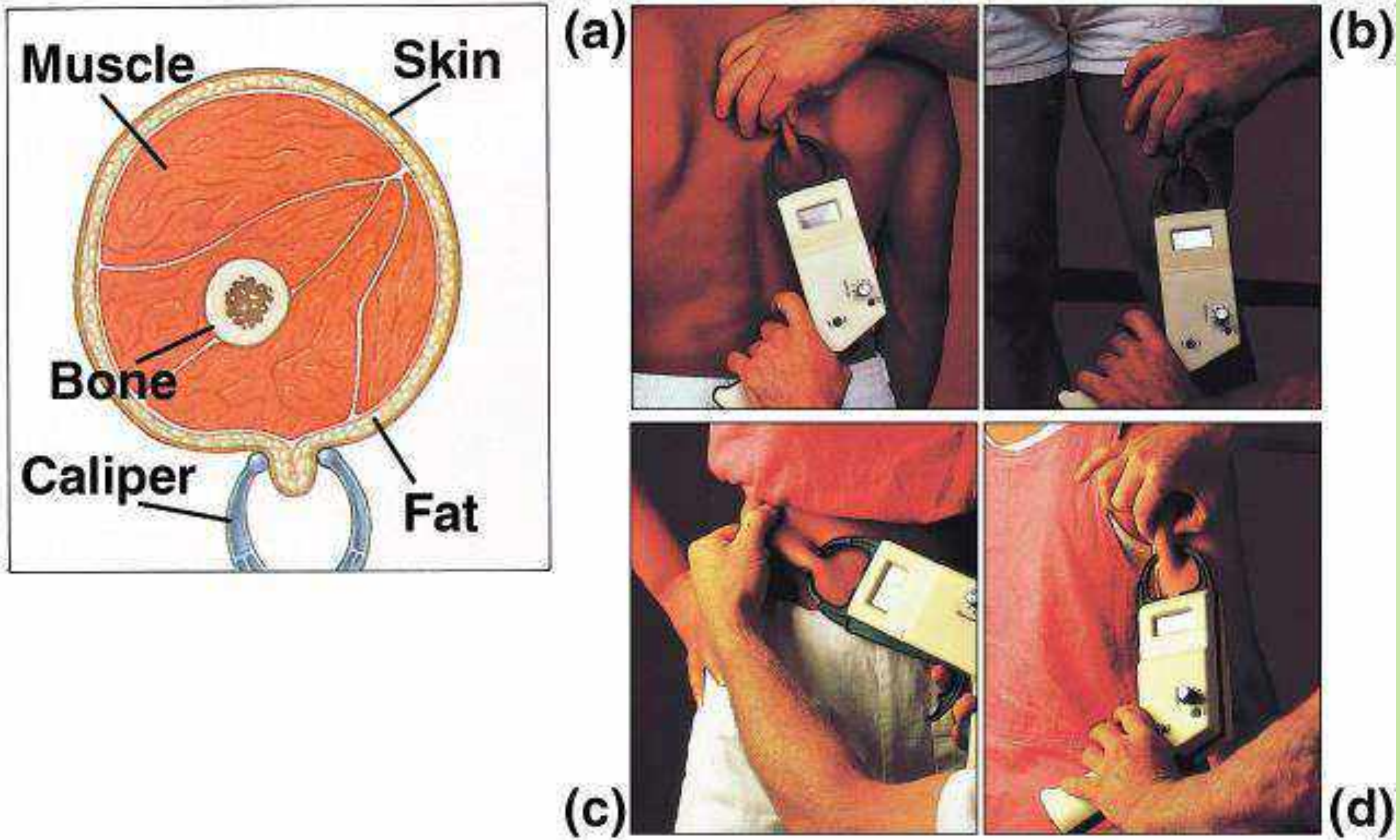


- Underwater weighing Most accurate
  - Fat is less dense than lean tissue
  - Fat floats

Estimation of Body Fat

- Bioelectrical impedance
  - Low-energy current to the body that measures the resistance of electrical flow
  - Fat is resistant to electrical flow; the more the resistance, the more body fat you have
- DEXA (dual x-ray photon absorptiometry)
  - An X-ray body scan that allows for the determination of body fat
- Infrared light
  - Assess the interaction of fat and protein in the arm muscle

Skinfold Measurements



Body Fat Distribution

Body Fat Distribution

Lower-body (gynecoid) obesity--Pear shape

- Encouraged by estrogen and progesterone
- After menopause, upper-body obesity appears
- Less health risk than upper-body obesity

Body Fat Distribution

Upper-body (android) obesity--Apple shape

- Associated with more heart disease, hypertension, Type II Diabetes
- Abdominal fat is released right into the liver
- Encouraged by testosterone and excessive alcohol intake
- Defined as waist measurement of > 40” for men and >35” for women

Body Mass Index (BMI)

- The preferred weight-for-height standard
- Calculation:

$$\frac{\text{Body wt (in kg)}}{[\text{Ht (in m)}]^2} \quad \text{OR} \quad \frac{\text{Body wt (in lbs)} \times 703.1}{[\text{Ht (in inches)}]^2}$$

Health risks increase when BMI is > 25

Overweight and Obesity

- Underweight = BMI < 18.5
- Healthy weight = BMI 18.5-24.9
- Overweight = BMI 25-29.9
- Obese = BMI 30-39.9
- Severely obese = BMI >40

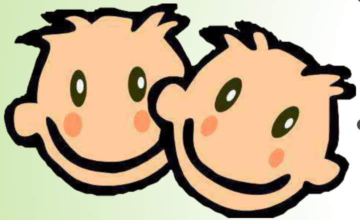
Juvenile-Onset Obesity

- Develops in infancy or childhood (usually before 10 years old)
- Increase in the **number** of adipose cells
- Adipose cells have long life span and need to store fat
- Makes it difficult to loose the fat (weight loss)
- Occurs twice as frequently in girls as boys

Adult-Onset Obesity

- Develops in adulthood
- Fewer (numbers of) adipose cells
- These adipose cells are larger (store excess amount of fat)
- If weight gain continues, the number of adipose cells can increase

Causes of Obesity



Nature debate

- Identical twins raised apart have similar weights
- Genetics account for ~40%-70% of weight differences
- Genes affect metabolic rate, fuel use, brain chemistry, body shape
- Thrifty metabolism gene allows for more fat storage to protect against famine

Causes of Obesity

Nurture debate

- Environmental factors influence weight
- Learned eating habits
- Activity factor (or lack of)
- Poverty and obesity
- Female obesity is rooted in childhood obesity
- Male obesity appears after age 30

Psychological factors

- Anxiety
- Substitute for love and security
- Tenseness or frustation

Genetic factors

- Somatotype

  -endomorphic (plump and round)

  -mesomorphic (muscular)

  -ectomorphic (linear and fragile)

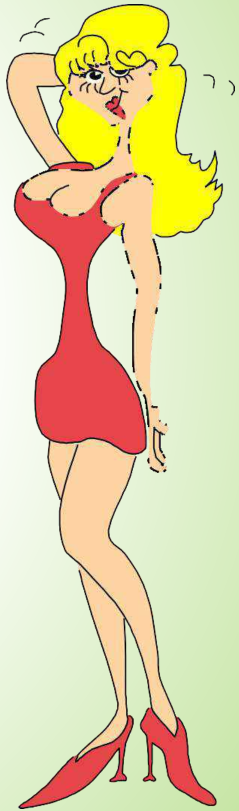
- Level of enzyme activity

  -lipogenesis

  -sensitivity of the hypothalamus

Perspective on Weight

- Unrealistic goals
- Listen to body's cues (for hunger)
- Eat a healthy diet
- Physical activity
- "Size acceptance"



Nature and Nurture

- Obesity is nurture allowing nature to express itself
- Location of fat is influenced by genetics
- A child of obese parents must always be concerned about his weight

Nature Vs. Nurture

- Those at risk for obesity will face a lifelong struggle with weight
- Gene does not control destiny
- Increased physical activity, moderate intake can promote healthy weight

Why Diets Don't Work

- Obesity is a chronic disease
  - Treatment requires long-term lifestyle changes
- Dieters are misdirected
  - More concerned about weight loss than healthy lifestyle
  - Unrealistic weight expectations

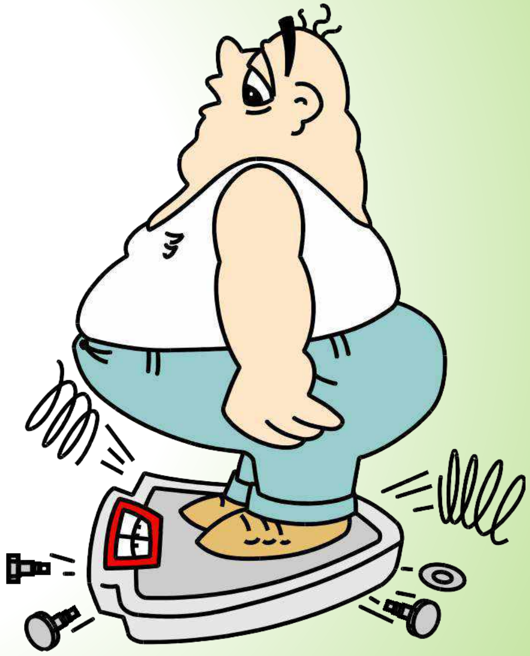
Why Diets Don't Work

Body defends itself against weight loss

- Thyroid hormone concentrations (BMR) drop during weight loss and make it more difficult to lose weight
- Activity of lipoprotein lipase increases making it more efficient at taking up fat for storage

Weight Gain in Adulthood

- Weight gain is common from ages 25-44
- BMR decreases with age
- Inactive lifestyle
- Goal: not gain more than 10-16 pounds more than your weight on reaching the age of 21



Changes in Body Composition

- Fluid is usually the first weight lost
- Loss in lean body tissue means lowering the BMR
- Very little fat is lost during weight loss

Lifestyle Vs. Weight Loss

- Prevention of obesity is easier than curing
- Balance energy in(take) with energy out(put)
- Focus on improving food habits
- Focus on increase physical activities

What It Takes To Lose a Pound

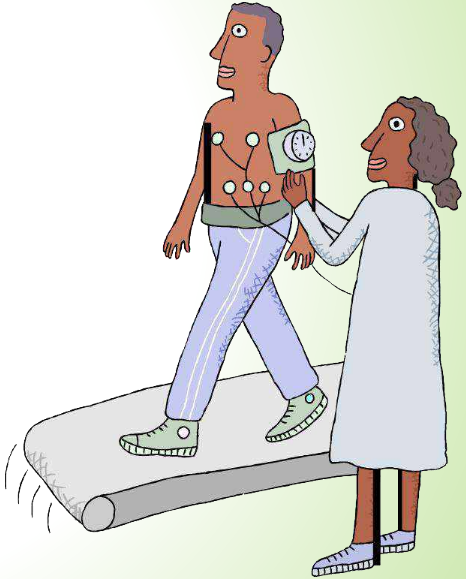
- Body fat contains 3500 kcal per pound
- Fat storage (body fat plus supporting lean tissues) contains 2700 kcal per pound
- Must have an energy deficit of 2700-3500 kcal to lose a pound per week

Do the Math

- To lose one pound (0,45 kg), you must create a deficit of 2700-3500 kcal
- So to lose a pound in 1 week (7 days), try cutting back on your kcal intake and increase physical activity so that you create a deficit of 400-500 kcal per day

Sound Weight Loss Program

- Rate of loss
- Flexibility
- Intake
- Behavior Modification
- Overall Health



Cutting Back

- 1200-1500 kcals per day
- Control calorie intake by being aware of kcal and fat content of foods
- "Fat Free" does not mean "Calories Free" (or "All You Can Eat")
- Read food labels
- Estimate kcal using the exchange system
- Keep a food diary

Regular Physical Activity

- Fat use is enhanced with regular physical activity
- Increases energy expenditure
- Duration and regularity are important
- Make it a part of a daily routine

Behavior Modification

- Modify problem (eating) behaviors
- Chain-breaking
- Stimulus control
- Cognitive restructuring
- Contingency management
- Self-monitoring

Chain-Breaking

- Breaking the link between two behaviors
- These links can lead to excessive intake

Snacking while watching T.V.

Stimulus Control

- Alternating the environment to minimize the stimuli for eating
- Puts <u>you</u> in charge of temptations

Cognitive Restructuring

- Changing your frame of mind regarding eating
- Replace eating due to stress with "walking"

Contingency Management

- Forming a plan of action in response to a situation
- Rehearse in advance appropriate responses to pressure of eating at parties

Self-Monitoring

- Tracking foods eaten and conditions affecting eating
- Helps you understand your eating habits

Weight Maintenance

- Prevent relapse
  - Occasional lapse is fine, but take charge immediately
  - Continue to practice newly learned behavior
  - Requires “motivation, movement, and monitoring”
- Have social support
  - Encouragement from friends/ family/ professionals

Weight Loss Triad

Control Energy Intake

Perform Regular Physical Activity

Control “Problem” Behaviors

Dieting Can Be Hazardous To Your Health

- Weight regained consists of a higher percentage of body fat than before
- Less healthy than before dieting
- Weight loss diet should **not** be considered unless you are committed and motivated

Diet Drugs

- Amphetamine (Phenteramine)
  - Prolongs the activity of epinephrine and norepinephrine in the brain
  - Decreases appetite
  - Not recommended for long term use (dependency)
- Sibutramine (Meridia)
  - Enhances norepinephrine and serotonin activity
  - Decreases appetite (eat less)
  - Not recommended for people with HTN

Diet Drugs

Orlistat (Xenical)

- Inhibits fat digestion
- Reduces absorption of fat in the small intestine
- Fat is deposited in the feces with its side effects
- Must control fat intake
- Malabsorption of fat-soluble vitamins
- Supplements needed

Very Low-Calorie Diets (VLCD)

- Recommended for people >30% above their healthy weight
- 400-800 kcal per day
- Low carbohydrates and high protein
- Causes ketosis
- Lose ~3-4 pounds a week
- Requires careful physician monitoring
- Health risks includes cardiac problems and gallstones

Underweight is Also a Problem

- 15-25% below healthy weight or BMI of <18.5
- Associated with increased deaths, menstrual dysfunction, pregnancy complications, slow recovery from illness/surgery
- Causes are the same as for obesity but in the opposite route

Treatment for Underweight

- Intake of energy-dense foods (energy input)
- Encourage meals and snacks
- Reduce activity (energy output)
- To gain a pound you need a total excess intake of 2700-3500 kcal

Weighing in on Weight Control*

***As Linda Milo Ohr reported on her March 2005 *Nutraceuticals & Functional Foods* column in *Food Technology*.**

Whole Grains

Whole grains and dietary fiber may aid in weight loss by promoting satiety

- A study of the dietary habits of 74, 091 female nurses in the U.S. showed that women who consumed more whole grains consistently weighed less than women who consumed less whole grains.
- An eight-year study of middle-aged men showed that increased consumption of whole grains was inversely related to weight gain.
- A study of more than 2,000 people suggested that three or more servings of whole-grain foods each day could reduce chances of developing metabolic syndrome, a condition marked by a combination of abdominal obesity, high blood pressure, poor blood sugar control, low high-density-lipoprotein (HDL) cholesterol, and high blood fats.

Dietary Fiber

- The American Dietetic Association (ADA) stated that dietary fiber has characteristics that are features of a dietary pattern to treat and prevent obesity. For example, "Consumption of dietary fibers that are viscous lowers blood cholesterol levels and helps to normalize blood glucose and insulin levels, making these kinds of fibers part of the dietary plans to treat cardiovascular disease and type 2 diabetes. A fiber-rich meal is processed more slowly, which promotes earlier satiety, and is frequently less calorically dense and lower in fat and added sugars.

Soy

- Data suggesting soy protein specifically aids in weight loss is very limited but the health advantages of soy protein make it a good choice for high protein diets.
- In a 12-week test among 100 obese volunteers, researchers reported that a group consuming a soy-based meal replacement lost significantly more weight and fat mass than a control group.
- Women snacked on the soy chips, as part of a healthy diet and lost an average of 7.3 lb in four weeks. Participants substituted the chips for in-between meal snacks, late-night snacks, and high-calorie drinks (soda and energy drinks) during the study period.

Dairy Foods

- Increasing dietary calcium inhibits the effects of low-calcium diets (stimulates lipogenesis, suppresses lipolysis, increases lipid accumulation) and markedly accelerates fat loss in mice subjected to caloric restriction.
- Obese people who consumed 3–4 daily servings of milk, yogurt, or cheese while on a balanced, reduced-calorie diet, lost significantly more weight and fat than those who consumed similar amounts of calcium through supplements, or who consumed one or fewer servings of milk, yogurt, or cheese per day.
- Whey protein, a dairy-derived ingredient, boast a high leucine content. Studies reveal that a diet containing leucine-rich proteins is beneficial to increasing fat loss and promoting lean muscle tissue.

Others

- Conjugated linoleic acid, reduces weight gain, increases lean muscle mass, reduces the amount of body fat, and maintains body weight level.

- Chromium picolinate, reducing hyperglycemia and stabilizing blood glucose, increasing lean body mass and reducing body fat, and maintaining healthy cholesterol levels.

- Forskolin, an extract from the roots of the Coleus forskohlii plant, increases lean body mass and optimizes body composition.

PROTEIN

ILMU GIZI DAN KESEHATAN

POKOK BAHASAN

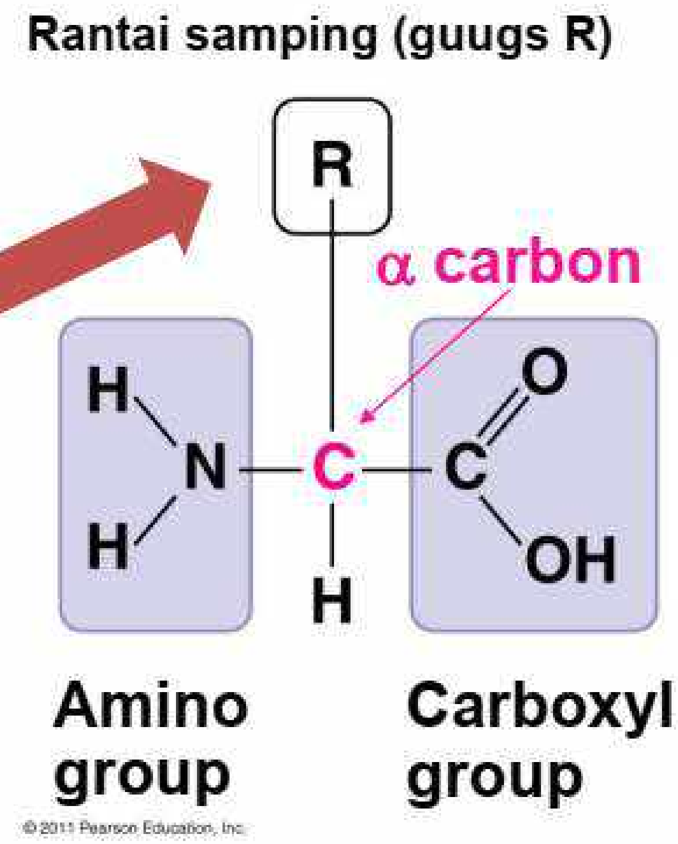
- PENDAHULUAN: asam amino dan protein
- FUNGSI PROTEIN
- PENCERNAAN (digesti) DAN ABSORPSI
- METABOLISME: anabolisme dan katabo-lisme
- KEBUTUHAN PROTEIN DAN NERACA N
- SUMBER PROTEIN
- EVALUASI MUTU PROTEIN

PENDAHULUAN

STRUKTUR ASAM AMINO

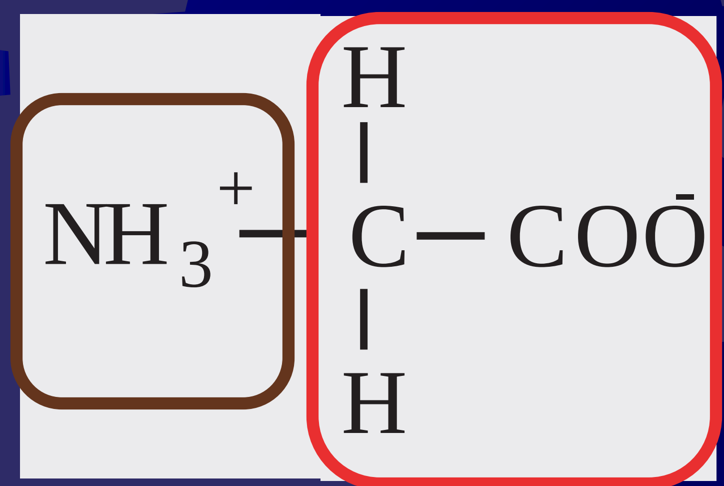
- **Asam amino** → molekul organik yang tersusun dari **gugus karboksil & gugus amino**

- Asam amino berbeda sifat berdasarkan variasi rantai samping → disebut gugus R



STRUKTUR ASAM AMINO

yang paling sederhana → GLISIN (gugus R berupa –H)



Fraksi Non-nitrogen

Fraksi nitrogen

Deaminasi?

SINGKATAN ASAM AMINO

Asam amino	Singkatan 3 huruf	Simbol 1 huruf
Alanin	Ala	A
Arginin	Arg	R
Asparagin	Asn	N
Aspartic acid	Asp	D
Cysteine	Cys	C
Glutamine	Gln	Q
Glutamic acid	Glu	E
Glycine	Gly	G
Histidin	His	H

SINGKATAN ASAM AMINO (LANJUTAN)

Asam amino	Singkatan 3 huruf	Simbol 1 huruf
Isoleusin	Ile	I
Leusin	Leu	L
Lysine	Lys	K
Metionin	Met	M
Phenylalanine	Phe	F
Prolin	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valin	Val	V

KLASIFIKASI ASAM AMINO

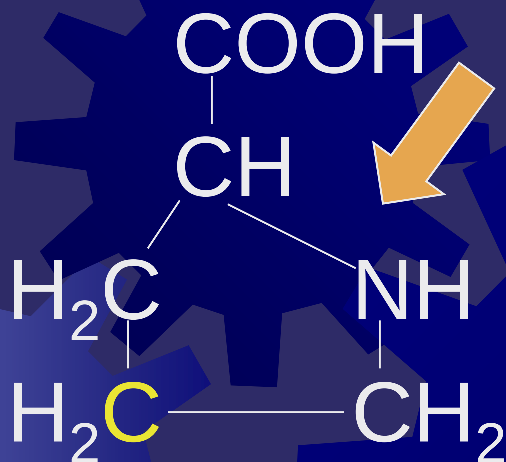
Klasifikasi	AA esensial (AAE)	AA non esensial (AANE)
NETRAL: -Alifatik -Aromatik -Heterosikli -Punya gugus –S	 Thr,Val,Leu, Ile Phe Trp, His Met	 Gly, Ala, Ser Tyr Pro, Hidroksiprolin Cys, Cystine
BASA	Lys	Arg, Hydroxylysine
ASAM		Asp, Glu

Proline

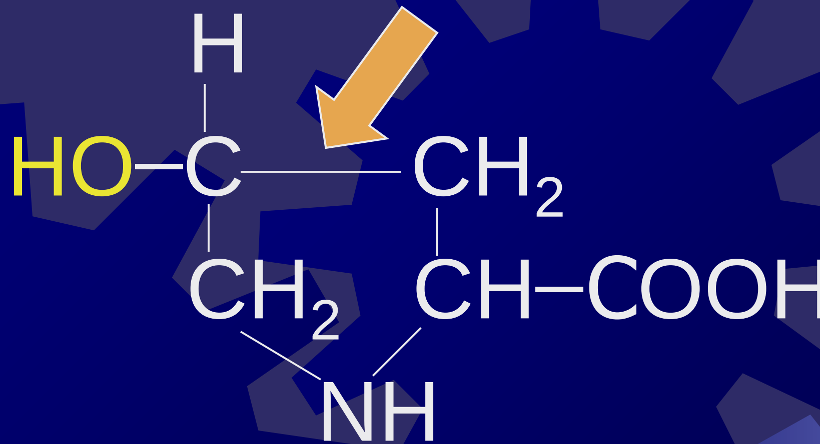
- Struktur prolin → gugus — NH dalam bentuk siklis (Lehninger, 1982, p.56)
- Termasuk asam amino karena perannya pada struktur protein serupa dengan asam amino
- *Special amino acids*:

→ 4-hidroksiprolin, 5-hidroksilisin (keduanya terdapat pada kolagen jaringan ikat),

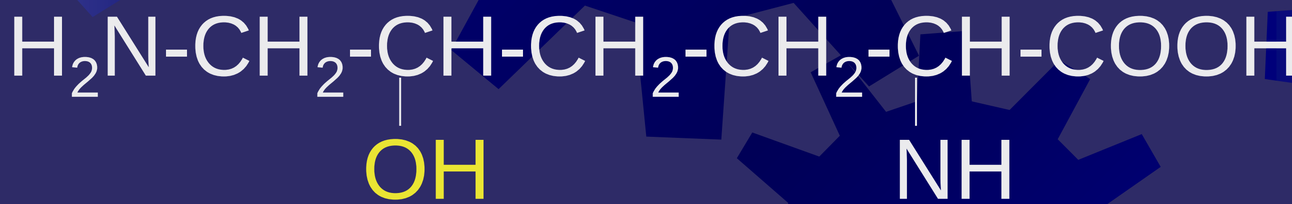
→ N-metillisin yang terdapat pada miosin (Lehninger, p. 103)



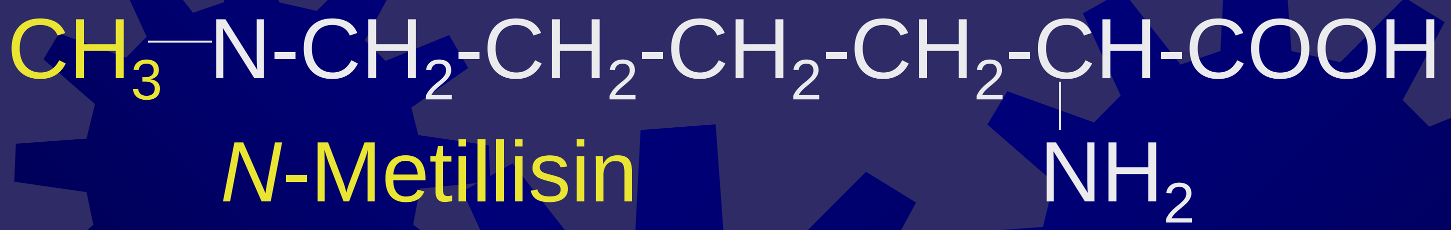
Prolin

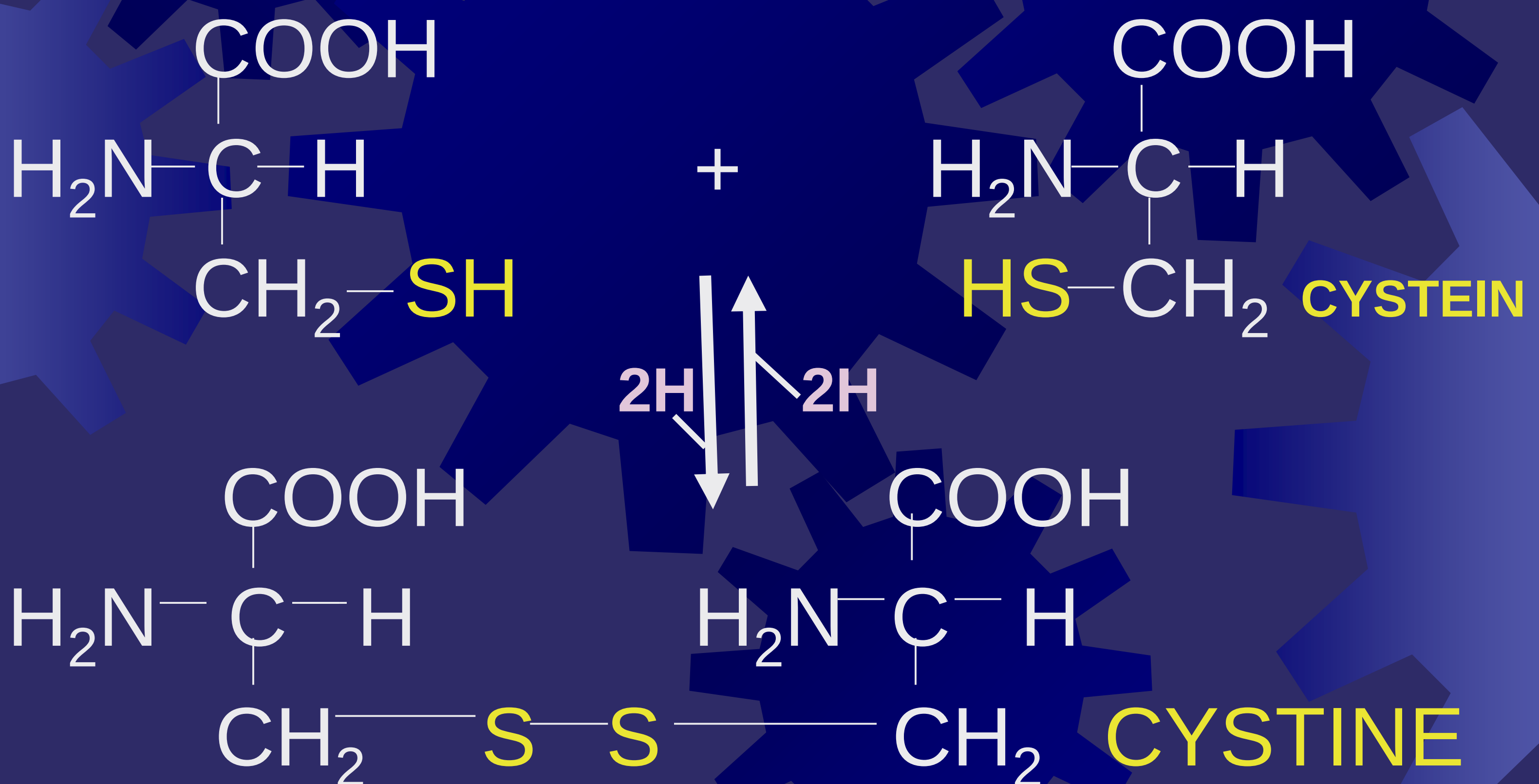


4-Hidroksiprolin



5-Hidroksilisin


CH3—N-CH2-CH2-CH2-CH2-CH-COOH
NH2
N-Metillisin


COOH
H2N—C—H
CH2—SH
+
COOH
H2N—C—H
HS—CH2
CYSTEIN
2H
2H
COOH
H2N—C—H
CH2—S—S—CH2
COOH
H2N—C—H
CYSTINE

FUNGSI KHUSUS ASAM AMINO

ASAM AMINO	FUNGSI
Triptofan	Prekusor vitamin niacin Prekusor neotransmiter serotin Merangsang aktivitas usus
Arginin, Glisin, dan Metionin	Bergabung membentuk creatine
Sistin	Komponen asam empedu
Asam aspartat	Sintesis asparagine
Glisin	Detoksifikasi racun Bagian dari hemoglobin Konstituen asam empedu

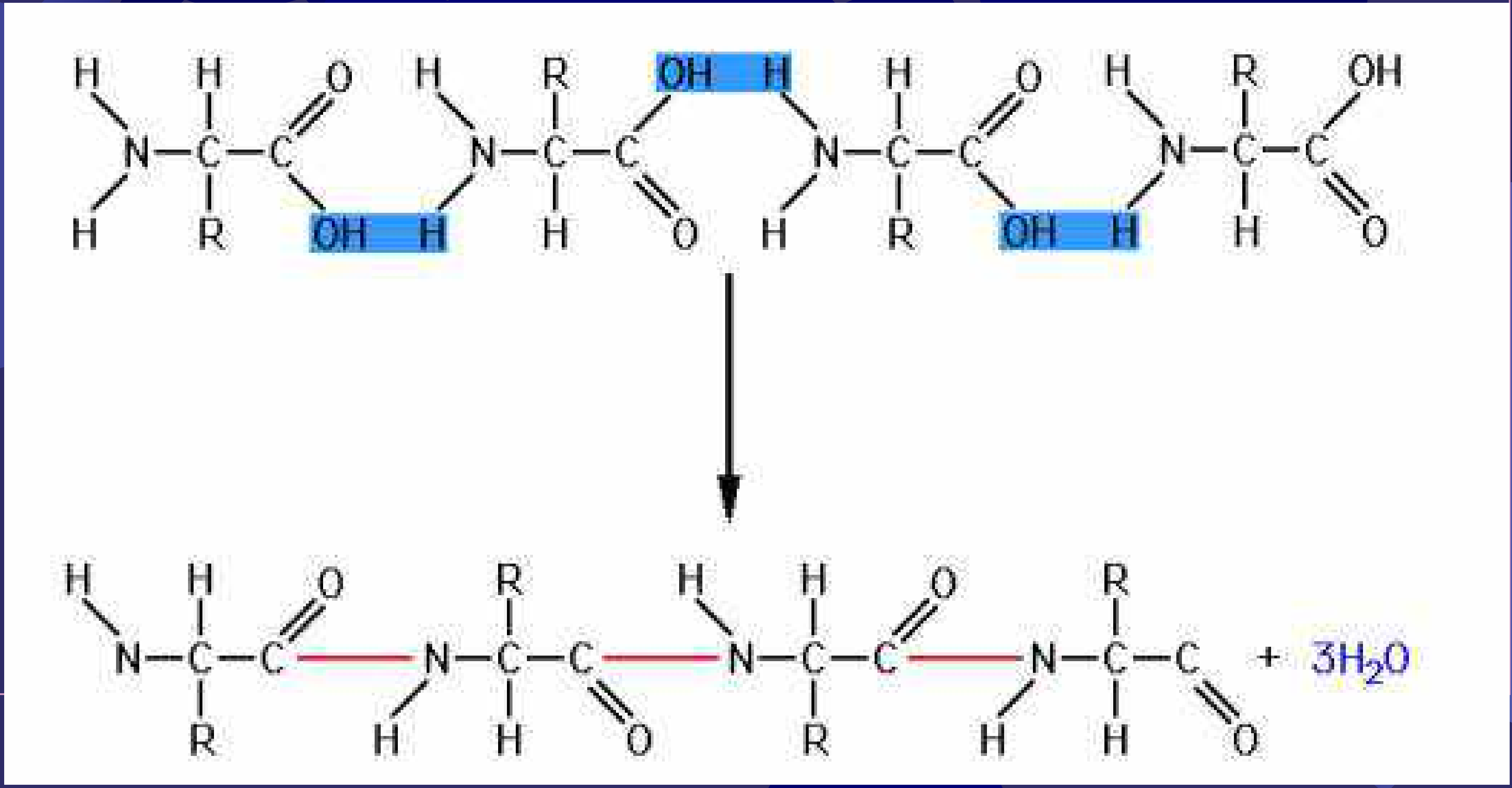
ASAM AMINO	FUNGSI
Glu, Cys, dan Gly	Sintesis glutathione (untuk reaksi oksidasi – reduksi)
Tirosin	Sintesis hormon epinephrine dan tyroxine Sintesis neurotransmiter dopamine & norepinephrine
Histidin	Sintesis histamine
Fenilalanin	Prekusor tyrosine Konstituen thyroxine dan epinephrine
Metionin	Memberikan gugus methyl (—CH3) untuk sintesis senyawa choline dan creatine

PROTEIN: polimer asam amino melalui ikatan peptida

- Dalam **SINTESIS** protein ➔ 2 molekul asam amino akan membentuk satu ikatan dipeptida + pelepasan 1 molekul H_2O
- Sebaliknya, dalam **HIDROLISIS** protein ➔ 1 molekul dipeptida + 1 H_2O akan menghasilkan 2 molekul asam amino

THE PEPTIDE BOND

- Peptide bond: how the amino acids are linked together to make a protein



PROTEIN → tersusun dari banyak sekali asam amino

- ASAM AMINO : ± 20 jenis → dapat membentuk protein dengan jenis tak terhingga
- Pada tubuh manusia terdapat ± 30.000 jenis protein yang berbeda (2% telah berhasil diidentifikasi)
- Setiap spesies membentuk protein yang khas → protein hemoglobin darah kuda tak dapat ditukar dengan Hb manusia

- Hb darah: td rantai 300 unit asam amino

Bila kedudukan 1 glutamat diganti valin ➔ hemoglobin tak mampu mengangkut O_2 ➔ individu ybs menjadi cacat

FUNGSI PROTEIN

(Burtis *et al*, 1988)

1. MEMBANGUN JARINGAN BARU PADA TUBUH

- Protein merupakan penyusun sel ➔ 20% dari berat total (50% dari berat kering) tubuh adalah protein (Guthrie, 1983)
- Selama masa pertumbuhan ➔ kebutuh-an protein NAIK untuk sintesa jaringan baru ➔ - bayi - anak-anak
  - remaja - wanita hamil

  Juga saat pemulihan dari: - sakit - operasi - luka termasuk luka bakar

2. MEMPERBAIKI JARINGAN TUBUH

Pada semua protein tubuh terjadi katabolisme secara kontinyu → jaringan protein baru mengalami resintesa dari asam-asam amino

3. MENGHASILKAN SENYAWA ESEN-SIAL

Enzim dan hormon: tersusun antara lain dari protein atau asam amino

4. MENGATUR NERACA AIR

Protein plasma merupakan senyawa aktif dalam pengaturan neraca cairan-elektrolit secara osmotik:

- Protein larut air membentuk larutan koloid (= menarik air)
- Albumin darah (=protein) menarik air dari cairan sel atau antar sel. Bila defisi-ensi protein → protein darah ↓ → tim-bul edema akibat terganggunya neraca osmotik

5. MENGATUR NERACA ASAM-BASA

Protein plasma = buffer yang dapat bereaksi baik dengan asam maupun basa ➔ untuk mempertahankan pH yang tepat

6. SUMBER BAHAN PERTAHANAN TUBUH

Antibodi (*body's main protection from disease*) merupakan PROTEIN

7. BERPERAN DALAM MEKANISME TRANSPORT

Protein membuat senyawa lipid tak larut air dapat diangkut dalam darah

8. SUMBER ENERGI

Setelah gugus amino mengalami deaminasi, kerangka karbon yang tersisa dapat dipakai untuk energi, sebesar 4 kkal/g

- Fungsi utama protein: **BUKAN SEBAGAI SUMBER ENERGI**
- **BEBERAPA KONDISI YANG MENDORONG DIGUNAKANNYA PROTEIN SEBAGAI SUMBER ENERGI:**

a. Asupan energi dari karbohidrat maupun lemak: kurang/tidak mencukupi
b. Asupan protein melebihi kebutuhan tubuh
c. Beberasa asam amino esensial tidak tersedia bagi sintesa protein tubuh

♣ KLASIFIKASI PROTEIN BERDA-SARKAN FUNGSINYA

Kelompok	Lokasi	Contoh	Fungsi
Protein struktural	Kulit,sendi, tulang	Kolagen	Komponen utama jaringan pengikat
Protein kontraktil	Jaringan otot	Aktin, miosin	Kontraksi otot
Antibodi	Plasma da-rah, sel lim-fa	α-globulin	Perlindung an thd penyakit

Kelom-pok	Lokasi	Contoh	Fungsi
Protein darah	Plasma darah	Albumin	Mengatur tekanan osmosa darah, mempertahankan kapasitas buffer
	Darah	Fibrino-gen	Pembekuan darah
	Darah	Hemoglo-bin	Transport oksigen

Kelom-pok	Lokasi	Contoh	Fungsi
Hormon	Kelenjar endokrin, saluran pencer-naan	Insulin	Mengatur metabolisme KH.
		Hormon pertumbuh-an	Merangsang sintesis protein & pertumbuhan
Enzim	Di selu-ruh tubuh		Mengkatalisis reaksi biokimiawi tubuh
	Lambung	Pepsin	Pencernaan protein
	Pankreas	Tripsin & Kemotripsin	Pencernaan protein

Kelompok	Lokasi	Contoh	Fungsi
Protein gizi		Daging, ikan, dsb	Sumber asam amino
Nukleopro-tein	Nukleus	DNA	Sifat menurun

PENCERNAAN DAN ABSORPSI PROTEIN

A. PENCERNAAN PROTEIN

- Molekul protein → besar dan kompleks
- Supaya bisa diabsorpsi usus → protein harus dicerna (digesti) lebih dahulu
- Dalam digesti: ikatan peptida dihidroli-sis → perlu enzim tertentu
- Untuk setiap ikatan peptida yang dihidrolisis → perlu 1 molekul H_2O
- Hasil:

- fragmen peptida yang lebih kecil
- asam amino bebas

- Sumber protein ENDOGENUS → termasuk produk katabolisme di dalam saluran pencernaan juga akan dihidroli-sis dan diabsorbsi bersama dengan protein pangan.
- Proses pencernaan dapat diringkas seperti pada:

Jalur Pencernaan Protein

mulut	protein
	↓
lambung	Gastrik protease
	↓
	Proteosa dan pepton
	↓
Usus halus	Pankreatik protease
	↓
	Intestinal protease
	↓
	dipeptida
	↓
Dinding usus	Intestinal dipeptidase
	↓
	Asam amino

Enzim pencerna protein, lokasi dan kerjanya

ENZIM DAN LOKASINYA	KERJA
LAMBUNG	
Pepsinogen	Diaktifkan menjadi pepsin oleh HCl
Pepsin	Menghidrolisis ikatan peptida pada gugus amino Phe atau Tyr
USUS HALUS	
Trypsinogen	Diaktifkan menjadi tripsin oleh enterokinase
Trypsin	Memotong ikatan peptida pada gugus karboksil Lys atau Arg
Chymotrypsinogen	Diaktifkan menjadi chymotrypsin oleh trypsin

ENZIM DAN LOKASINYA)	KERJA
USUS HALUS (lanjutan) **Chymotrypsin**	Memecah ikatan peptida pada gugus karboksil Trp, Met, Tyr, atau Phe

ENZIM DAN LOKASINYA	KERJA
INTESTINAL MUCOSA	
Amino peptidase	Memotong ikatan peptida dekat ujung gugus amino
Karboksipeptidase	Memotong ikatan peptida dekat ujung gugus karboksil

URAIAN PENCERNAAN PROTEIN

1. LAMBUNG

- Proses hidrolisis dimulai di LAMBUNG → HCl mengaktifkan pepsinogen menjadi pepsin (pepsinogen diproduksi oleh sel khusus lambung di bawah kontrol hormon gastrin)

$$\text{Pepsinogen} \xrightarrow{\text{HCl}} \text{PEPSIN}$$

- Aksi proteolitik pepsin: menghidrolisis ikatan peptida yang mempunyai gugus amino Phe dan Tyr

- Pepsin menginisiasi hidrolisis protein dengan BM tinggi menjadi bentuk yang sederhana yang disebut pepton dan polipeptida

- Hidrolisisis terjadi melalui pemecahan protein antara asam-asam amino pada rantai peptida. Tetapi pepsin biasanya tidak menghirolisis protein secara sempurna menjadi asam-asam amino

2. USUS HALUS

- Di dalam USUS HALUS → enzim melanjutkan proses hidrolisis protein intermediet hasil digesti oleh pepsin
- Di usus halus: asam dinetralkan sehingga kondisi menjadi sedikit alkalis dan pepsin menjadi inaktif

- Hormon pankreosimin memacu pankreas untuk mengeluarkan: tripsinogen dan khimotripsinogen
- Begitu disekresikan ke duodenum ➔ keduanya menjadi tripsin dan khimotrip-sin yang aktif

  Tripsinogen $\longrightarrow$ tripsin

  Khimotripsinogen $\longrightarrow$ khimotripsin
- Masing-masing enzim memiliki fungsi spesifik dalam memotong rantai peptida

- Tripsin ➔ memecah ikatan pada gugus karboksil Arg dan Lys
- Khimotripsin ➔ memecah ikatan pada gugus karboksil Tyr, Phe, Trp, dan Met
- Hasil digesti oleh tripsin dan khimotripsin:

30% asam amino (dapat langsung diabsorpsi)

+

70% dipeptida, tripeptida, dan fragmen yang lebih kompleks dari tripeptida ➔ akan dihidrolisis lebih lanjut

3. INTESTINAL MUCOSA

- Enzim di dalam sel-sel epithel intestine dapat mengakhiri konversi menjadi asam-asam amino
- Karboksipeptidase: memecah ikatan di dekat ujung karboksil ➔ hasil: asam amino
- Aminopeptidase: memecah ikatan dari ujung terminal amino sampai tersisa dua asam amino yang terikat sebagai dipeptida
- Di *brush border* ➔ dipeptida tersebut dihi-drolisis oleh dipeptidase; hasil: 2 asam amino (Guthrie, 1983)

RINGKASAN PENCERNAAN PROTEIN

1. **PEPSIN**: menghidrolisis ikatan peptida yang mempunyai gg amino Phe dan Tyr

   Hasil: pepton, polipeptida

2. **TRIPSIN** ➔ memecah ikatan pada gugus karboksil Arg dan Lys

3. **KHIMOTRIPSIN** ➔ memecah ikatan pada gugus karboksil Tyr, Phe, Trp, dan Met

   Hasil: 30% asam amino + 70% dipeptida, tripeptida, dan fragmen yang lebih kompleks dari tripeptida

4. **KARBOKSIPEPTIDASE**: memecah ikatan di dekat ujung karboksil → hasil: asam amino

5. **AMINOPEPTIDASE**: memecah ikatan dari ujung terminal amino sampai tersisa dua asam amino yang terikat sebagai dipeptida

6. Di *brush border* → dipeptida tersebut dihidrolisis oleh DIPEPTIDASE; hasil: 2 asam amino (Guthrie, 1983)

UJUNG TERMINAL N ATAU TERMINAL AMINO

NH_2

HC—R1 Glu   AMINOPEPTIDASE: MEMOTONG IK. PEPTIDA DEKAT UJUNG AMINO

C=O

NH

HC—R2 Lys   TRIPSIN: MEMOTONG IK. PEPTIDA PADA GUGUS KARBOKSIL Lys, Arg

C=O

NH

HC—R3 Leu   PEPSIN: MEMOTONG IK. PEPTIDA PADA GUGUS AMINO Phe, Tyr

C=O

NH

HC—R4 Phe   KARBOKSIPEPTIDASE: MEMOTONG IK. PEPTIDA DEKAT UJUNG GUGUS KARBOKSIL

C=O

NH

HC—R5 Ile

C=O

OH

UJUNG TERMINAL C ATAU TERMINAL KARBOKSIL

- INGAT: semua enzim penghidrolisis protein **membutuhkan H_2O** untuk menghasilkan asam amino → berlawanan dengan proses SINTESIS protein: setiap 2 asam amino yang berikatan akan dilepaskan 1 molekul H_2O
- Koefisien digestibility → lihat tabel

Tabel. Koefisien digestibility beberapa protein

Food	Koef. digestibility
Telur	97
Daging, ikan	97
Susu	97
Gandum (70 to 74% extraction)	89
Buah-buahan	85
Beras	84
Legumes	78
Root vegetable	74
Other vegetables	65

B. ABSORPSI

- Asam amino bebas ➔ cukup sederhana untuk diabsorpsi melewati usus ke pembuluh darah
- Absorpsi asam amino = transport aktif ➔ perlu energi, vit. B_6, dan manganese (Mn)

- Sisi absorpsi asam amino:

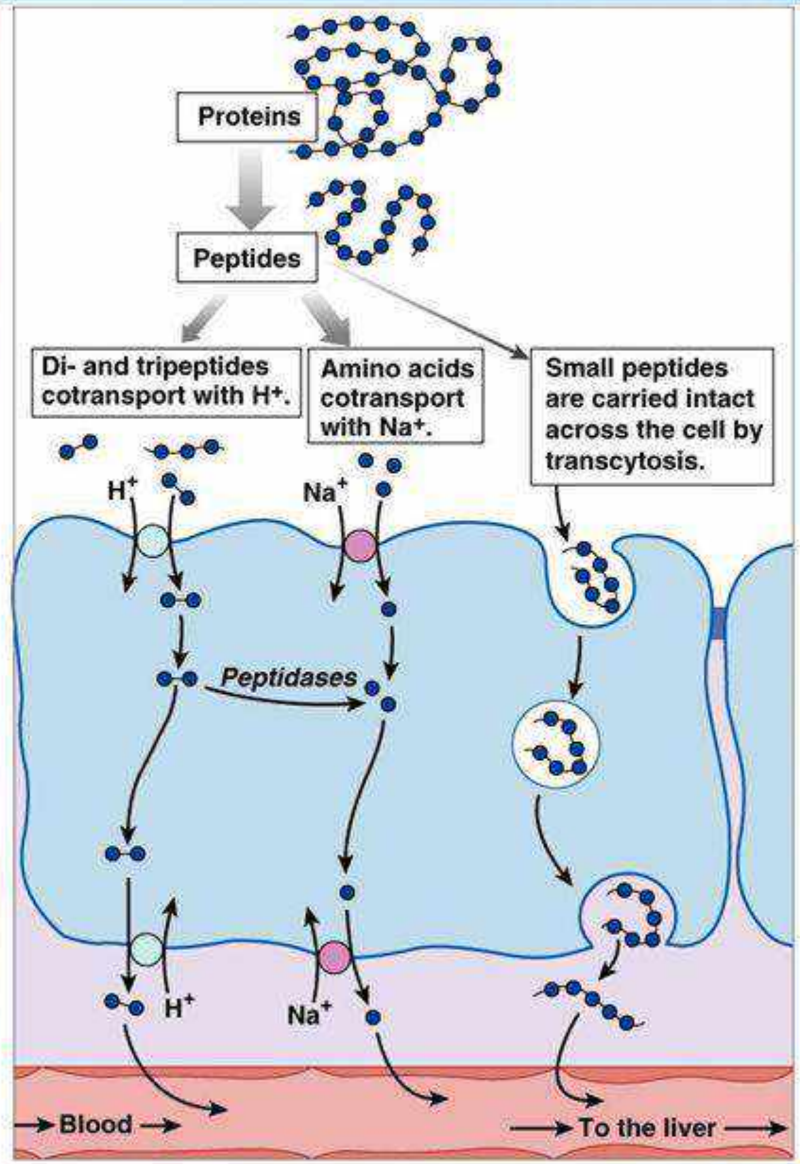
  - **lambung: 12%**
  - **usus halus: 60%**
  - **usus besar (kolon): 28%**

- Asam amino → lewat dinding usus → VENA PORTAL → hati → distribusi ke seluruh tubuh

- Tripeptida dan molekul yang > tripeptida, bahkan protein ➔ dapat masuk ke pembuluh darah (= proses pinositosis) ➔ **timbul reaksi alergi**
- BAYI ➔ pada bulan pertama kehidupannya, bayi mampu mengabsorpsi protein (antara lain: **ANTIBODI**) ➔ merupakan faktor penting dalam pembentukan imunitas ➔ **bayi menjadi tahan terhadap penyakit menular**

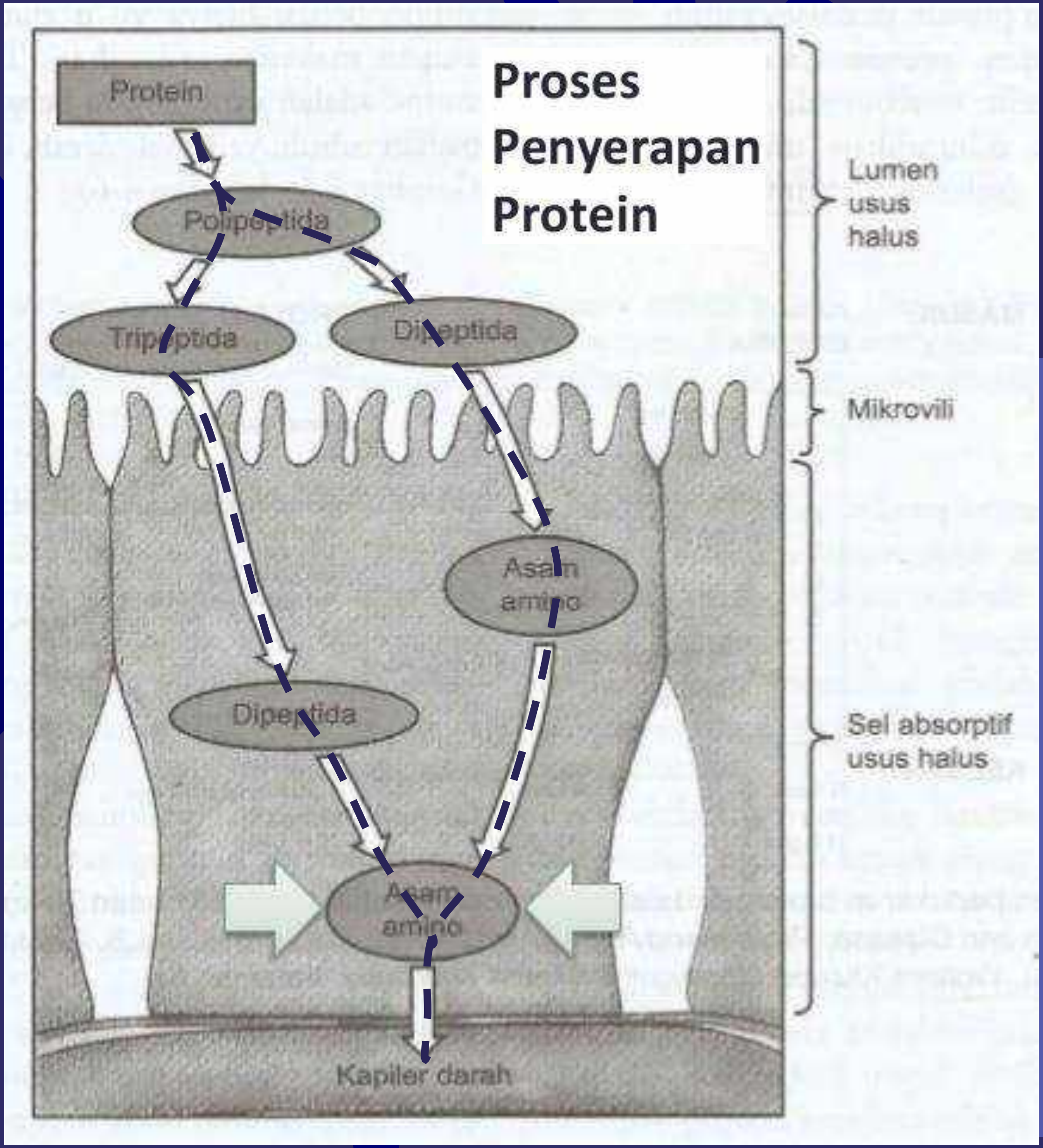
Absorption of peptides in the small intestine

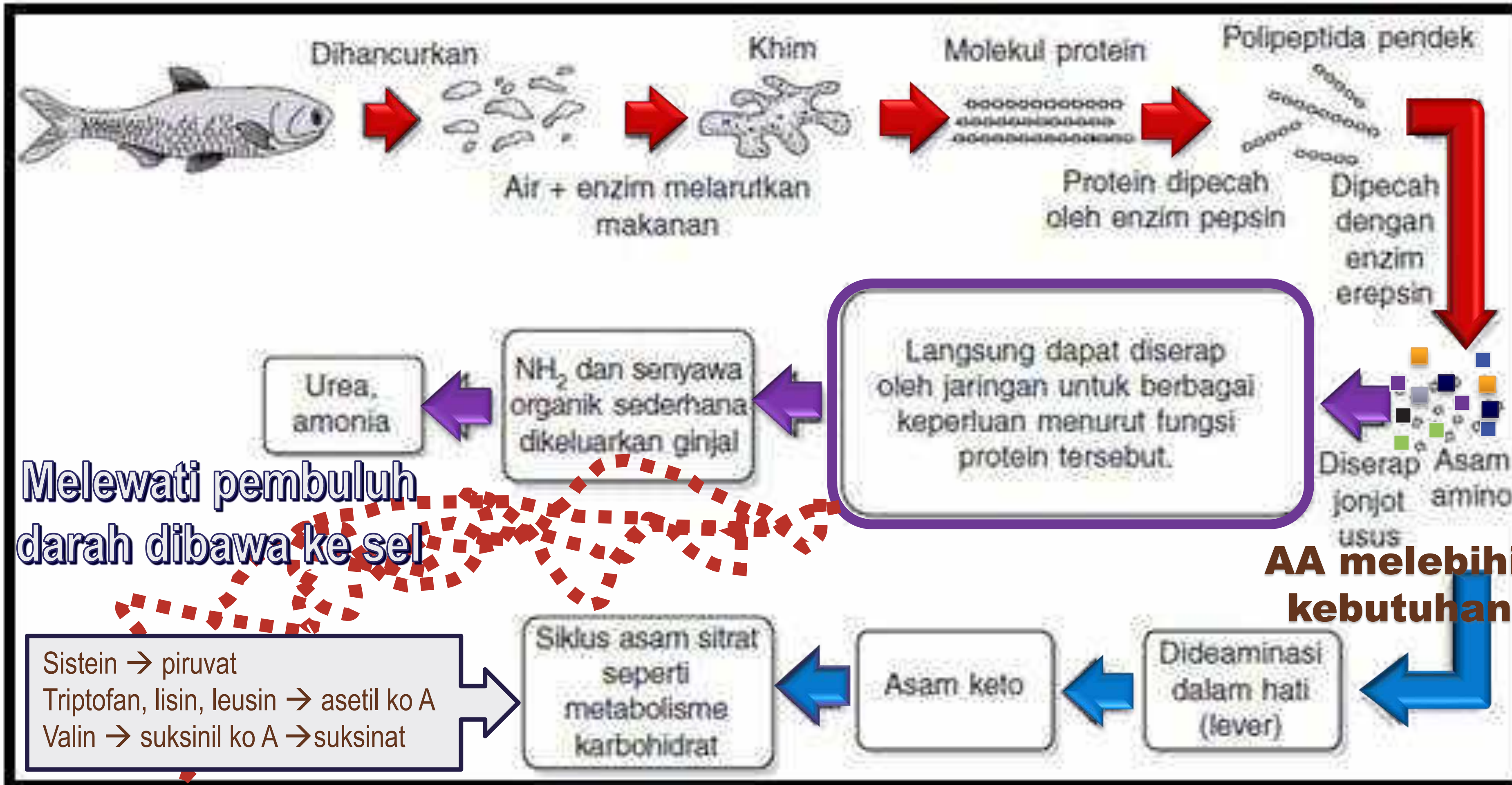
- There are dipeptidases in the cells of the villi, so most of the luminal dipeptides are hydrolysed at the moment of absorption.
- There are four different carrier molecules:
  - One for the neutral amino acids
  - One for the basic amino acids
  - One for the dicarboxylic amino acids (glutamic and aspartic)
  - and the fourth for proline, hydroxyproline and glycine.
- The presence of the Na+ ion speeds the carrier-mediated movement of amino acids into the intestinal cell. The role of sodium here may be similar its role in glucose absorption.



METABOLISME PROTEIN

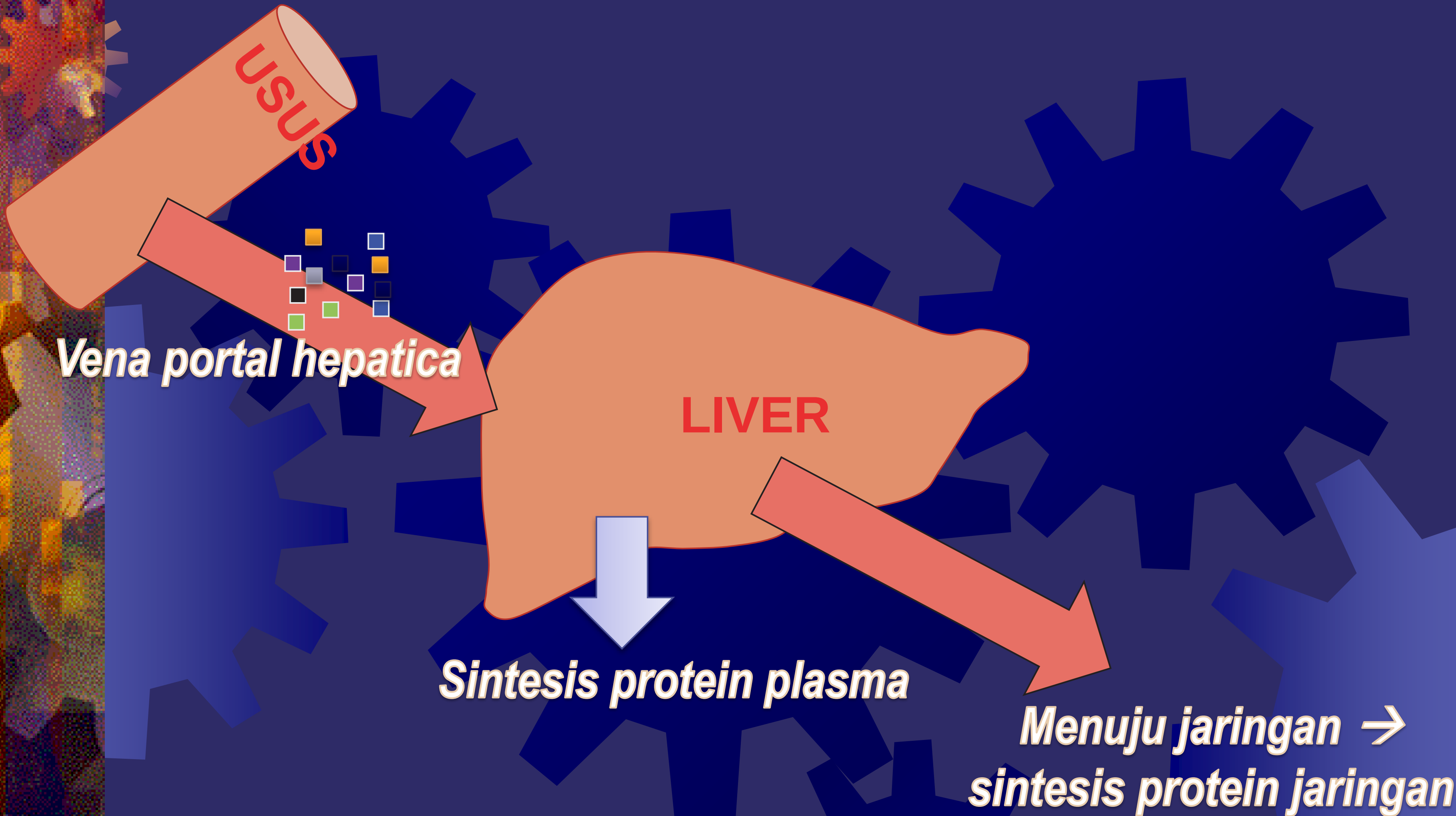
- Setelah absorpsi di usus halus, asam amino (disingkat: AA) dibawa ke sel mukosa, lalu ikut aliran darah
- AA masuk melalui VENA PORTAL menuju ke HATI/LIVER
- Level AA di vena portal sesudah makan dapat naik sampai beberapa kali lipat dari level normal di sirkulasi





Menempel pada tRNA untuk sintesis protein → TRANSLASI

Disusun menjadi komponen protein fungsional (enzim, hemoglobin, hormon, dll)



- Sebagian AA disintesis menjadi protein plasma oleh hati
- AA sisanya → masuk ke jalur sirkulasi (peredaran darah) → dengan cepat akan diambil oleh sel dan digunakan untuk sintesis protein

- Hati → merupakan AMINOSTAT yang memonitor asupan dan pemecahan semua AA; kecuali AA bercabang (*branched-chain amino acids* = BCAA) yang dimetabolisasi di otot
- Hati mengatur AA yang masuk dalam sirkulasi hanya pada level tertentu, sehingga masing-masing AA hanya tersedia sesuai dengan kebutuhan sel untuk proses sintesis masing-masing protein individual

- Bila level AA individual naik sampai jumlahnya melebihi kebutuhan, maka kelebihan AA tersebut akan dipindah-kan dan dioksidasi ➔ hasil: energi

$$\text{Asam amino} \xrightarrow{\text{deaminasi}} \text{rantai C + urea}$$

- Rantai C ⟶ $H_2O + CO_2$ + energi
- Gugus —NH_2 hasil deaminasi ➔ dieks-kresikan melalui urine dalam bentuk urea
- Saat sel mensintesis protein ➔ semua AAE yang dibutuhkan harus tersedia secara simultan. Bila tidak ➔ sintesis protein GAGAL ➔ AAE dilepas oleh sel untuk diambil dan digunakan oleh sel lain, atau dioksidasi menjadi energi

- Dalam darah, level N asam amino yang normal adalah 4-6 mg/dL ➔ merupakan level yang menciptakan keseimbangan antara absorpsi, pembentukan, dan penggunaan

- Metabolisme protein ➔ selalu berada da-lam kondisi dinamik, dengan proses kata-bolisme dan anabolisme yang berkesi-nambungan. Bahkan pada masa pertum-buhan ➔ katabolisme meningkat sejalan dengan proses remodeling sel menjadi jaringan yang *highly organized*

- Selain protein eksogen (dari diet), PROTEIN ENDOGEN (dari katabolisme jaringan) akan melepaskan AA yang dapat dipakai untuk reaksi anabolik
- This reservoir of amino acids is called *AMINO ACID METABOLIC POOL* ➔ berfungsi untuk mempertahankan "*dynamic state of equilibrium*"

Digesti

Protein diet → POOL ASAM AMINO ↔ Protein jaringan

Absorpsi

SINTESIS

Katabolisme → Urea

Protein baru

Hormon

Enzim

Heme

Asam nukleat

Kreatin

CO_2 + H_2O + ENERGI

- *Amino acid metabolic pool* (70 g AA) ➔ bukan merupakan simpanan yang besar
- Kenaikan ukuran otot ➔merupakan kenaikan massa tubuh, bukan simpan-an protein
- Oleh karena itu, untuk mempertahan-kan status protein yang baik ➔ perlu asupan harian AAE karena sintesis protein bersifat sangat sensitif terhadap asupan diet

ANABOLISM-CATABOLISM BALANCE

- Anabolisme = proses sintesis, untuk membentuk senyawa tubuh + “*storage material*” ➔ perlu energi
- Katabolisme = proses pemecahan, terutama untuk menghasilkan energi. Berbagai *waste products* yang dihasilkan ➔ diekskresikan dari tubuh

- Proses anabolik dan katabolik dikontrol oleh hormon
- HATI merupakan organ utama pengaturan
- Proses anabolik dan katabolik → menggunakan asam amino dari absorpsi dan pool AA metabolik

a. Anabolisme

- Selain dipengaruhi oleh hormon, anabolisme tergantung pada ketersediaan semua AAE
- Sintesis protein juga dipengaruhi oleh asupan energi
- Bila energi < kebutuhan ➔ protein jaringan digunakan untuk energi, akibat: ekskresi N meningkat (melalui urine)

- Produksi AANE di hati merupakan proses TRANSAMINASI ➔ gugus amino ditransfer dari suatu senyawa ke kerangka karbon lain, membentuk AA

- Proses transaminasi memerlukan vit. B_6

- Contoh (Lehninger, p.616):

$$NH_4^+ + \alpha\text{-ketoglutarat} \leftrightarrow \text{L-glutamat} + NADP^+ + H_2O$$

- Protein disintesis oleh sel individual untuk digunakan sendiri.
- Suatu sel tidak bisa mensintesis protein yang digunakan oleh jenis sel yang berbeda
- DNA di inti sel ➔ berperan sebagai cetakan dan mengontrol sintesis protein
- mRNA (messenger RNA) ➔ meng-copy pola dari DNA di inti sel dan membawa “kode pembentukan protein” tersebut ke ribosoma di sitoplasma

Misal: AAG – lysine

AGA – arginin

GAA – asam glutamat

- tRNA (transfer RNA) → datang membawa AA dan mengarahkan AA yang sesuai dengan kode yang dibawa mRNA, ke posisi yang benar dalam rantai
- Kemudian tRNA bergabung dengan mRNA sesuai dengan pasangan basanya
- Asam-asam amino akan berjajar-jajar dalam urutan yang sesuai dengan kode, sehingga terbentuk protein

b. Katabolisme

- AA are catabolyzed principally in the LIVER but, in some extent, in KIDNEY
- Katabolisme dimulai dengan deaminasi AA. Kerangka karbon yang dihasilkan dapat digunakan untuk:

1. Membuat AANE
2. Memproduksi energi lewat siklus Kreb
3. Konversi menjadi lemak dan disimpan sebagai lemak jaringan

KESIMPULAN: protein diet akan digu-nakan melalui beberapa jalur:

1. Bila asupan energi mencukupi ➔ AA digunakan untuk sintesis protein tubuh, sepanjang diperlukan
2. Bila:
   a. Asupan energi tidak mencukupi kebutuhan ATAU
   b. Terdapat kelebihan AA yang tersedia dibanding dengankebutuhan untuk sintesis protein ATAU

c. Tidak semua AAE tersedia secara simultan saat diperlukan untuk sintesis protein tubuh (baik jenis maupun jumlahnya). BILA DEMIKIAN, MAKA asam amino mengalami DEAMINASI ➔ hasil: ♣ gugus amino, diekskresikan sebagai urea melalui urine

♣ fraksi non-nitrogen digunakan sebagai sumber energi

3. Bila AA GLUKOGENIK mengalami deaminasia, maka AA akan dikonversi menjadi glukosa dan dimetabolisasi sebagai glukosa

4. Bila AA KETOGENIK mengalami deaminasi, maka AA akan dikonversi menjadi asam lemak dan selanjutnya:

a. Digunakan secara langsung sebagai sumber energi
b. Dikonversi menjadi trigliserida dan disimpan sebagai lemak

Keterangan:

- AA glukogenik: AA yang mampu membentuk glukosa ➔ Ala Gly

  Met Ser

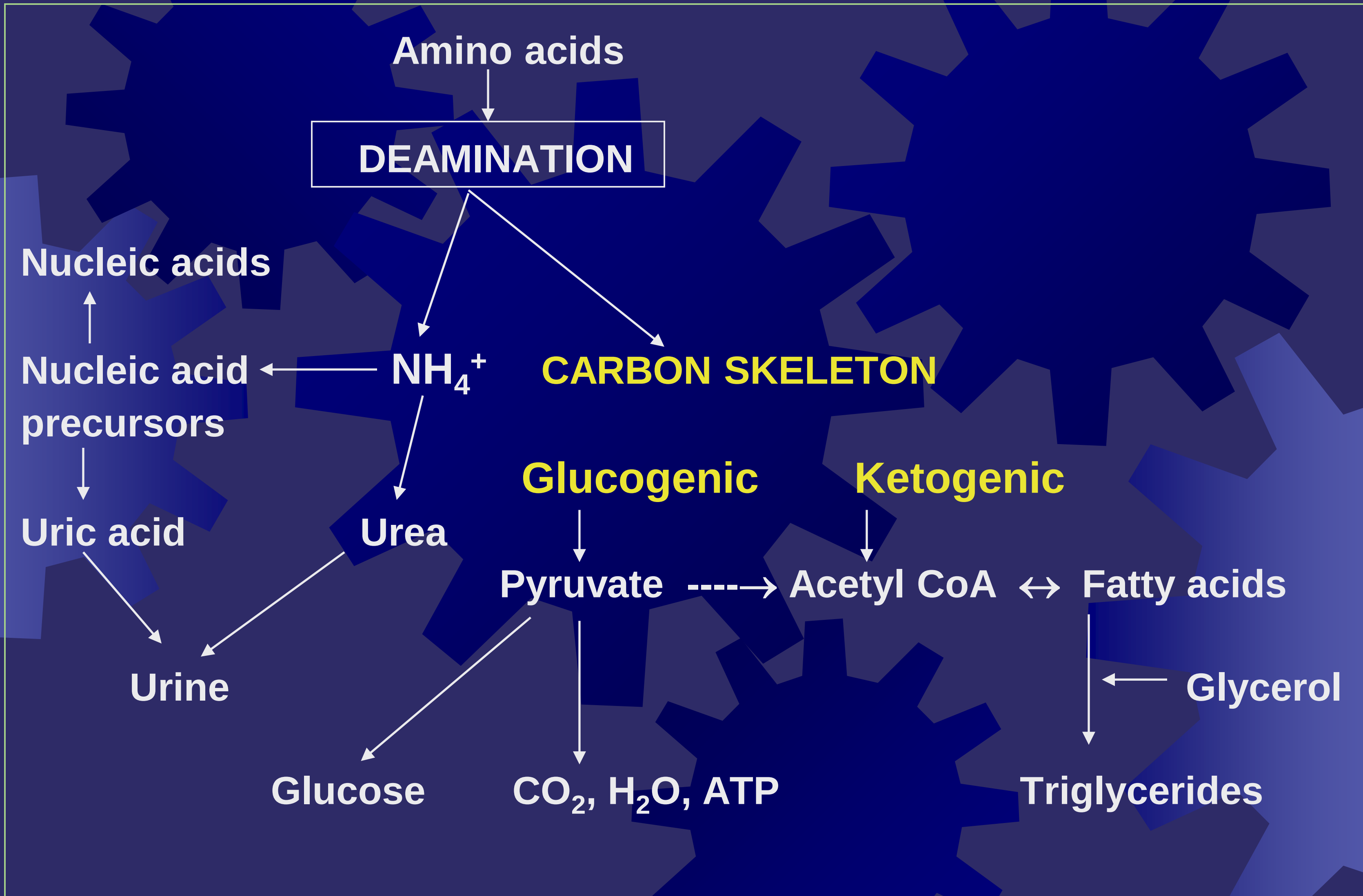
  Cys Trp

- AA ketogenik: AA yang mampu membentuk asam lemak atau fragmen C-2 (= hasil pemecahan asam lemak) ➔

  Phe Leu

  Lys

Deaminasi asam amino



Kelainan metabolisme asam amino

1. 1.Fenilketourea (PKU): kegagalan metabolisme Phe ➔ Phe menumpuk di darah ➔ hambatan mental
2. 2.Homosistinuria: kegagalan konversi Cys → Met
3. 3.Maple sugar urine disease: kegagalan metabolisme Leu + Val ➔ urine berbau sirup maple
4. 4.Kegagalan dalam melakukan metabolisme His ➔ ciri: cacat pada cara berbicara

NERACA NITROGEN DAN KEBUTUHAN PROTEIN

A. NERACA NITROGEN

- N seimbang: protein tubuh → konstan
  ➔ asupan N = ekskresi N
- Neraca N positif: terjadi kenaikan protein tubuh ➔ asupan N > ekskresi N
- Neraca N negatif: terjadi penurunan protein tubuh ➔ ekskresi N > asupan N

Positif N balance	Negative N balance
Growth **Pregnancy** **Convalescent periode (masa penyembuhan)** **Athletic training**	**Inadequate intake of protein (fasting, GI tract disease)** **Inadequate caloric intake** **Illnesses:fever, trauma, infection** **Injury** **Deficiency of AAE** **Accelerated of protein loss (albuminuria)** **Burns (luka bakar)** **Increased secretion of thyroxine & glucocorticoid**

Asupan dan ekskresi nitrogen

- Asupan N ➔ dapat diukur berdasarkan jumlah protein yang dimakan. Kadar N protein = 16% ➔ 1 g N setara dengan 6,25 g protein
- Ekskresi nitrogen ➔ terutama dalam urine; dalam jumlah kecil juga diekskre-sikan lewat feces, keringat, muntah, kulit, cairan menstruasi, dan rambut

Nitrogen serum dan urine

- Status protein → diukur dari N serum darah dan urin, sebagai hasil metabolis-me protein
- Kadar N urea urine → merupakan indeks pencernaan protein dan mencer-minkan kecukupan protein.
- Kreatin & kreatinin = produk akhir meta-bolisme protein.
- Asam urat = produk akhir metabolisme purin (banyak terdapat dalam daging)

Nilai hematologik dan urine dipengaruhi oleh status neraca nitrogen

Uji	Nilai normal
Serum nonprotein nitrogen	15 - 35 mg/dL
Serum urea	20 - 45 mg/dL
Urinary urea nitrogen	9 - 20 mg/dL (30 g/24 jam)
Uric acid: males	3,8 -7,1 mg/dL
females	2,6 – 5,6 mg/dL
children	2,0 – 5,5 mg/dL
Creatinine (serum)	1,0 – 1,5 mg/dL
Urinary creatinin: males	1 – 2 g/24 jam
females	0,8 – 1,8 g/24 jam

B. KEBUTUHAN PROTEIN

- Berdasarkan neraca N ➔ jumlah asup-an yang dianjurkan = 1g/kg BB/hari

  $\Downarrow$

  berasal dari: angka estimasi + 20% + asumsi nilai kecernaan = 70%
- Anak dan perempuan hamil ➔ kebutuh-an meningkat
- untuk menjaga kesehatan perempuan muda dewasa ➔ perlu 0,8 g protein/kg BB/hari

Cuplikan AKG rata-rata (per orang per hari)

Kelompok umur	Berat badan, kg	Protein, g
ANAK: 0-6 bln	6	10
1-3 th	12	25
7-9 th	25	45
PRIA: 10-12 th	35	50
16-18 th	55	65
19-29 th	56	60
WANITA: 10-12 th	37	50
16-18 th	50	50
19-29 th	52	50
HAMIL (tambahan)		+ 17
MENYUSUI (tambahan)		+ 17

Estimasi kebutuhan AA pada manusia (Burtis, dkk)

Asam amino	Kebutuhan (mg/kg berat badan/hari)			Pola AA protein bermutu baik (mg/g protein)
	Bayi	Anak-anak	Dewasa	
His	33	7	7	17
Ile	83	28	12	42
Leu	135	42	16	70
Lys	99	44	12	51
AA-S (Met+Cys)	49	22	10	26
AA aromatik (Phe + Tyr)	141	22	16	73
Thr	68	28	8	35
Trp	21	4	3	11
Val	92	25	14	48

Pengaruh kelebihan asupan protein

- Kenaikan lemak tubuh
- Kemungkinan disertai dengan asupan lemak yang juga tinggi (makanan tinggi protein umumnya kaya akan lemak)
- **Dehidrasi** → karena AA akan menga-lami deaminasi. Deaminasi → perlu air untuk ekskresi urea dalam urine

Jadi: kenaikan asupan protein harus disertai dengan peningkatan asupan air

- *Calsium loss* → bila asupan protein = 2 x AKG dalam setelah jangka waktu lama akan mengakibatkan osteoporosis

DEFISIENSI PROTEIN

Kwashiorkor (protein deficiency):

in the hospital, kwashiorkor occurs with insufficient dietary intake accompanied by the stress of major surgery, injury, or infection

Marasmus: deficiency disease from a lack of calories; ussualy other nutrients are deficient also

Tanda klinis kwashiorkor:

1. Kegagalan pertumbuhan (underweight)
2. Odema (terutama pada ½ bagian tubuh bagian bawah
3. Rambut mudah rontok, kasar, kemerahan
4. *Moon face*; rewel; nafsu makan ↓
5. Muntah dan diare.

Hasil lab.: albumin serum < 2,8 g/dL

transferin serum < 150 mg/dL

Akibat klinis: penyembuhan luka ↓

"immunocompetence" ↓

infeksi dan komplikasi lain ↑

Waktu kemunculan: beberapa minggu

Angka kematian: tinggi (umumnya akibat infeksi + komplikasi lain)

Tanda klinis marasmus

- Weight loss due to loss of muscle and fat (= very underweight = kurus kering, tinggal kulit pembalut tulang)
- Diminished skinfold thickness
- Reduced midarm circumference
- Old man's face
- No edema

♣ FAKTOR YANG MEMPENGARUHI PENGGUNAAN PROTEIN OLEH TUBUH

1. Keseimbangan AA

   Jenis dan jumlah AAE seimbang → penggunaan = efisien

2. Asupan energi

   Asupan kurang → sebagian AA akan di deaminasi

Asupan cukup → tingkat penggunaan tergantung pada mutu & kebutuhan protein

3. Imobilitas: kurang gerak → kebutuhan N menurun

4. Luka → ekskresi N naik

5. Stabilitas emosional: stress (takut, marah, kedinginan) → ekskresi N naik

SUMBER PROTEIN

- BAHAN MAKANAN SUMBER PROTEIN:

- Nilainya tergantung dari komposisi asam amino penyusunnya → jenis asam amino dan jumlah masing-masing asam amino
- Bila komposisi tersebut = komposisi asam amino kebutuhan tubuh → dikatakan: protein ybs memiliki MUTU YANG BAIK

- ***INCOMPLETE PROTEIN*** : tidak meng-andung AAE dalam jenis dan jumlah yang cukup untuk sintesis protein tubuh. Misal: zein pada jagung
- ***COMPLETE PROTEIN*****:** mengandung semua AAE dalam proporsi yang mampu menunjang pertumbuhan dan pemeliharaan jaringan bila digunakan sebagai sumber protein tunggal. Misal: glisinin (kedelai), glutenin (gandum), protein hewani kecuali gelatin

AAE = asam amino esensial, AA = asam amino

- ***PARTIALLY COMPLETE PROTEIN*** : mengandung semua AAE tapi dalam jumlah yang relatif kecil sehingga hanya cukup untuk pemeliharaan jaringan bila digunakan sebagai sumber protein tiunggal. Misal: gliadin (gandum)

↓

Supaya kebutuhan protein tubuh terpenuhi ➔ konsumsi makanan sumber protein sebaiknya berasal dari berbagai sumber sehingga AAE dapat saling melengkapi

TINDAKAN MENUJU *COMPLETE PROTEIN*:

1. Mencampur 2 sumber protein dengan *limiting AA* yang berbeda tapi saling mengisi ➔ KOMPLEMENTASI
   Misal: gandum (Lys↓ dan Met↑ di-campur dgn kedelai (Met↓ dan Lys↑)
2. Menambah *limiting AA* pada sumber protein ➔ FORTIFIKASI
3. Menambah *incomplete protein* dgn protein hewani ➔ SUPLEMENTASI

- *Complete protein* akan menjadi *partially complete protein* apabila dikonsumsi dalam jumlah SEDIKIT dalam diet
- ***LIMITING AMINO ACID***: asam amino dalam bahan makanan atau diet, yang terdapat dalam jumlah terkecil dibanding dengan jumlah yang diperlukan tubuh. Misal: lisin pada sereal

  metionin pada *legume*

  Penentuan *limiting amino acid* akan dibahas pada bahasan evaluasi mutu protein

Amount amino acid present

- X = ---------------------------------------

Amount amino acid required

- Limiting amino acid is the one with THE LOWEST ratio “X” for all essential amino acids in a food or diet (Guthrie, 1983 p. 72)

Asam amino pembatas beberapa bahan pangan

BAHAN PANGAN	ASAM AMINO PEMBATAS
Serelia	*Lysine & Threonine*
Legume	*Methionine, Tryptophan*
Kedelai, beras	*Methionine*
Biji *sesame*, biji bunga matahari	*Lysine*
Kacang tanah	*Methionine, Lysine, Threonine*
Sayuran berdaun hijau	*Methionine*

FOOD SOURCES

Food	Protein	Protein quality
Susu Keju Cottage Es krim	3,2 % 22,8 % 4,0 %	Complete Complete Complete
Daging,ikan, ayam Telur	6,4-25,2% 6 g per butir	Complete Complete
Sayuran Buah-buahan	0,4- 4,7 % 0,3 – 2,5 %	Incomplete Incomplete
Bread, wheat Macaroni, mie, Rice	2 – 3 g per slice 2 g per ½ cup, cooked	Incomplete (Lys) Incomplete (Lys) Incomplete (Lys & Thr)

EVALUASI
MUTU PROTEIN

- Nilai gizi (mutu) suatu protein ditentukan oleh

1. Kadar (%) dalam *food*
2. Kecernaan
3. Fungsinya dalam menunjang pertumbuhan dan pemeliharaan jaringan

- Protein yang mengandung semua AAE dalam proporsi yang baik (sesuai dengan kebutuhan tubuh) ➔ mutu = baik
- Complete protein ➔ AAE = 33%, AANE = 66%

- Kadar protein/AA yang tinggi → tidak menjamin sintesis protein tubuh berlangsung dengan baik
- Pengukuran *relative value* protein sebagai komponen diet = KOMPLEKS

METODA PENENTUAN MUTU PROTEIN

1. Metoda kimiawi:

   skor AA, Indeks AAE, CPER (*Calcu-lated Protein Efficiency Ratio*)

2. Metoda biologik:

   PER, BV (*biological value*), NPU (*net protein utilization*)

3. Metoda enzimatis (+ kimiawi)

   kecernaan (*digestibility*)

Metoda kimiawi:
SKOR ASAM AMINO

- TAHAPAN ANALISA:

1. Dilakukan analisa kadar semua AAE protein (dalam satuan: mg AA/g protein atau mg AA/g N)
2. Dilakukan penilaian : masing-masing AAE secara individual dibandingkan kadar AAE yang sama pada protein acuan

- Ratio masing-masing AA

mg AA dalam 1g protein yang diuji

= --

mg AA dalam 1g protein acuan

Atau

mg AA dalam 1g N protein yang diuji

= --

mg AA dalam 1g N protein acuan

↓

RATIO YANG TERKECIL = SKOR AA ➔ merupakan AA pembatas (*limiting AA*)

- TELUR & ASI → distribusi AAE pada telur dan susu ibu direkomendasikan oleh FAO untuk digunakan sebagai pola acuan ideal.
- Tetapi pada tahun 1973 diusulkan pola baru (lihat tabel)

PERBADINGAN POLA AA STANDAR FAO/WHO DENGAN SUSU IBU, SUSU SAPI, DAN TELUR (mg/g protein)

Asam amino	Pola SAA FAO/WHO 73	Susu ibu	Susu sapi	Telur
Histidine	*	26	27	22
Isoleucine	40	46	47	54
Leucine	70	93	95	86
Lysine	55	66	78	70
Metionine + Cystein	35	42	33	57

Asam amino	Pola SAA FAO/WHO 73	Susu ibu	Susu sapi	Telur
Phe + Tyr	60	72	102	93
Threonine	40	43	44	47
Triptofan	10	17	14	17
Valine	50	55	64	66
Total	360	434	477	490
+ histidine		460	504	512

Contoh soal (Pellet and Young, p.27):

Scoring pattern protein acuan (mg/g N)	Protein sereal (mg/g N)	Ratio AA sereal terhadap AA protein acuan
Ile : 250	225	0,90
Leu : 440	400	0,91
Lys : 340	150	➔ 0,44
Met + Cys : 220	240	1,09
Phe + Tyr : 380	390	1,03
Thr : 250	190	0,76
Trp : 60	70	1,17
Val : 310	300	0,97

SKOR ASAM AMINO = 0,44 → AA pembatas: lisin

Ada pula: SKOR KIMIAWI PROTEIN = 44 L

- Untuk meningkatkan skor AA → sereal (300g) dicampur dengan legume (100g) + susu bubuk (50g). BUKTI: MANA ?

	N, g/kg (a)	Komposisi dalam campuran, g (w)	N campuran, g $\frac{(w\ xa)}{1000} = n$
Sereal	20	300	6,0
Legume	35	100	3,5
Susu	54	50	2,7
TOTAL			**12,2**

Catatan: N_m = berat N mixture = N campuran

	AA individual, mg/g N (diketahui)				N_m, g (n)	mg AA individual dalam campuran (dihitung)			
	Lys (b)	SAA (c)	Thr (d)	Trp (e)		Lys nxb	SAA nxc	Thr nxd	Trp nxe
Sereal	150	240	190	70	6,0	900	1440	1140	420
Legume	460	150	260	85	3,5	1610	525	910	298
Susu	500	180	230	80	2,7	1350	486	621	216
TOTAL					12,2	3860	2451	2671	934
mg AA per 1 gram N protein campuran						316	201	219	77
ACUAN FAO 1973						340	220	250	60
Ratio AA campuran: acuan (lihat rumus) **JADI SKOR AA CAMPURAN = 0,88** **→ AA pembatas = treonin**						0,93	0,91	0,88	1,28

Metoda biologik:

1. Protein Efficiency Ratio / PER

- Prinsip: pertambahan berat badan tikus vs waktu

→ Sebenarnya pertambahan berat badan tersebut tidak hanya didukung oleh protein saja, melainkan merupakan resultante dukungan semua unsur gizi dalam diet

- Digunakan: tikus sapihan (usia 21 hari), jantan, satu jenis (misal: Wistar)
- Ada kelompok standar: kasein
- Kandang: individual; 10 ekor/kelompok
- Sebelum dimulai, ada masa adaptasi 4 hari → lama uji 28 hari

- Ransum: *ad libitum* → komposisi: lihat tabel
- Selama pengujian, tikus ditimbang secara periodik (misal: 7 hari sekali)
- Setiap hari, pakan diganti → sisa pakan ditimbang → utk menghitung konsumsi pakan

Komposisi ransum untuk uji PER

Komponen	Kadar (%)
Protein	10
Minyak	8
Serat	1
Air	5
Vitamin mix	1
Mineral mix	5
Pati jagung	70

Rumus PER:

- $$PER = \frac{\text{gram pertambahan berat badan}}{\text{gram protein yang dikonsumsi}}$$

- Standar: PER kasein = 2,5

- $$\text{PER terkoreksi} = \frac{2{,}5}{\text{PER kasein}} \times \text{PER uji}$$

Langkah pembuatan ransum (misal: kedelai)

1. Dilakukan analisis komposisi kedelai dan kasein standar. Misal pada kedelai:

   protein = A % mineral = D %

   air = B % serat = E %

   minyak = C %

   Karbohidrat = (100-A-B-C-D-E) % = F %

2. Dilakukan analisis kadar air pati jagung ➔ misal = G %

3. Menghitung kebutuhan ransum:

a. Ransum kasein standar =

(10x28x12,5) + (20x4x12,5)g = 4.500g

b. Ransum kedelai =(10 x 28 x 12,5) g = 3.500 g → membuat 3.750 g

4. Kedelai yang harus disediakan (untuk ransum dg protein = 10%)

= (100/A) x (10/100) x 3.750 g = P g

5. Dalam P g kedelai, terkandung:

a. Air = (B/100) x P g = Q g
b. Minyak = (C/100) x P g = R g
c. Mineral = (D/100) x P g = S g
d. Serat = (E/100) x P g = T g
e. Karbohidrat = (F/100) x P g = U g

Banyaknya air, minyak, mineral, serat, dan karbohidrat tersebut harus diperhitungkan.

- Minyak yang ditambahkan untuk ransum = {(8% x 3.750) - R} g
- Mineral mix yang ditambahkan untuk ransum = {(5% x 3.750) - S} g
- Serat = {(1% x 3.750) - T} g
- Pati jagung = {[(70% x 3.750) - U} g = Z g
- Air = {(5% x 3.750) – Q – (G% x Z)} g

Hal yang sama juga dilakukan terhadap kasein

- Dalam uji PER, analisis kadar protein umumnya memakai metoda Kjeldahl ➔ % protein = % N x faktor konversi
- Faktor konversi ➔ serealia = 5,83; susu = 6,38; umum = 6,25
- Ingat: SCP (“*single cell protein*”) ➔ banyak mengandung asam nukleat ➔ faktor koreksi sebesar 6,25 tak dapat dipakai ➔ faktor konversi bisa sp 9,0

2. NILAI BIOLOGIK (“biological value” / BV)

- Mengukur hubungan antara retensi protein (oleh tubuh) vs absorpsi protein
- Dasar: bila AA berada dalam jenis dan jumlah yang cukup untuk memenuhi kebutuhan tubuh, maka retensi protein akan tinggi
- Lama uji: 28 hari, kandang: metabolit

- Thomas (1909):

$$BV = \frac{N\ \text{tertahan}}{N\ \text{terabsorpsi}} \rightarrow \text{sulit dilakukan}$$

- Mitchell (1923):

$$BV = \frac{I - \{(F - Fo) + (U - Uo)\}}{I - (F - Fo)}$$

- Catatan simbol:

1. I = “*intake*” = asupan
2. F = N feses
3. U = N urine
4. Fo = N feses bila subyek dipertahan-kan pada diet bebas N
5. Uo = N urine bila subyek dipertahan-kan pada diet bebas N

- Bila tanpa Fo dan Uo ➔ merupakan BV semu (“*apparent BV*”)
- BV: ↑ berarti N yang tetap tinggal da-lam tubuh: ↑ ➔ protein mengandung AA dengan jenis dan jumlah yang sesuai dengan kebutuhan tubuh
- BV telur = 87-97; susu = 85-90; beras, tahu = 75
- BV $\geq$ 70 ➔ dianggap mampu menun-jang pertumbuhan, bila asupan energi: cukup

3. Net Protein Utilization (NPU)

1. 1.Teknik nitrogen tubuh

- Oleh Binder & Miller (1953)
- Langsung digunakan karkas tikus jantan, strain sama, sapihan.
- Ada 2 grup: grup non-protein 10 ekor
  grup protein 10 ekor
- Lama uji: 10 hari (tidak termasuk 4 hari adaptasi)

- Pada akhir masa uji, tikus dibunuh, dibelah, dikeringkan, dihancurkan, dan dilakukan analisis kadar N
- Rumus:

$$\text{NPU} = \frac{\text{(N tubuh grup protein – N tubuh grup non-protein}}{\text{konsumsi N grup protein}}$$

2. Secara perhitungan

- Tikus: 5 – 10 ekor / grup
- Lama uji: 5 – 10 hari, tak tms adaptasi
- Kandang: metabolik ➔ urin dan feses dikumpulkan setiap 2 hari sekali, disimpan di almari es. Di akhir uji ➔ dioven, dihaluskan, dianalisis N total

$$NPU = \frac{I - \{(F - Fo) + (U - Uo)\}}{I}$$

- Hubungan antara BV dan D (*digestibi-lity*):

$$D = \frac{I - (F - Fo)}{I}$$

NPU = BV x Digestibility

- Hubungan antara skor AA dan NPU
- Ligika: bila skor AA ↑ maka NPU juga ↑ ➔ hanya betul bila D juga ↑
- Lebih menguntungkan untuk menghu-bungkan skor AA dengan D sehingga estimasi pemanfaatan protein oleh tu-buh lebih mendekati fakta
- Perkiraan pemanfaatan protein oleh tubuh = skor AA x D

- Contoh:

	Skor AA	NPU
Protein telur	1,00	0,95
Protein biji kapas	0,81	0,41 → berarti ada AA yang tidak available

4.Net Protein Ratio (NPR)

- Memperhitungkan fungsi protein sebagai pemelihara jaringan
- Lama uji: 10 – 14 hari
- Ada 2 grup:

\- grup dengan ransum protein (10%)

\- Grup dengan ransum non-protein

- Rumus NPR (Pellet & Young, p.48):

$$NPR = \frac{\text{pertambahan BB grup prot.} - \text{penurunan BB grup non-protein}}{\text{konsumsi protein yang diuji}}$$

$$\text{Relative NPR} = \text{R NPR} = \frac{\text{NPR protein uji}}{\text{NPR standar}}$$

Contoh soal:

	Rerata pe+ BB (g)	Rerata konsumsi ransum (g)	N ransum (%)	NPR	R NPR
Laktalbumin (= standar)	69,7	249,2	1,3	4,04	1,00
Protein A	63,2	243,6	1,57	3,15	0,78
Protein B	11,7	125,3	1,89	1,89	0,47
Non- protein	– 12,1	90,3	0		

$$\text{NPR laktalbumin} = \frac{(69{,}7 + 12{,}1)}{(249{,}2 \times 1{,}3 \times 6{,}25) / 100} = 4{,}04$$

R NPR protein A = (3,15): (4,04) = 0,78

Metoda enzimatis-kimiawi: kecernaan protein

1. Menggunakan enzim pepsin-pankreatin

- Prinsip:

  Protein — $\boxed{\text{digesti oleh protease}}$ → fragmen yang larut ➔ analisis N terlarut

- Pepsin → pH aktivitas = 2 ± 0,5
- Pankreatin → pH aktivitas = 7,5

Sampel (pH=2±0,5)— Inkubasi 37^{o}C,2jam → Ana-lisa N terlarut *

+ pepsin

Inkubasi 37^{o}C, 2 jam

* menggambarkan digesti di lambung

+ $NaHCO_3$ sampai pH = 7,5

+ pankreatin

Inkubasi 37^{o}C, 2 jam

Analisa N terlarut

(menggambarkan digesti di usus usus halus)

- Rumus kecernaan:

$$\text{Kecernaan} = \frac{\text{N terlarut}}{\text{N total sampel}} \times 100\%$$

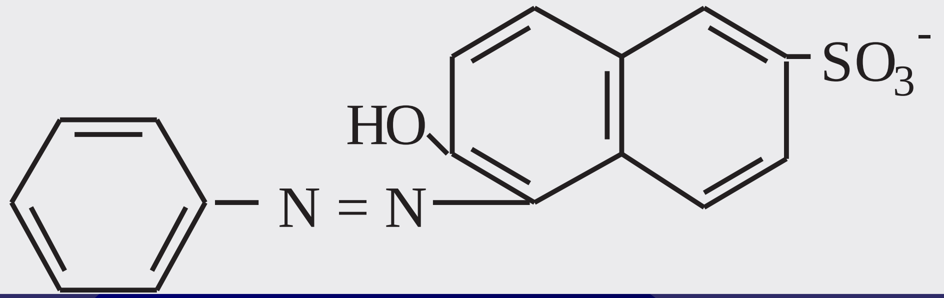
- Sebelum analisa N terlarut ➔ dilakukan penghentian proses digesti ➔ cara: + TCA 20%
- Pemisahan fargmen larut + tak larut ➔ sentrifugasi + penyaringan/dekantasi

Ketersediaan asam amino

- Penggunaan suhu tinggi (misal dalam pengeringan susu) ➔ terjadi kerusakan lisin ➔ lisin menjadi tidak "*available*".
- Lisin yang available dapat bereaksi de-ngan FDNB (1-fluro-2,4-dinitrobenzen)
- FDNB-lisin ➔ dapat ditera pada A_{435}.
- Contoh kejadian: lihat tabel

Dye Binding Method

Acid Orange 12:

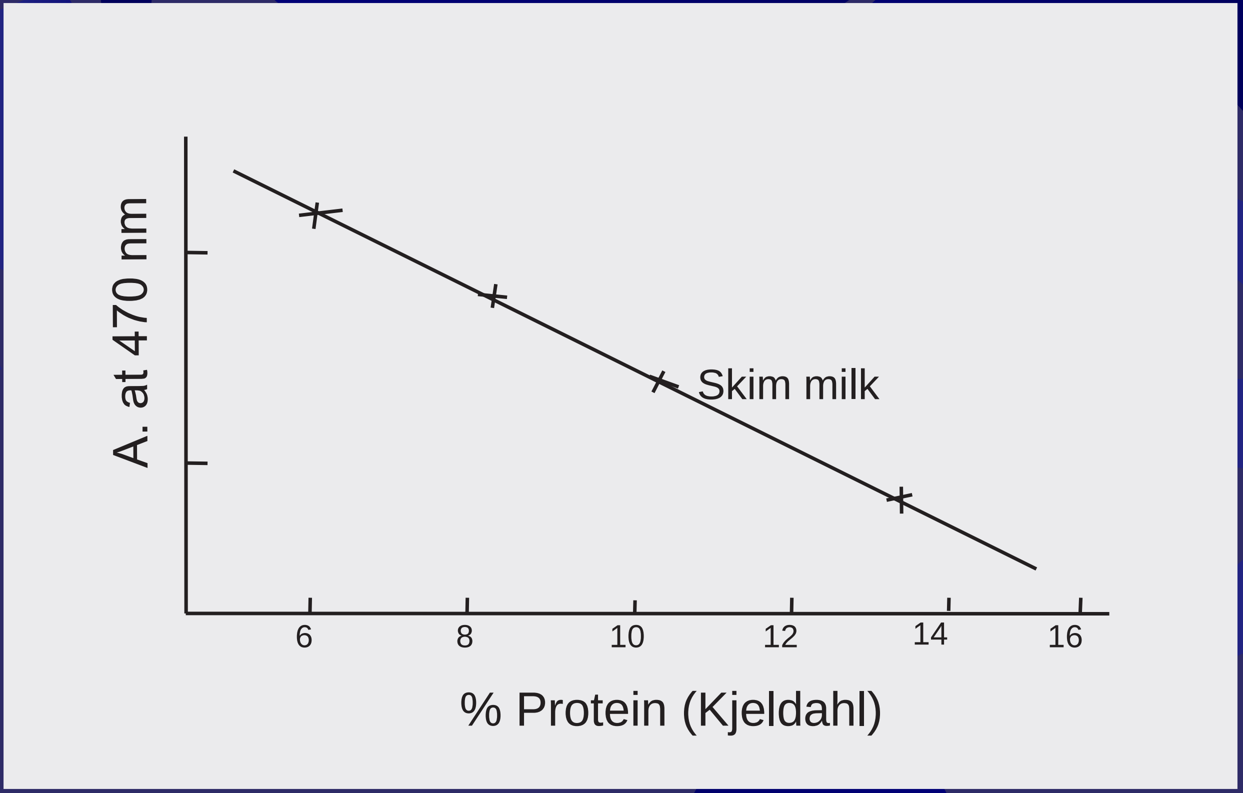


Procedure:

1. Mix protein, dye, buffer pH = 2.
2. Filter or centrifuge.
3. Measure optical density (O.D.) of filterate.

Dye Binding Method

Abosrbance of dye bound by protein A dye initial - A. filterate



Dye Binding Method

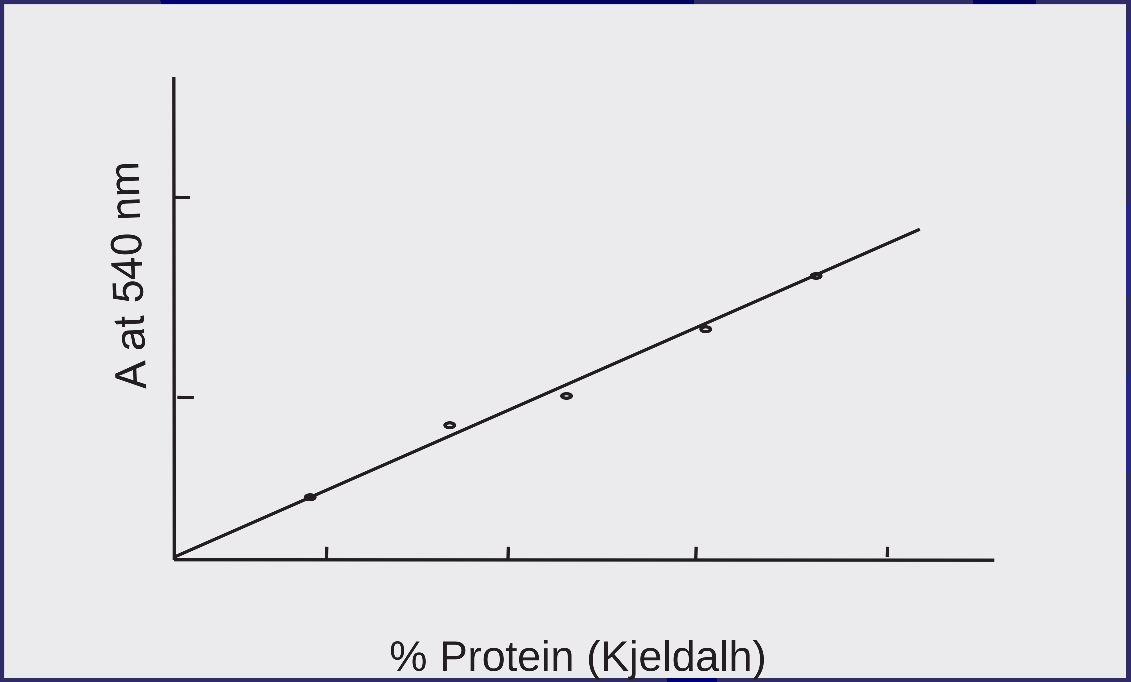
Factors Influencing Dye Binding determination:

1. Temperature
2. Non-proteins.
3. Buffers systems.
4. Protein quality.

3. Biuret Method

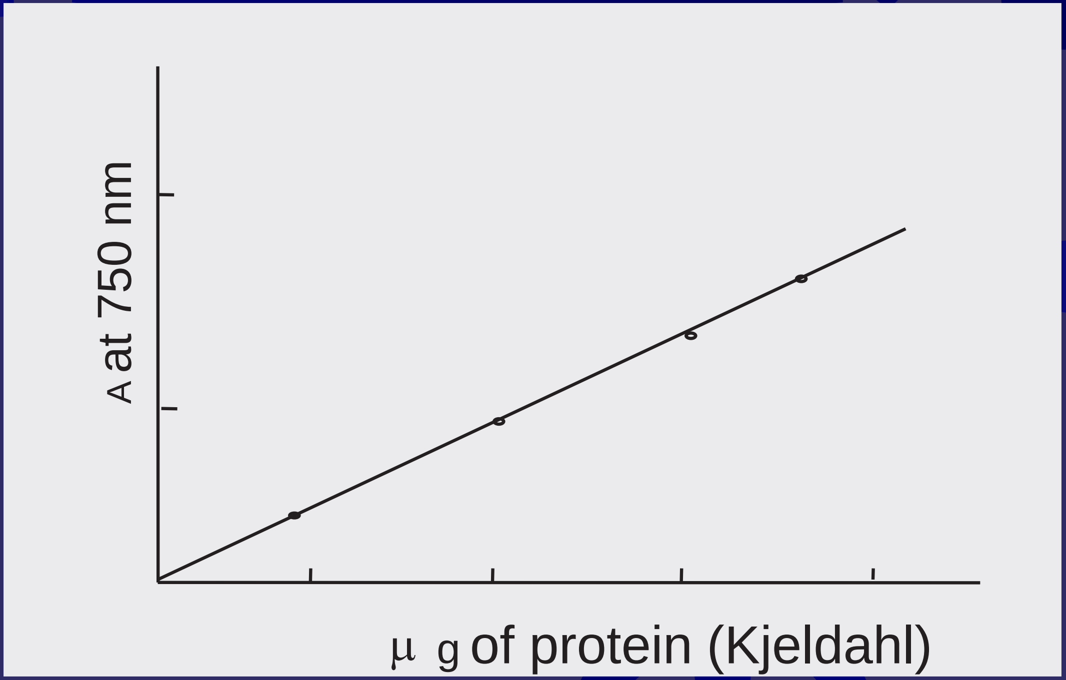
Principles: Cu++ in alkaline solution form complexity with peptide bonds - give pinkish-purple color.

Measure the intensity of color at 540 nm.



4. Lowry Method: (one of most sensitive methods)

- Cu^{++} in alkaline solution to form complexity with protein.
- Cu++ catalyses oxidation of phenol group of tyrosine with phosphomolybdic-phosphotungstic acid.



5. Ultra-violet Absorption (UV) at 280 nm

1. Chromophoric side chains of aromatic amino acids (Trosine, Tryptophan).
2. Absorption at 280 nm. "Non-destructive means to determine protein".
3. Calculation protein conc. based upon absorption

6. Fluorescence Method

Tyrosine is a fluorescent compound.

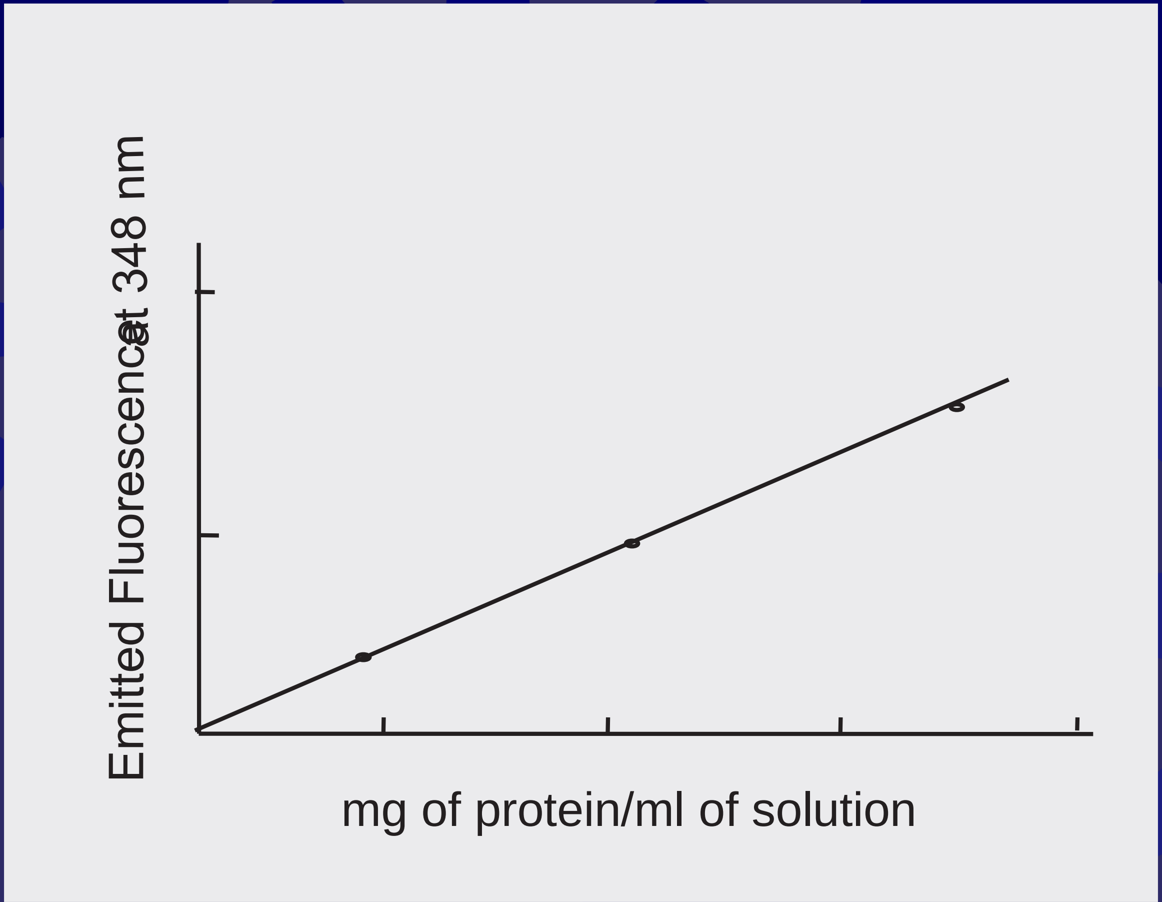
Tryptophane is a fluorescent compound.

Excite the amino acids at 280 nm.

Measure emission at 348 nm.

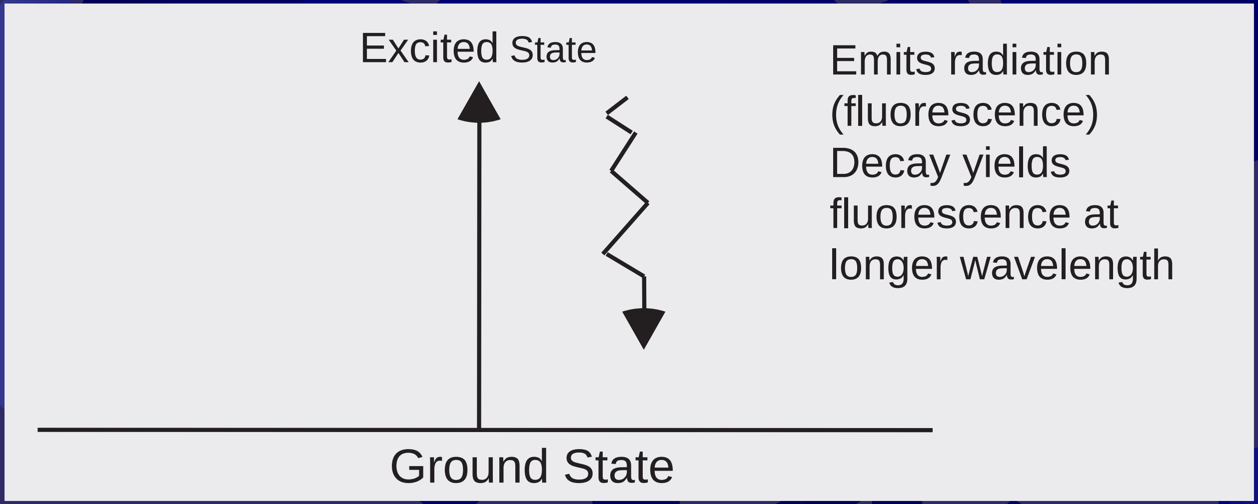
Advantage: more sensitive than UV absorption.

Fluorescence Method



Fluorescence Method

What is fluorescence and how to measure it?



By using specific λ (wavelength) to excite and measure output at a specific λ. It is rather specific.

Problems: Turbidity/Quenching (self or others)/Expensive/ Quantitation is difficult.

Amino Acid Determination

A. Hydrolysis

1. Overnight in 6 M HCl at 100 C.
2. Enzymes.

B. Separation by ion exchange.

Some Important Reactions of Proteins

Denaturation

Changes in 2o, 3o, 4o structure.

By heat.

Heavy metals (Hg is most common).

pH (trichloroacetic acid, phosphotungstic acid)

Salt (NaCl or ammonium sulfate $[NH_4]_2\ SO_4$)

Reasons for Precipitating Proteins

1. Purify, concentrate protein.
2. Remove protein which cause: turbidity/emulsion/troublesome.

Protein Denaturation

<u>Manifestation of Denaturation</u>

1. Decreased solubility.
2. Alteration of size and shape
3. greater reactivity
4. Decreased biological activity (enzyme + immune proteins)
5. Increased sensitivity to electrolytes.
6. Nutritive value.

What is essential amino acids?

Amino acids which the body cannot make (or make enough of) for protein synthesis due to lack of enzymes.

Essential Amino Acids:

Histidine,	Isoleucine,	Leucine
Lysine,	Methionine,	Phenylalanine
Threonine,	Valine	

Limiting amino acid is the essential amino acid which is lacking in the protein to have a balanced protein.

Product	**Limiting Amino Acid**
Corn	Lysine
Oats	Lysine
Rice	Lysine
Wheat	Lysine
Sesame Seed	Lysine
Cow’s Milk	Methionine
Potato	Methionine
Chick Pea	Methionine
Green Pea	Methionine
Cotton Seed	Isoleucine
Beef	Valine
Chicken	Tryptophan

PROTEIN QUALITY DETERMINATION

1. Protein Efficiency Ratio.
2. Biological Value.
3. Net Protein Utilization.

What are the measurements of protein quality?

For labeling purposes, one needs to know the protein efficiency ratio.

1. If PER = casein (2.5), the RDA = 45 g/day.
2. If 0.5 < PER < 2.5, then RDA = 65 g/day.
3. If PER < 0.5 (20% of casein), then “not a significant source of protein”.

How does one determine PER?

1. Male lab rats ε 21 days, ≤ 28 days of age, at least 10 rats/group.

2. Feed a standardized diet containing salt mix, vitamins, cotton seed oil, cellulose, starch or sucrose + water for 28 days.

3. Measure weight gain and food intake at regular intervals, not > 7 days.

4. PER = Weight Gain/Gram of Protein in Diet.

5. Usually normalized for casein = 2.5.

6. Determine protein quality of sample as ratio of sample PER to reference casein PER.

Protein Efficiency Ratio = Gain in weight per gram protein taken.

Protein Efficiency Ratio for Different Foods

Product				PER
Rice	100%			2.30
Rice	70%	Black Beans	30%	2.70
	50%		50%	2.60
	20%		80%	1.30
			100%	NIL
Corn				
	+ 0.4% Lysine			
	+ 0.07% Tryptophan			2.14
Corn (50%) + Black Beans (50%)				2.05

.

Protein Efficiency Ratio for Foods

Product	PER
Soybean	2.32
Cotton Seed Meal	2.25
Egg	3.90
Chick Peas	1.68
Peanuts (ground nuts)	1.65
Kidney Beans	0.88

OTHER PROTEIN QUALITY DETERMINATION METHOD

Biological Value (BV)

Net Protein Utilization (NPU)

BV = Retained Nitrogen (nitrogen intake - fecal & urinary nitrogen)/Absorbed Nitrogen (nitrogen intake - fecal nitrogen)

NPU = Retained Nitrogen/Intake Nitrogen = BV × Digestibility

CONTOH (laki-laki dewasa 70 kg)

Asam amino	**AKG, mg/hari**	PROTEIN A		PROTEIN B	
		56 g	X	56 g	X
Thr	560	700	>1	600	>1
Ile	840	800	0,95	700	0,83
Lys	840	900	>1	900	>1
Trp	210	300	>1	300	>1
Leu	1.120	950	0,84	950	0,84
Met	700	950	>1	200	→ 0,21
Val	980	700	→ 0,71	700	0,71
Phe	1.120	850	**0,76**	850	**0,76**

- Asam amino dengan nilai X TEREN-DAH diantara semua AAE dalam *food*/diet disebut *LIMITING AMINO ACID*
- Pada contoh: METIONIN = limiting AA dari protein B
- *Complete protein* akan menjadi *partially complete protein* apabila dikonsumsi dalam jumlah SEDIKIT dalam diet

AIR

SEBAGAI ZAT GIZI, PERAN DALAM METABOLISME DAN KECUKUPAN KONSUMSI AIR

Matakuliah ILMU GIZI DAN KESEHATAN

WAHIDAH MAHANANI RAHAYU, S.T.P., M.Sc.

TEKNOLOGI PANGAN

UNIVERSITAS AHMAD DAHLAN

Konten

- AIR SEBAGAI ZAT GIZI
- PERAN AIR DALAM METABOLISME
- KECUKUPAN KONSUMSI AIR

Air sebagai zat gizi/nutrient

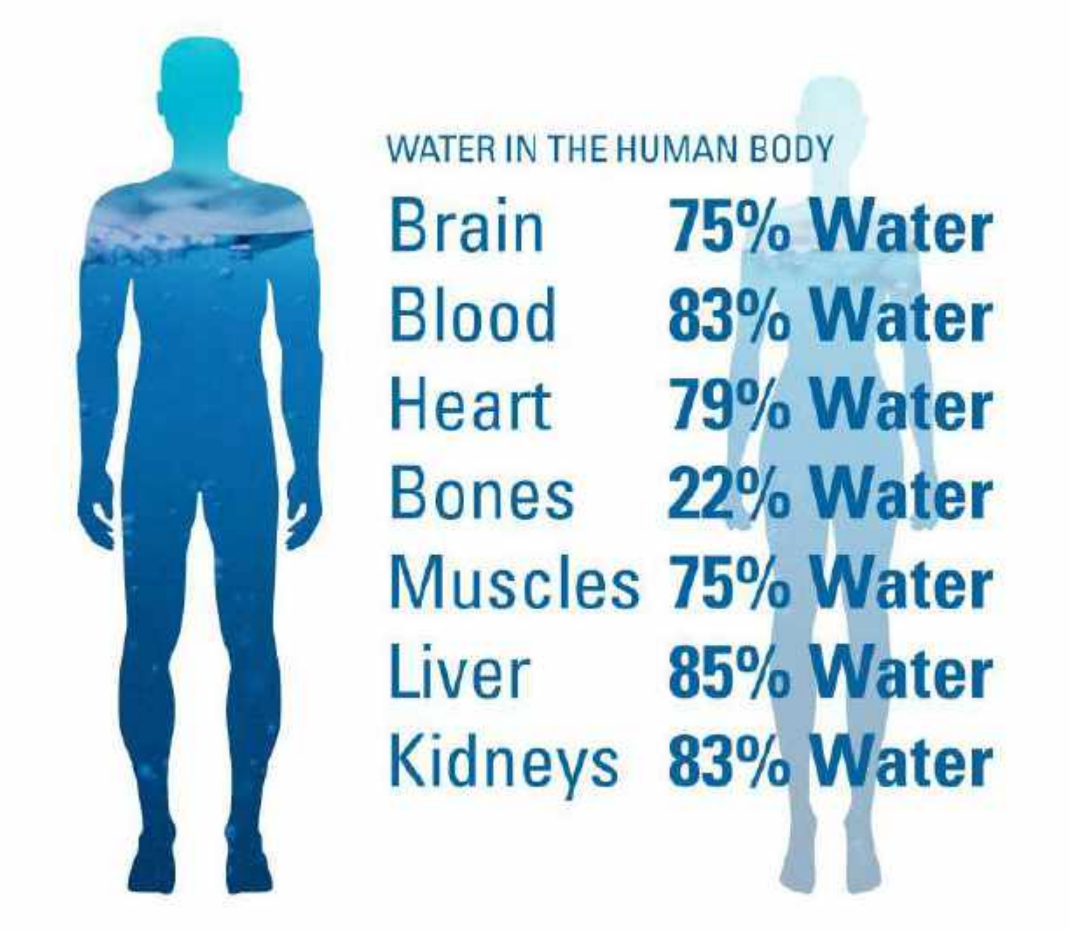
- Zat gizi adalah bahan-bahan yang diambil dari lingkungan → diperlukan organisme untuk BERFUNGSI NORMAL, untuk hidup dan tumbuh normal → AIR adalah bahan penting yang kita butuhkan dan kita ambil dari lingkungan
- Zat gizi

Air sebagai zat gizi/nutrient

- Do we really need water?
- Tanpa makanan dan hanya dengan air → 2 bulan
- Tanpa air 9-12 hari → manusiakehilangan 20% berat badan → batas manusia bisa hidup
- Water is the **most important** macronutrient

Tahukah Anda?

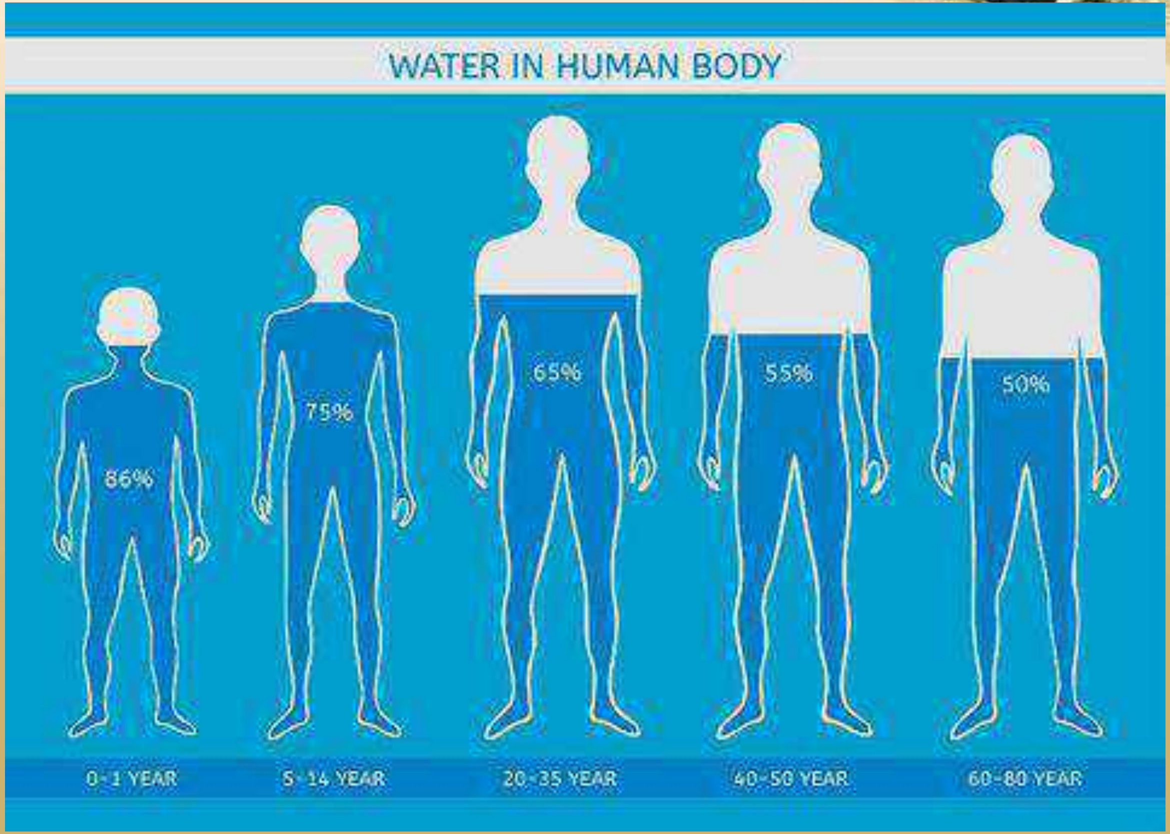
½ - ¾ komposisi tubuh manusia adalah air?



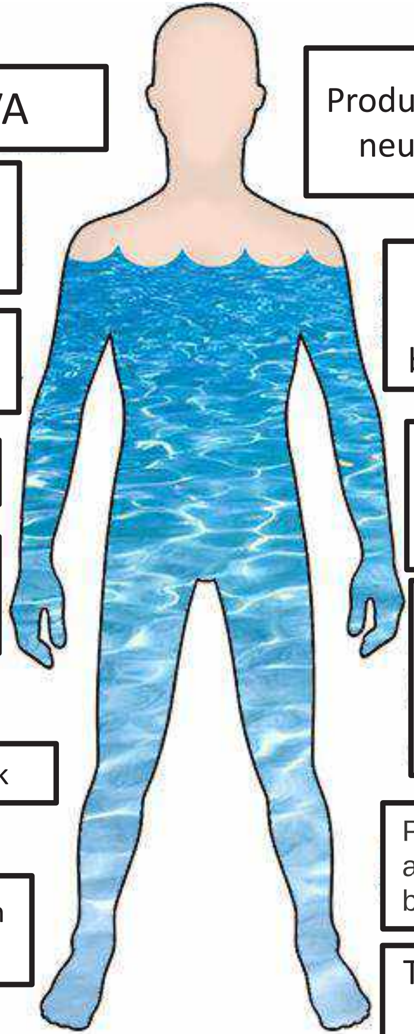
Komposisi berbeda seiring usia

- kesimpulan:

anak-anak membutuhkan air lebih banyak daripada orang dewasa



Peran air dalam tubuh manusia



- Main component of most cells
- Necessary for growth and reproduction
- Aids digestion

Fungsi penting lainnya

- Optimal cognitive performance
- Mengurangi kanker dan batu ginjal
- Menjaga kondisi pasien penyakit degeneratif
- Mengurangi kalori intake dari fluid
- Optimal celullar organ

Water balance

Metabolism 400 ml

Solid food 500 ml

Fluids 1500 ml

in

out

Keringat 400 ml

Uap air di nafas 400

Urin 1500 ml

Water balance

Ketika kita minum, air tidak langsung masuk ke jaringan, menunggu sekitar 10 – 15 menit untuk masuk ke plasma darah, lalu dibawa ke jaringan

in

out

Padahal air keluar lewat keringat dan nafas

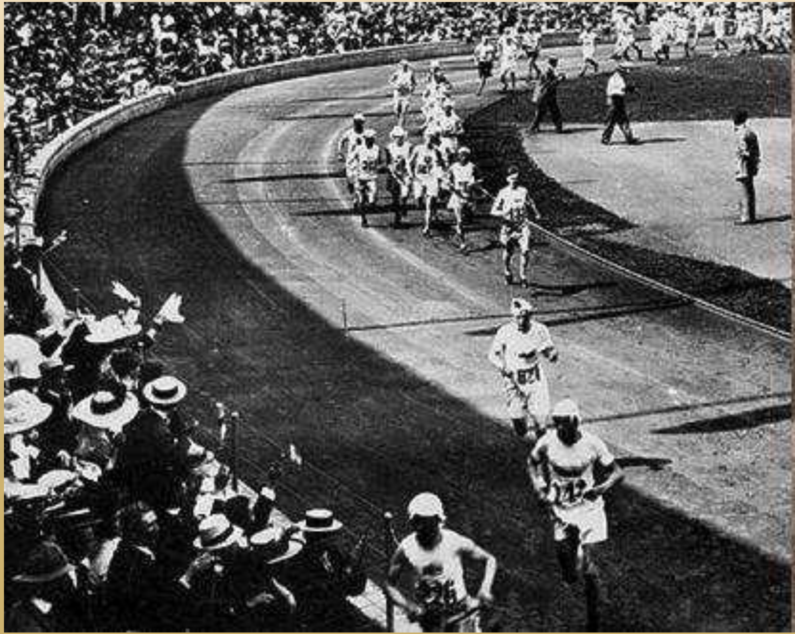
Jika kita menunggu minum hingga haus → thermal regulation tidak bagus → kita perform lower

Keringat dan urin itu penting!!

- Sweat is important for body dynamics
- Pengurangan air melalui keringat dan urine akan menciptakan mekanisme keseimbangan dan stabilitas suhu tubuh
- HAUS → penanda bergesernya keseimbangan pemasukan dan pengeluaran air

Fransisco Lázaro (1891-1912) atlit olimpiade Portugis

- Lázaro **was the first athlete to die during a modern Olympic event** → collapsing at 30 km mark (19 miles) of marathon → body temperature of 41 °C.



Fransisco Lázaro (1891-1912) atlit olimpiade Portugis

- Dia berpikir bahwa semakin banyak berkeringat, maka kecepatan larinya menurun → mengoleskan semacam minyak/lilin ke seluruh tubuh agar tidak berkeringat.
- Ambruk pada km ke 30 karena **hipertermia**, suhu tubuh 40^0C → keesokan paginya dia mati
- Before the race, he had supposedly said: "Either I win or I die."

JANGAN MENUNDA MINUM

- Hasil riset:
- Segera setelah kita minum, level haus menurun hingga 0 hingga 5 menit
- Padahal level plasma darah baru akan menurun 10-15 menit kemudian
- Kesimpulan: MINUM dapat membuat kita merasa lebih baik → bahkan meski air belum masuk ke jaringan tubuh

JANGAN MENUNDA MINUM

- Hasil riset:
- Orang tua lebih rentan dehidrasi → tidak mudah merasakan haus dibandingkan anak muda → langsung minum ketika haus
- Kenapa kita **tidak langsung merasa haus** meski sebenarnya tubuh kurang air?
- Our body tent to survive → dulu saat fasilitas air kurang → 0,5 % dehidrasi kita bisa merasa gila karena haus → hewan akan membahayakan hidupnya bahkan untuk minum air
- Sekarang kita mudah memperoleh air → MAGER ambil air
- Semakin gelap warna kuning urin kita → semakin dehidrasi

PENGATURAN ASUPAN AIR & CAIRAN

- Faktor apa saja yang mempengaruhi: umur, Aktivitas, lokasi, pola makan
- Misalnya: di cina rekomendasinya lebih rendah dari Indonesia karena tiap makan mengkonsumsi sup

Riset Departemen Kesehatan RI

- Masalah kekurangan air:
- Jakarta 40,9%
- Jatim 48%
- Sulsel 49,9%

(Dr. Ir. MINARTO, MPS.; DIREKTUR BINA GIZI MASYARAKAT, DEPKES)

Orang Indonesia mengkonsumsi cairan terbanyak dari air putih (1,8 L/hari)

Kekurangan konsumsi vs berlebihan air

- KEKURANGAN AIR
- Dehidrasi
- Haus
- Urin warna kuning gelap
- pusing
- Lemas
- Kepala berkunang-kunang

Kekurangan konsumsi vs berlebihan air

- BERLEBIHAN AIR
- INTOKSIKASI

- Drinking too much water is uncommon.
- consuming excessive amounts of water in a short time → 4 liter air kurang dari 2 jam → bahaya, bisa menyebabkan kematian
- Air melarutkan sodium dari darah → kurang sodium → keseimbangan elektrolit terganggu

Intoksikasi air

Kasus terkenal

13 Januari 2007, Jennifer Strange (28 thn) asal California → kontes minum air diselenggarakan Nintendo game → 6 liter air, 3 jam → pusing → beberapa jam kemudian meninggal

Penentuan kebutuhan air

1. berdasarkan keseimbangan air tubuh (air masuk = air keluar) pada orang sehat
2. berdasar luas permukaan tubuh, berat badan, umur
3. berdasar asupan energi (kal): pada Aktivitas fisik ringan dan suhu normal
4. berdasar median asupan air subjek yang sehat
5. pada bayi berdasarkan ml produksi ASI (95% air) eksklusif bagi bayi sehat 0-6 bulan
6. Iklim → suhu dan RH udara

Suhu lingkungan dan suhu tubuh

- Suhu tubuh → 37°C
- Suhu tubuh terlalu tinggi →kerusakan jaringan
- Untuk mencegah kerusakan jaringan→ berkeringat.
- Evaporasi → menurunkan suhu tubuh
- Udara panas atau demam → lebih banyak berkeringat
- Saat olahraga, cuaca panas, demam → minum air lebih banyak.
- Cuaca dingin → sering buang air kecil → tetap harus minum untuk memenuhi kebutuhan air

Kebutuhan air harian

- Faktor penentu kebutuhan air:
- Usia
- Berat badan
- ukuran badan
- Aktivitas
- Cuaca

Kebutuhan air harian

- Umumnya, orang membutuhkan 1.5–2 liter air per hari
- Sumber?
- Air terbaik → bersih, bebas mikrobia, bebas gula, tanpa zat tambahan apapun, pH netral
- Lainnya?
- soft drink rendah gula, susu, jus buah, teh, kopi, dll, panas/dingin
- Sekitar 20–30% air → dari makanan
- Makanan berkuah, sayuran dan buah berair
- 70 – 80% from drinks and drinking water

Ditentukan ukuran tubuh

- Semakin besar ukuran tubuh kita, semakin luas permukaan, semakin tinggi evaporasi → Body Surface Area/luas permukaan tubuh
- Tiap 1 m^2 luas permukaan, seseorang butuh 1,5 liter air (Minarto, 2012).

$$BSA\ (m^2) = \sqrt{\frac{\text{tinggi (cm)} \times \text{berat (kg)}}{3600}} \quad \text{(Mosteller, 1987)}$$

Kebutuhan air (ml) = BSA x 1500 ml

Ditentukan ukuran tubuh

Contoh:

$$\text{BSA } (m^2) = \sqrt{\frac{\text{tinggi (cm)} \times \text{berat (kg)}}{3600}} = \sqrt{\frac{160{,}5 \times 61{,}3}{3600}} = 1{,}65$$

Kebutuhan air = 1,65 x 1500 ml = 2479,75 ml atau sekitar 2,5 liter air

Kebutuhan secara umum

- Widyakarya Pangan dan Gizi Indonesia 2004
- **Rekomendasi WKGI** sebesar 40 ml/kg BB

Kebutuhan air (ml) = 40 x BB (kg)

(Proboprastowo, 2004)

Contoh

KA (ml) = 40 x 61,3 = 2452 ml atau sekitar 2,5 ml air

Kebutuhan secara umum

- Lansia → 1500 ml air
- Jika berlebihan → hyponatermia (kelebihan air) → bahaya bagi ginjal yang sudah lemah
- 1,8 liter untk Indonesia dan Filipina
- 2,4 liter di USA → kebutuhan air orang dewasa
- Kebiasaan makan, ukuran tubuh

Konsumsi air kita??

- Sering-sering, sedikit-sedikit (masing-masing 200 ml atau segelas air)
- Jangan menunggu haus
- Puasa?
- Sering minum air di malam hari

SUDAH MINUM BERAPA LITER AIR HARI INI??