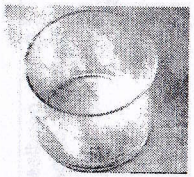
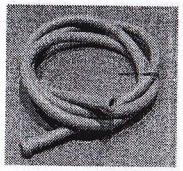
Materials

intestine model:



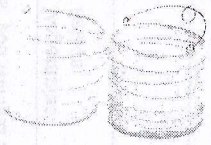
cylindrical glass



elastic hose (ca.4 m long / Ø 3 cm)

⇨ hose should fit into glass as good as possible

Lampion model:



3 paper ones, if possible same colour as hose!

On board:

Human small intestine

⇨ ca. 4 m long / Ø 3 cm !

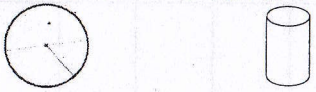
⇨ digestion and absorption of nutrients !

⇨ the larger the (inner) surface the better the absorption !

FORMULAS CYLINDER

Circle: $U = \pi d$ / $A = \pi r^2$

surface: $O = 2A + M$ / $M = \pi d h$

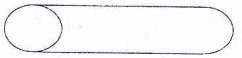


ASSUMPTIOM SURFACE

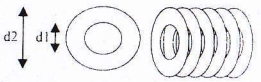
e.g. 2 m²/ 5 m² / 12 m² / 50 m²

Segments for overhead:

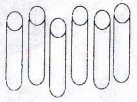
a) SMALL INTESTINE AS TUBE:
length: 4 m / diameter: 3 cm
CALCULATION:



b) CIRCULAR FOLDS:
height: 1 cm => d1 = 1 cm / d2 = 3 cm
ca. 600 along the whole small intestine!
CALCULATION:



c) finger-like **INTESTINAL VILLI:**
Height: 1mm / diameter: 0,06 mm
Along the whole surface: ca. 1 mm² ~ 40 villi
CALCULATION:



CARRY OVER of b)

d) microscopic / hair-like **MICRO VILLI:**
height: 1,5 µm / diameter: 0,03 µm
on ca. 1mm² ~ ca. 200 million mikro villi
CALCULATION:

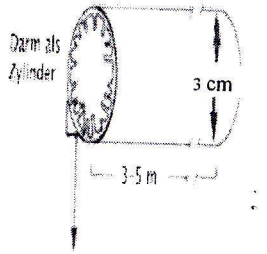
CARRY OVER of c)

Worksheet mathematics and biology Name:_____ Class: ____

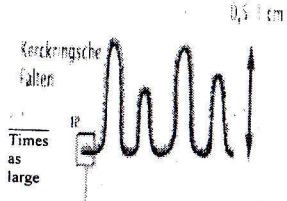
Surface of small intestine

Area: Middle of lower belly => between stomach and colon => lots of slings => thickness ca. 2,5 – 3,5 cm / length: 3-5 Meter => longest part of digesting system
Function: mainly digesting food and absorbing nutrients => the larger the surface the better the absorption!

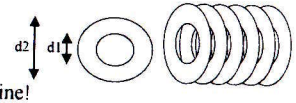
3 parts:
a) duodeneum ca. 25–35 cm ; b) jejunum ca. 1–2 m; c) ileum ca. 2–3 m
Inner layer:
Ideal: maximum surface => ENLARGING SURFACE in three different ways/ foldings

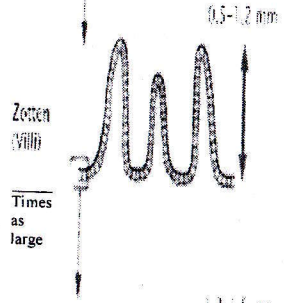


a) SMALL INTESTINE AS TUBE:
length: 4 m / diameter: 3 cm
CALCULATION:

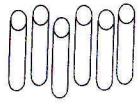


b) CIRCULAR FOLDS:
height: 1 cm => d1 = 1 cm / d2 = 3 cm
ca. 600 along the whole small intestine!
CALCULATION:

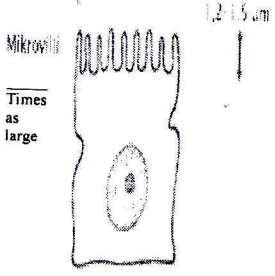




c) finger-like **INTESTINAL VILLI:**
Height: 1mm / diameter: 0,06 mm
Along the whole surface: ca. 1 mm² ~ 40 villi
CALCULATION:



CARRY OVER of b)



d) microscopic / hair-like **MIKRO VILLI:**
height: 1,5 µm / diameter: 0,03 µm
on ca. 1mm² ~ ca. 200 million mikro villi
CALCULATION:

CARRY OVER of c)

SURFACE OF WHOLE INTESTINE: _____ m²

Worksheet mathematics and biology Name:_____ Class: ____

Surface of small intestine

Area: Middle of lower belley => between stomach and colon => lots of slings => thickness ca. 2,5 – 3,5 cm / length: 3-5 Meter => longest part of digesting system
Function: mainly digesting food and absorbing nutrients => the larger the surface the better the absorption!

3 parts:
a) duodeneum ca. 25–35 cm ; b) jejunum ca. 1–2 m; c) ileum ca. 2–3 m
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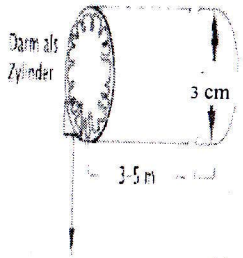
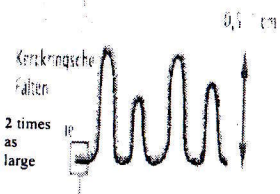
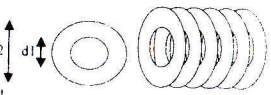


a) SMALL INTESTINE AS TUBE:
length: 4 m / diameter: 3 cm
CALCULATION:

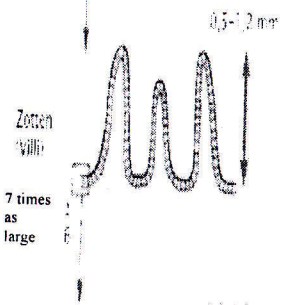
d =3 cm = 0,03 m
lateral area of cylinder: $M = \pi * d * l = \pi * 0.03\ m * 4\ m = \underline{\mathbf{0,38\ m^2}}$



b) CIRCULAR FOLDS:
height: 1 cm => d1 = 1 cm / d2 = 3 cm
ca. 600 along the whole small intestine!
CALCULATION:

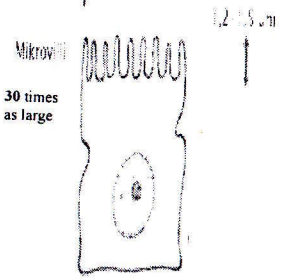


d2 = 0,03 m => r2 = 0,015 m / d1 = 0,01 m => r1 = 0,005 m
area circular ring: $A_2 - A_1 = \pi * r_2^2 - \pi * r_1^2 = \pi * 0.015^2 - \pi * 0.005^2$
$A_2 - A_1 = 7.068*10^{-4}\ m^2 - 7.854*10^{-5}\ m^2 = \underline{6.283*10^{-4}\ m^2}$
surface:
both sides => $2 * 6.283*10^{-4}\ m^2 * 600 = \underline{\mathbf{0,754\ m^2}}$



c) finger-like **INTESTINAL VILLI:**
Height: 1mm / diameter: 0,06 mm
Along the whole surface: ca. 1 mm² ~ 40 villi
CALCULATION:

h = 0.001 m / d = $6*10^{-3}\ m$ *=> r =* $3*10^{-5}\ m$
lateral area cyl.: $M = \pi*d*h = \pi* 6*10^{-5}m*0.001m = \underline{1,88*10^{-7}\ m^2}$
circle area: $A = \pi * r^2 = \pi * (3*10^{-5}m)^2 = \underline{2,83*10^{-9}\ m^2}$
surface villi: $M + A = \underline{\mathbf{1,9*10^{-7}\ m^2}}$
CARRY OVER of b)
Surface circular folds: 0,754 m² = 754.000 mm²
*Number of villi: 754.000 mm² * 40 = 30.160.000 villi*
*Whole Surface of villi: 30.160.000 Z * 1,9*10⁻⁷ m² =* $\underline{\mathbf{5,75\ m^2}}$



d) microscopic / hair-like **MICRO VILLI:**
height: 1,5 µm / diameter: 0,03 µm
on ca. 1mm² ~ ca. 200 million mikro villi
CALCULATION:

h = $1.5*10^{-6}\ m$ */ d =* $3*10^{-8}\ m$
lateral area: $M = \pi * d * h = \pi * 3*10^{-8}m * 1.5*10^{-6}m = \underline{1,41*10^{-13}\ m^2}$
CARRY OVER of c)
*Number of micro villi: 5.750.000 mm² * 200 Millions =* $1.15*10^{15}$ *V whole*
surface of micro villi: $1.15*10^{15}*1.41*10^{-13} = \underline{\mathbf{162,15\ m^2}}$

SURFACE OF WHOLE INTESTINE: ca. 150-160 m²