



The Need for an Aerosol Data-Base to be utilized for Health Effects Assessment in Jordan

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Loss of visibility due to traffic and industrial emissions in Cairo, Egypt
تردي الرؤية بسبب انبعاثات عوادم وسائل النقل و الصناعة في القاهرة، مصر



A working day
يوم عمل

A weekend day
يوم في نهاية الأسبوع



Loss of visibility due to sand storm episode in Amman, Jordan
تردي الرؤية بسبب عواصف رمالية في عمان، الأردن



A dusty day
يوم عاصف بالرمال

A clear day
يوم نقي



WHO Air Pollution Guidelines

Particulate matter (PM)

PM₁₀:

- ▶ annual mean **20 µg/m³**
- ▶ 24-hour mean **50 µg/m³**

PM_{2.5}:

- ▶ annual mean **10 µg/m³**
- ▶ 24-hour mean **25 µg/m³**

Gaseous

Ozone (O₃):

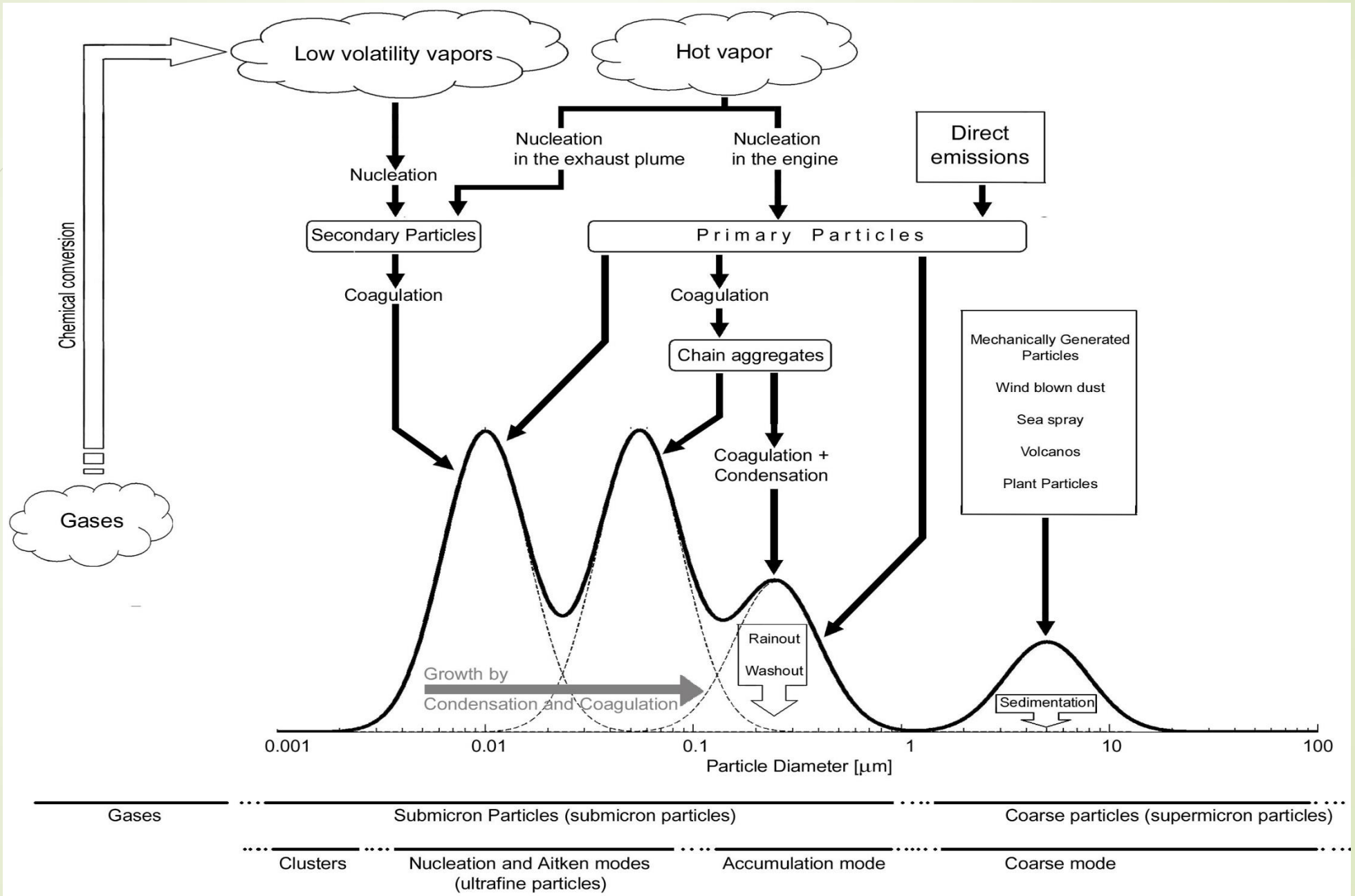
- ▶ 8-hour mean **100 µg/m³**

Nitrogen dioxide (NO₂):

- ▶ annual mean **40 µg/m³**
- ▶ 1-hour mean **200 µg/m³**

sulfur dioxide (SO₂):

- ▶ 24-hour **20 µg/m³**
- ▶ 10-minute mean **500 µg/m³**



A simple principle to calculate the inhaled deposited dose
in the respiratory system

مبدأ بسيط لحساب الجرعة المترسبة في الرئة

Inhaled Deposited Dose

الجرعة المترسبة

Pollutant
Concentration

تركيز الملوثات

Deposited
Fraction

الجزء المترسب

Breathing Rate

معدل التنفس

Exposure Time

فترة التعرض

The respiratory system

الجهاز التنفسي

The respiratory system consists of three main regions:

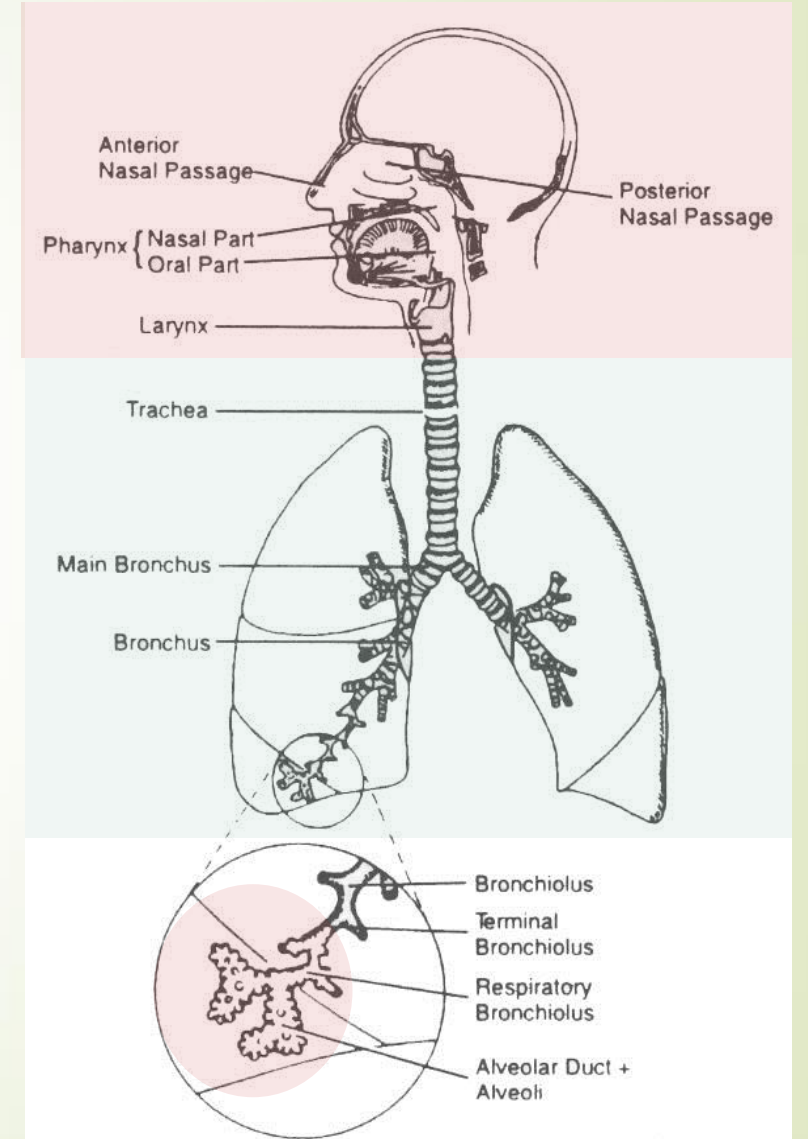
- Head airways (nasal passage, larynx, etc.)
- Main airway leading into and inside the lungs (trachea, main bronchus, bronchus, etc.)
- Alveolar

الجهاز التنفسي يحتوي على ثلاث مناطق رئيسية:

➤ الشعب الهوائية في الرأس و الرقبة (الأنف، الفم، الحنجرة، ...)

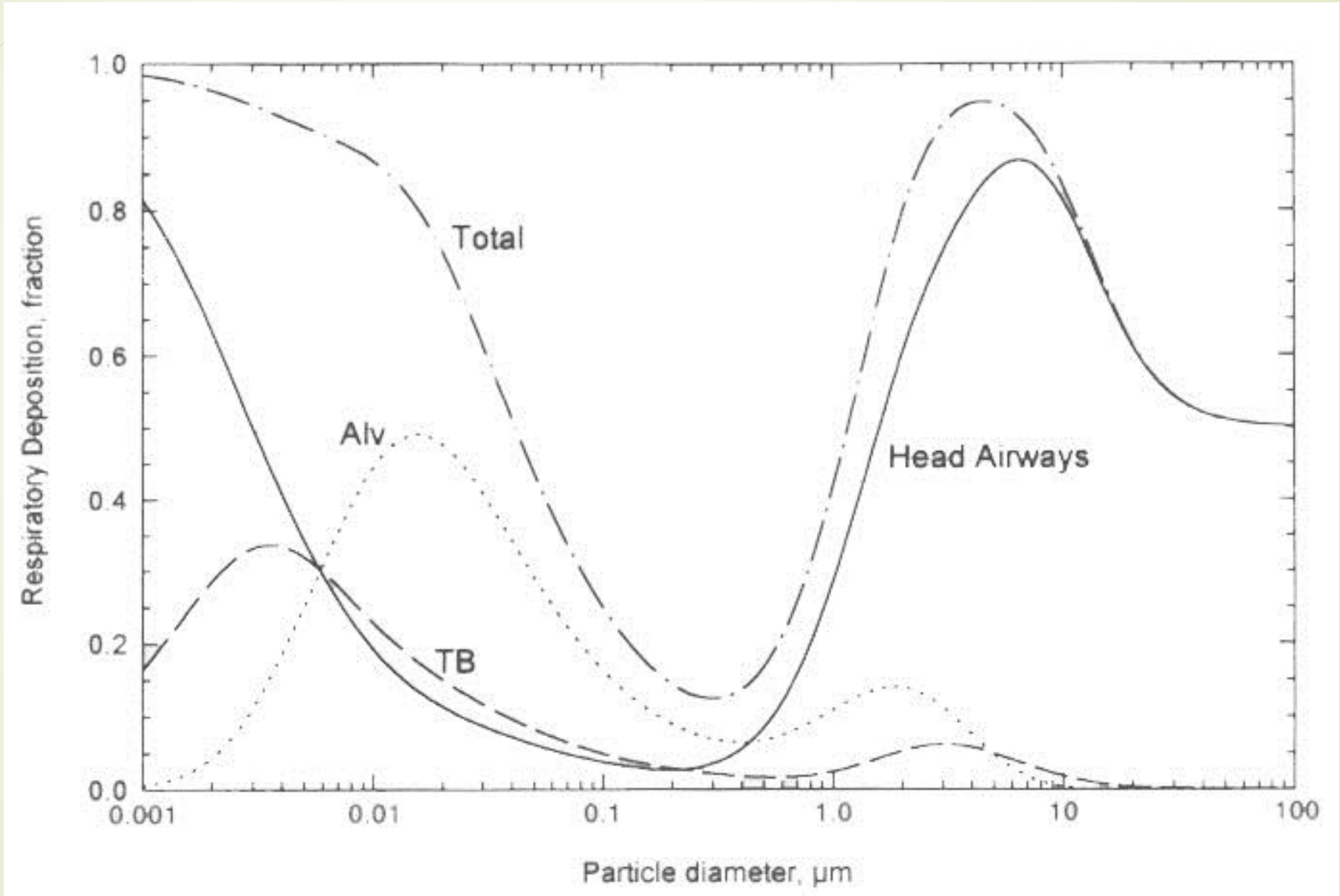
➤ الشعب الهوائية الرئيسية المؤدية إلى الرئة (الترقية، القصبات الهوائية الرئيسية، ...)

➤ الحويصلات الهوائية



Deposition fraction of aerosols in the respiratory system

الجزء المترسب من العوالق الهوائية في الجهاز التنفسي



Volume of air breathed reported by the California Environmental Protection Agency (Holmes, 1994).

Activity	Volume of air breathed [l/min (m ³ /h)]		
	Children	Adults	
		Females	Males
Housework	-	17 (1.02)	-
Car maintenance	-	-	23 (1.38)
Mowing lawn	-	-	37 (2.22)
Yard work	-	18 (1.08)	29 (1.74)
Playing outdoors	17.5 (1.05)	-	-
Running (5 mph \cong 8.0 km/h)	-	50.5 (3.03)	58 (3.48)
Running (4 mph \cong 6.4 km/h)	31.5 (1.89)	45 (2.70)	33 (1.98)
Walking (3 mph \cong 4.8 km/h)	17.5 (1.05)	-	-
Walking (2.5 mph \cong 4.0 km/h)	-	20 (1.20)	23 (1.38)
Walking (2 mph \cong 3.2 km/h)	14 (0.84)	-	-
Driving car	-	8.5 (0.51)	11 (0.66)
Riding in car	-	8 (0.48)	10 (0.60)
Standing	8 (0.48)	8 (0.48)	11 (0.66)
Sitting	7 (0.42)	7 (0.42)	9 (0.54)

Dust exposure scenario

التعرض للغبار

Scenario:

48 hours exposure to a dust episode

Smoke particles:

GMD = 4 μm

Concentration = 750 $\mu\text{g}/\text{m}^3$

Density = 2.2 g/cm^3

Subject:

Child (15 years old)

Sitting (breath rate = 0.42 m^3/h)

Deposition fraction:

Head = 0.85

TB = 0.05

Alv = 0.10



750 $\mu\text{g}/\text{m}^3$

0.85

0.05

0.10

0.42
 m^3/h

48 hours

Head = 12.9 mg

TB = 0.8 mg

Alv = 1.5 mg

Exposure to water-pipe smoke

التعرض لدخان الأرجيلة

Scenario:

6 hours Smoking

Smoke particles:

GMD = 100 nm

Concentration = 10^6 particles/cm³

Density = 1 g/cm³

Subject:

Child (15 years old)

Sitting (breath rate = 0.42 m³/h)

Deposition fraction:

Head = 0.15

TB = 0.25

Alv = 0.55



«محمد» قاعد في نفس الغرفة
The son is in the same room

«أبو محمد» سهران بأرجل

The father is smoking water-pipe

10^{12}
particles/m³

0.15
0.25
0.55

0.42
m³/h

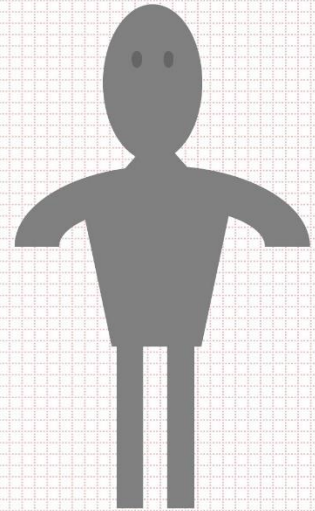
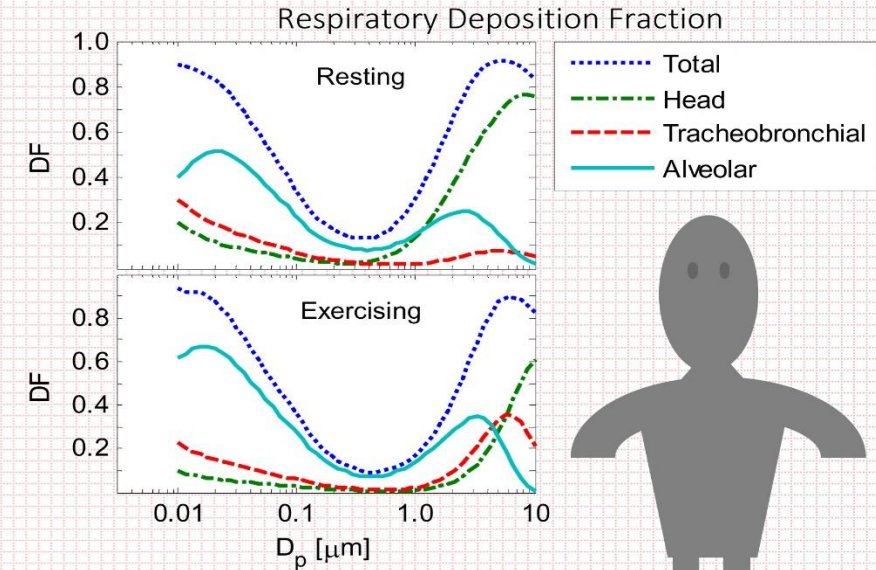
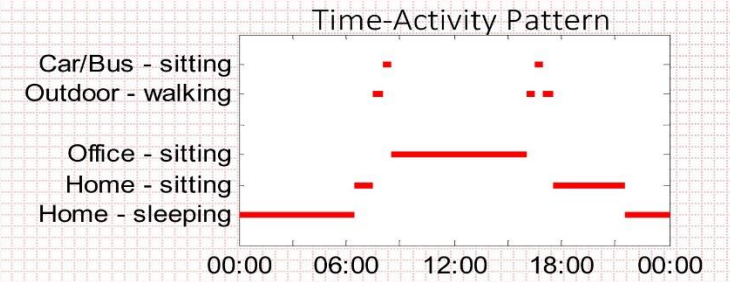
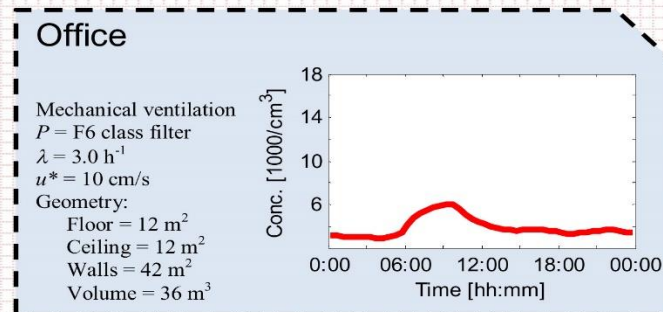
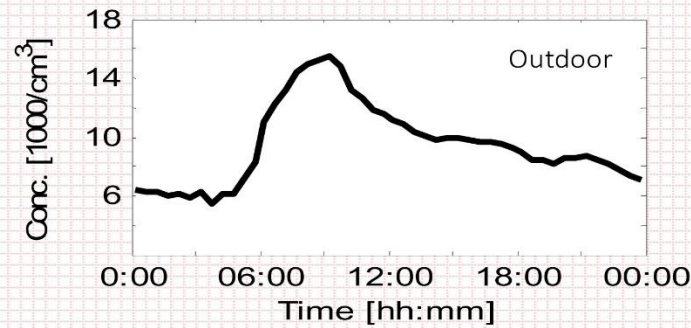
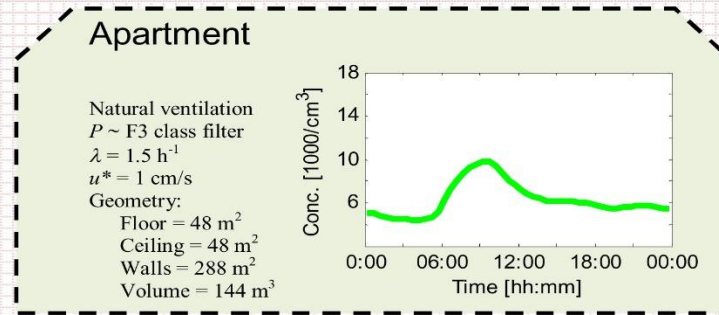
6 hours

Head = 378×10^9 particles
TB = 630×10^9 particles
Alv = 1386×10^9 particles

Head = 198 ng
TB = 330 ng
Alv = 726 ng

A detailed scenario

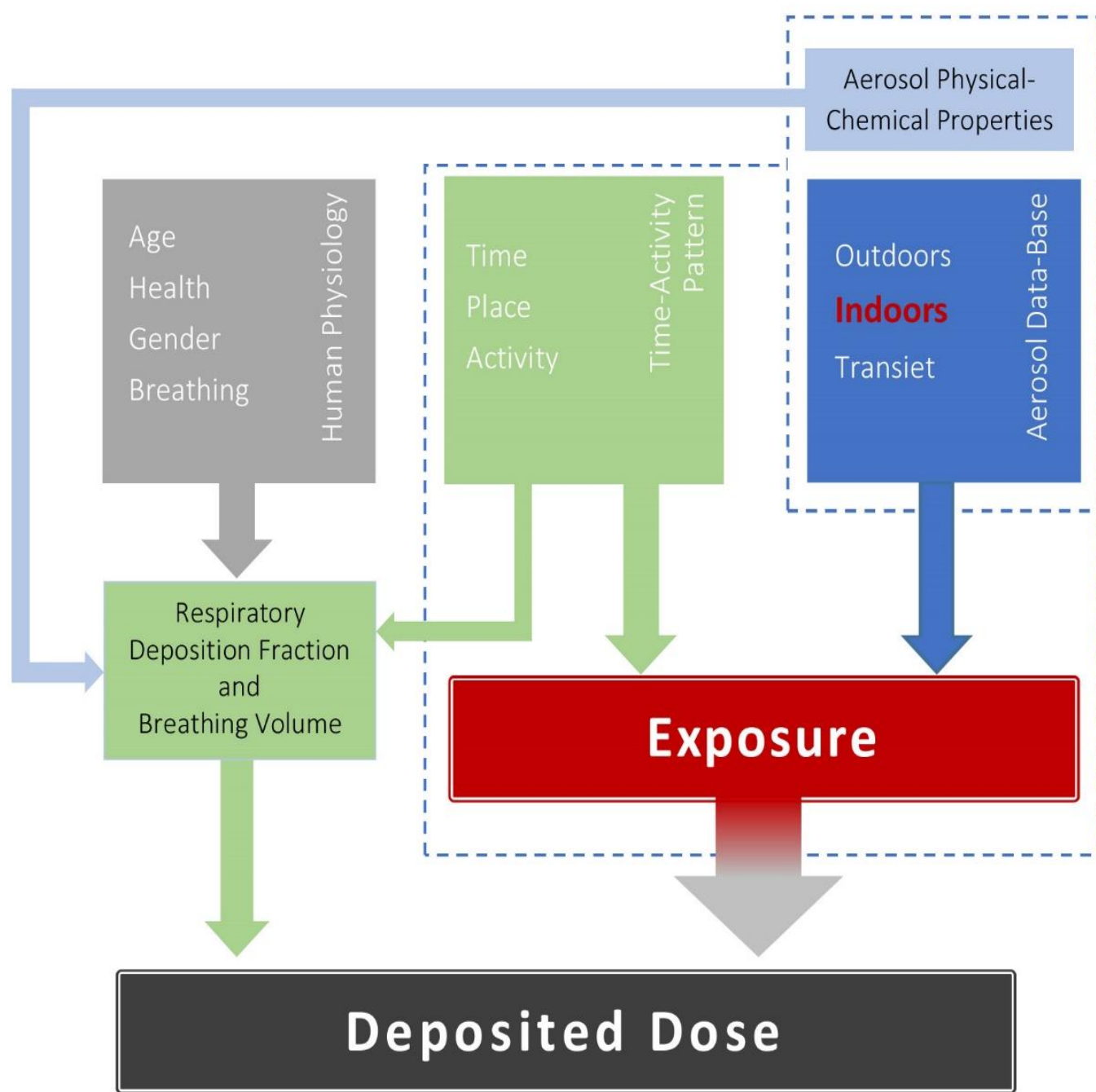
مشهد مفصل

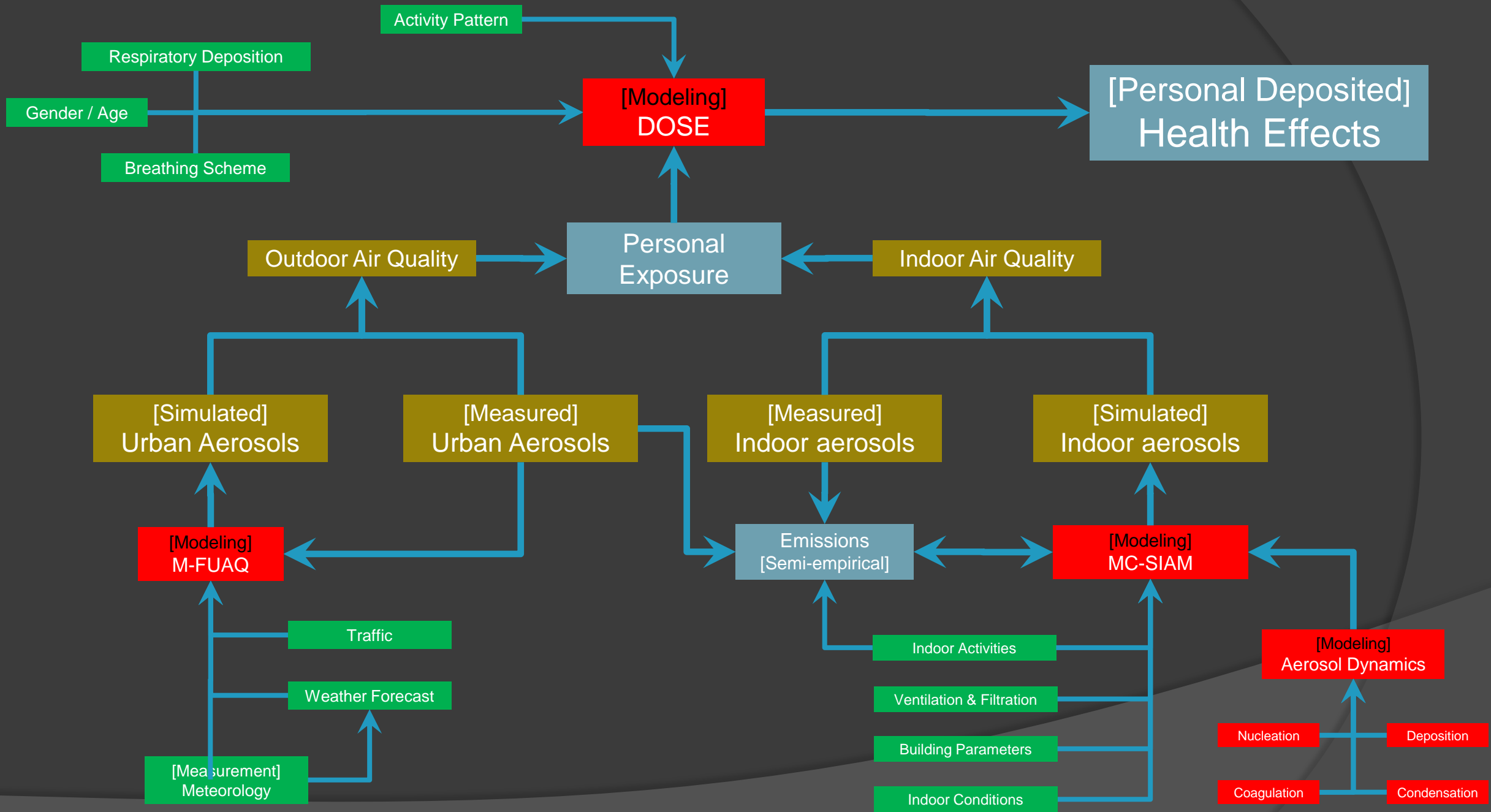


Minute Ventilation, V_E :
 Walking = 23 L/min
 Standing = 11 L/min
 Sitting = 9 L/min

24-hours Deposited Dose in the Adult Male

	Particle Number [$\times 10^9$ particles]			Particle Mass [μg]		
	FP	UFP	ACCU	FP	UFP	ACCU
Total	59.51	56.20	3.40	42.29	1.57	40.77
Head	7.51	6.50	1.02	18.52	0.21	18.32
TB	11.94	11.55	0.41	4.02	0.31	3.72
P	40.07	38.15	1.97	19.75	1.05	18.73





Respiratory Deposition

Gender / Age

Breathing Scheme

Activity Pattern

[Modeling] DOSE

[Personal Deposited] Health Effects

Outdoor Air Quality

Personal Exposure

Indoor Air Quality

[Simulated] Urban Aerosols

[Measured] Urban Aerosols

[Measured] Indoor aerosols

[Simulated] Indoor aerosols

[Modeling] M-FUAQ

Emissions [Semi-empirical]

[Modeling] MC-SIAM

[Measurement] Meteorology

Traffic

Weather Forecast

Indoor Activities

Ventilation & Filtration

Building Parameters

Indoor Conditions

[Modeling] Aerosol Dynamics

Nucleation

Deposition

Coagulation

Condensation



What do we need?!

- ▶ Human activity patterns for Jordanians in cities
 - ▶ Indoor exposure period
 - ▶ Outdoor exposure period
- ▶ Continuous aerosol data-base for PM, O₃, NO₂, and SO₂
- ▶ There is a need for
 - ▶ Aerosol data-base on the particle number concentration and particle number size distribution
 - ▶ Physical-chemical properties of aerosol particles
- ▶ We need to understand the indoor-to-outdoor relationship of aerosol particles:
 - ▶ Building properties: penetration, ventilation, interior surfaces, etc
 - ▶ Indoor sources



How is that possible?!

- There are several data-bases PM, O₃, NO₂, and SO₂:
 - Ministry of Environment
 - The Royal Scientific Society
 - private laboratories
 - Scientific Institutions and Universities

- But what about:
 - particle number concentration, particle number size distribution, and physical-chemical properties?!
 - Indoor-to-outdoor relationship
 - Exposure indoors versus outdoors
 - Exposure to local versus regional aerosols