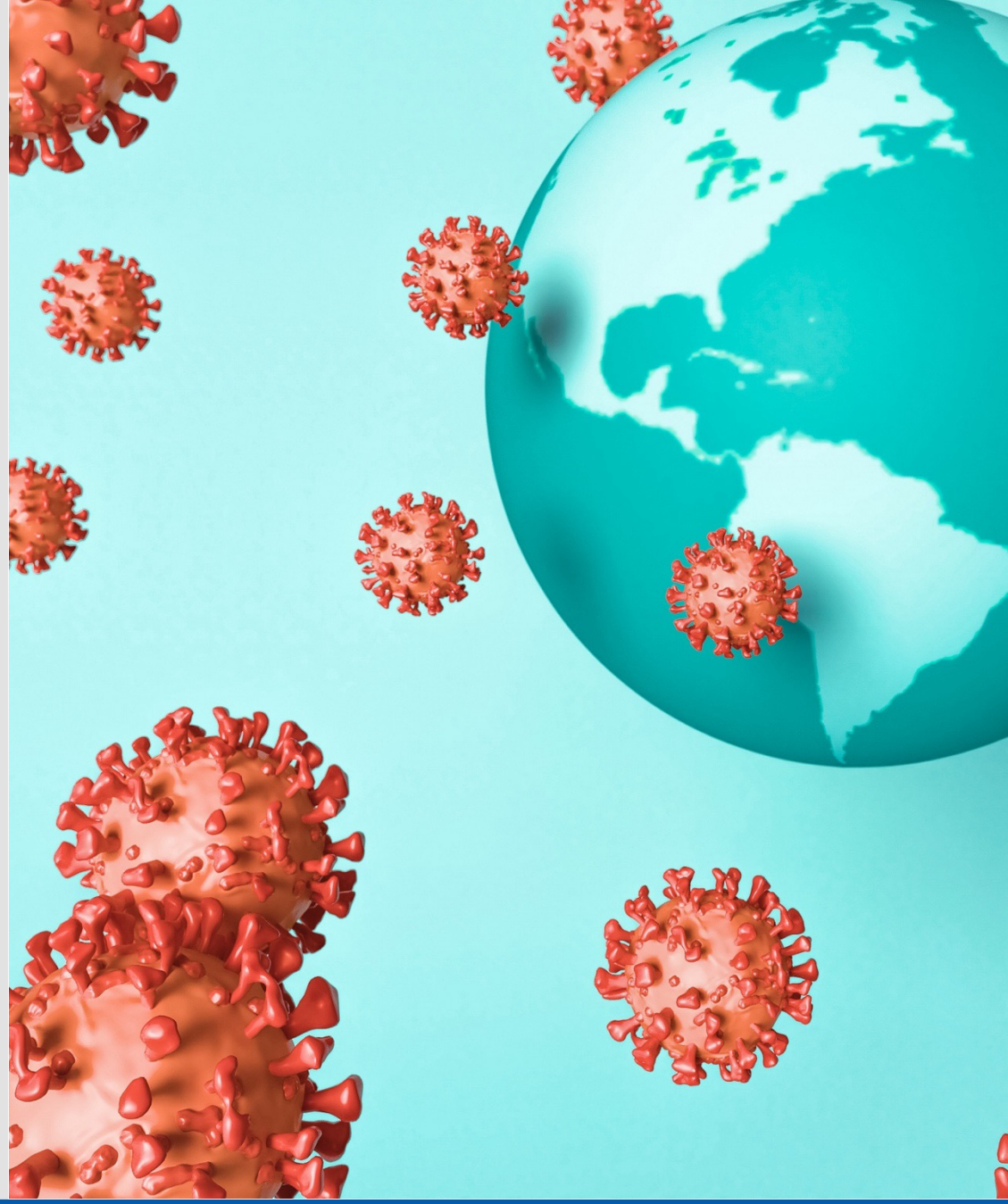
Topik 10
Keberlanjutan Kualitas Lingkungan I: Risiko Lingkungan & Kesehatan Manusia

BI-2001 PENGETAHUAN LINGKUNGAN

SEMESTER 2 – 2023/2024

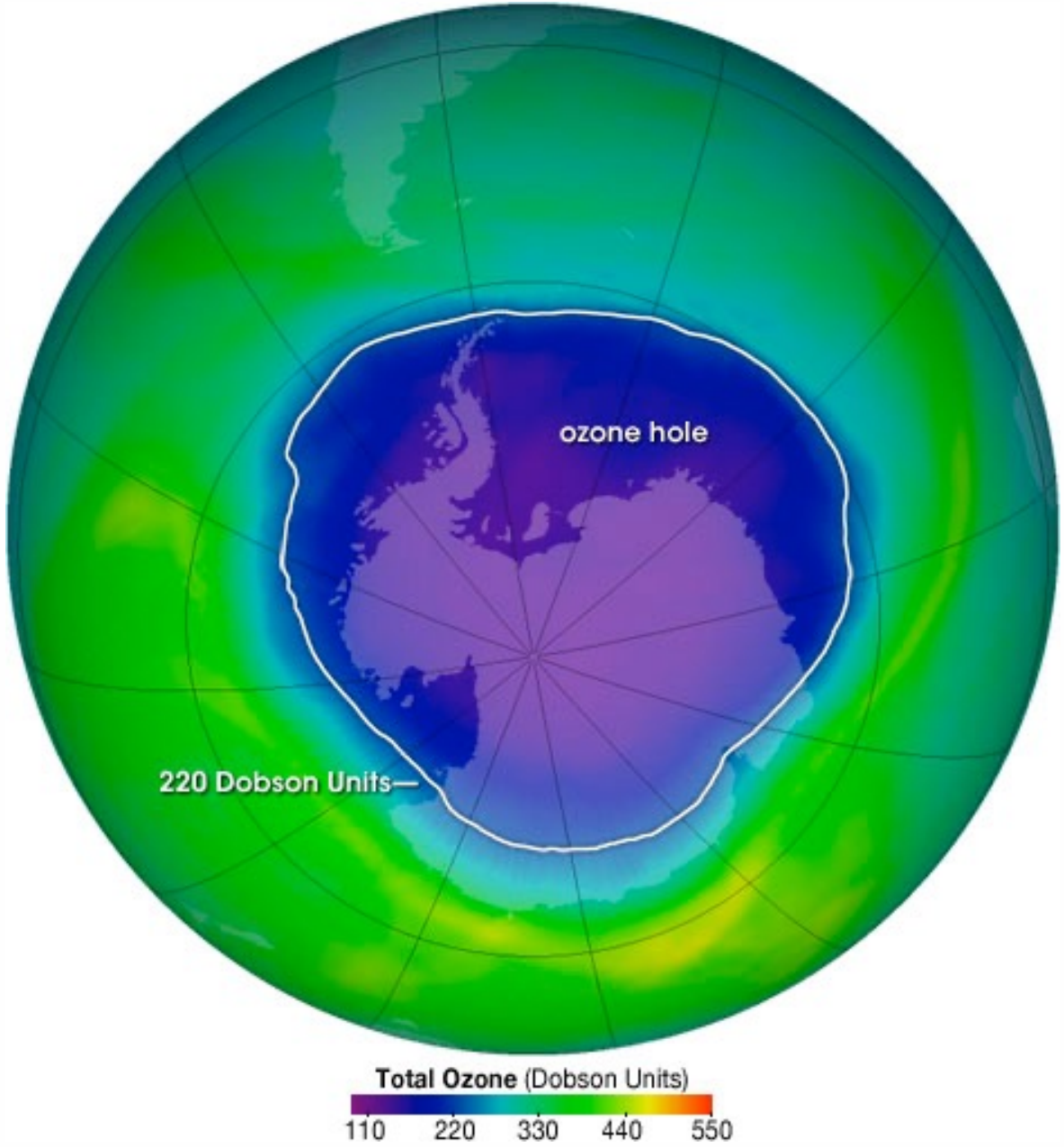


https://www.biofarma.co.id/id/berita-terbaru/detail/kenali-virus-covid19

Capaian Pembelajaran Topik 10

Mahasiswa dapat:

- mengidentifikasi sumber risiko lingkungan yang mengancam kesehatan manusia;
- menjelaskan isu lingkungan terkait perubahan iklim dan atmosfer; dan
- menjelaskan alternatif solusi yang berkelanjutan.



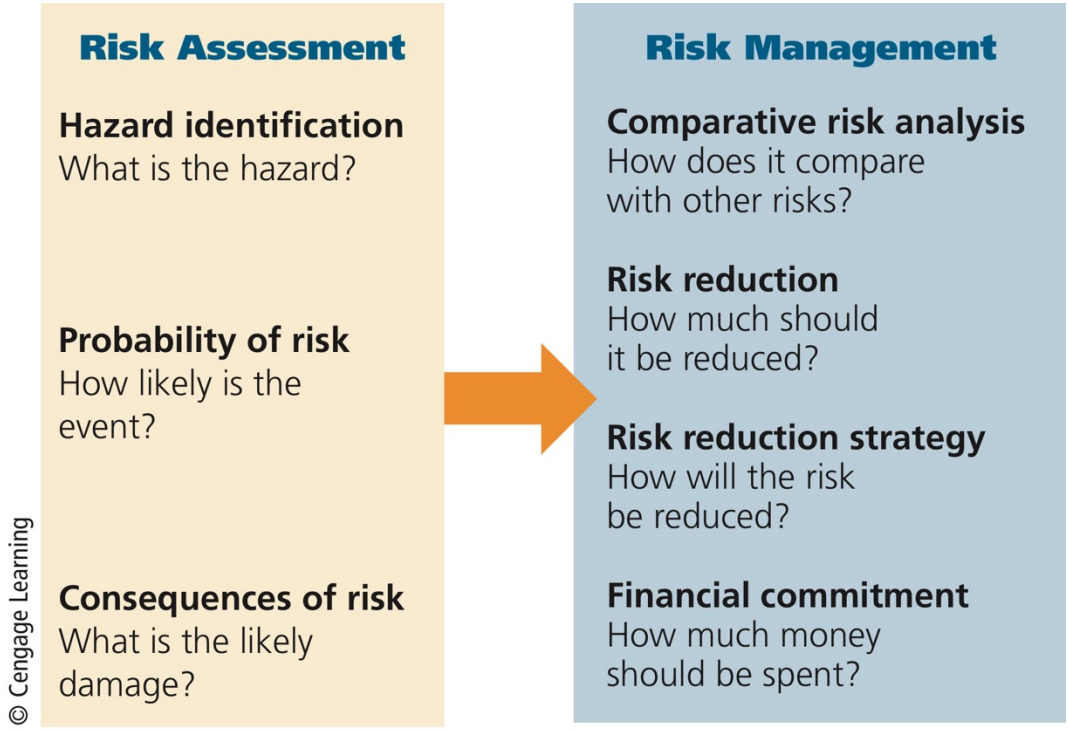
https://ozonewatch.gsfc.nasa.gov/facts/hole_SH.html

A. Risiko Lingkungan & Sumbernya

https://ejatlas.org/conflict/pt-kahatex-pt-insan-sandan-internusa-and-pt-five-star-textile

Risiko Lingkungan

- Risiko lingkungan dapat diartikan sebagai kemungkinan adanya efek berbahaya bagi kesehatan manusia atau sistem ekologi yang dihasilkan dari paparan terhadap **bahaya lingkungan / *environmental hazard***, baik yang bersifat fisika, kimia, maupun biologis.
- Pada materi ini, kita akan membahas risiko lingkungan dalam kaitannya dengan kesehatan manusia.



- ***Risk Assessment*** adalah penggunaan metode statistik untuk memperkirakan seberapa besar bahaya yang dapat ditimbulkan suatu *hazard*.
- ***Risk management*** melibatkan pengambilan keputusan terkait apakah dan bagaimana cara mengurangi risiko tertentu ke tingkat tertentu dan berapa biayanya.

Dirangkum dari Miller & Spoolman (2016)

Jenis *Hazards*

Biological hazards

- Bakteri
- Virus

Chemical hazards

- Zat kimia berbahaya di tanah, air, udara

Natural hazards

- Banjir
- Gempa Bumi
- Letusan gunung api

Cultural hazards

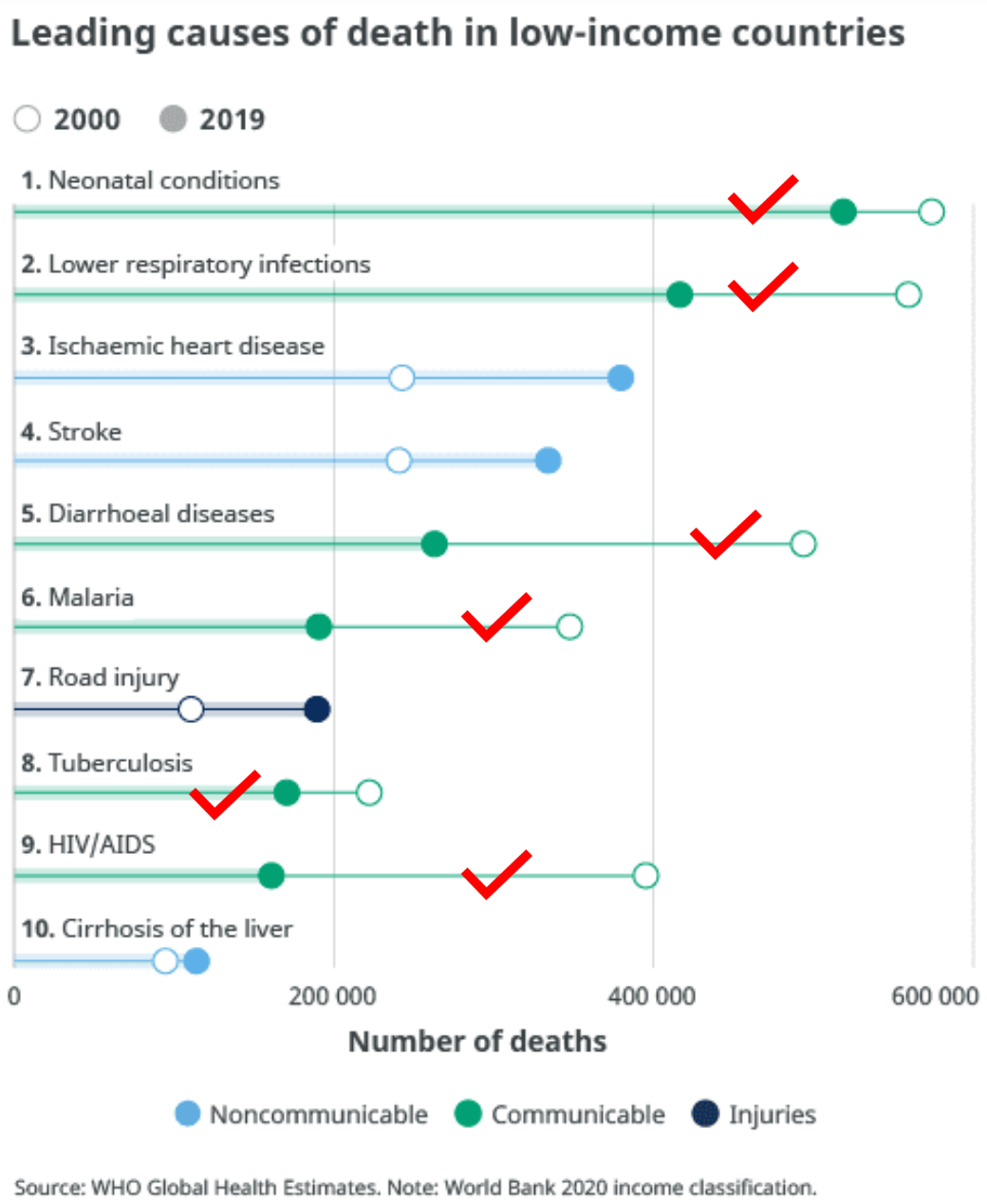
- Kondisi kerja yang buruk
- Tindak kejahatan
- Kemiskinan

Lifestyle hazards

- Merokok
- Minum minuman beralkohol

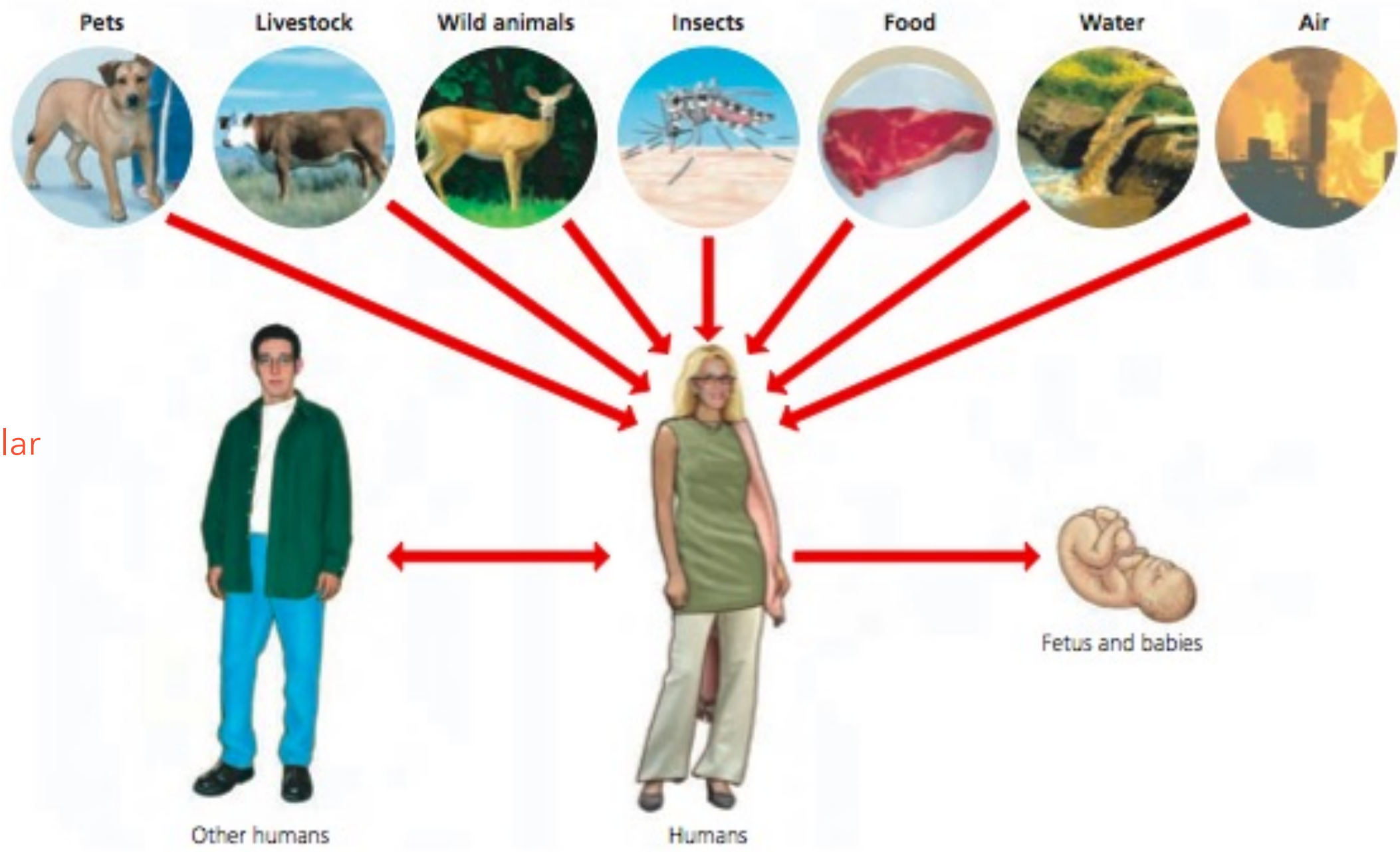
1. Biological Hazards

- Meskipun levelnya telah menurun drastis sejak tahun 1950-an, *biological hazard* paling serius yang kita hadapi masih berupa **penyakit menular** seperti flu, AIDS, TBC, diare, malaria, & covid-19.
- Ditularkan melalui udara, air, makanan, & cairan tubuh (feses, urin, darah, & droplet saat bersin/batuk), serta oleh serangga seperti nyamuk.
- Terutama **umum di negara berkembang** dengan akses yang relatif rendah pada fasilitas sanitasi dan kesehatan yang layak.



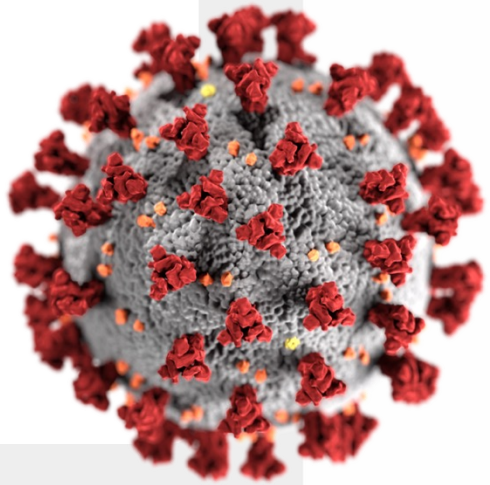
Dirangkum dari Miller & Spoolman (2016) & who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death

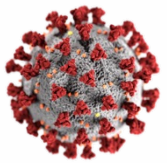
Jalur Transmisi Penyakit Menular



Wabah, Epidemi, Pandemi

- **Wabah penyakit**/*disease outbreak* adalah kejadian kasus penyakit yang melebihi kenormalan.
- **Epidemi** adalah wabah penyakit menular berskala besar di suatu daerah atau negara
- **Pandemi** adalah epidemi berskala global





COVID-19 CORONAVIRUS PANDEMIC

Last updated: February 12, 2024, 01:03 GMT

Weekly Trends - Graphs - Countries - News

Coronavirus Cases:

702,954,452

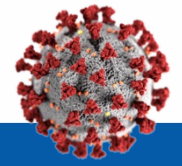
view by country

Deaths:

6,981,064

Recovered:

673,837,141

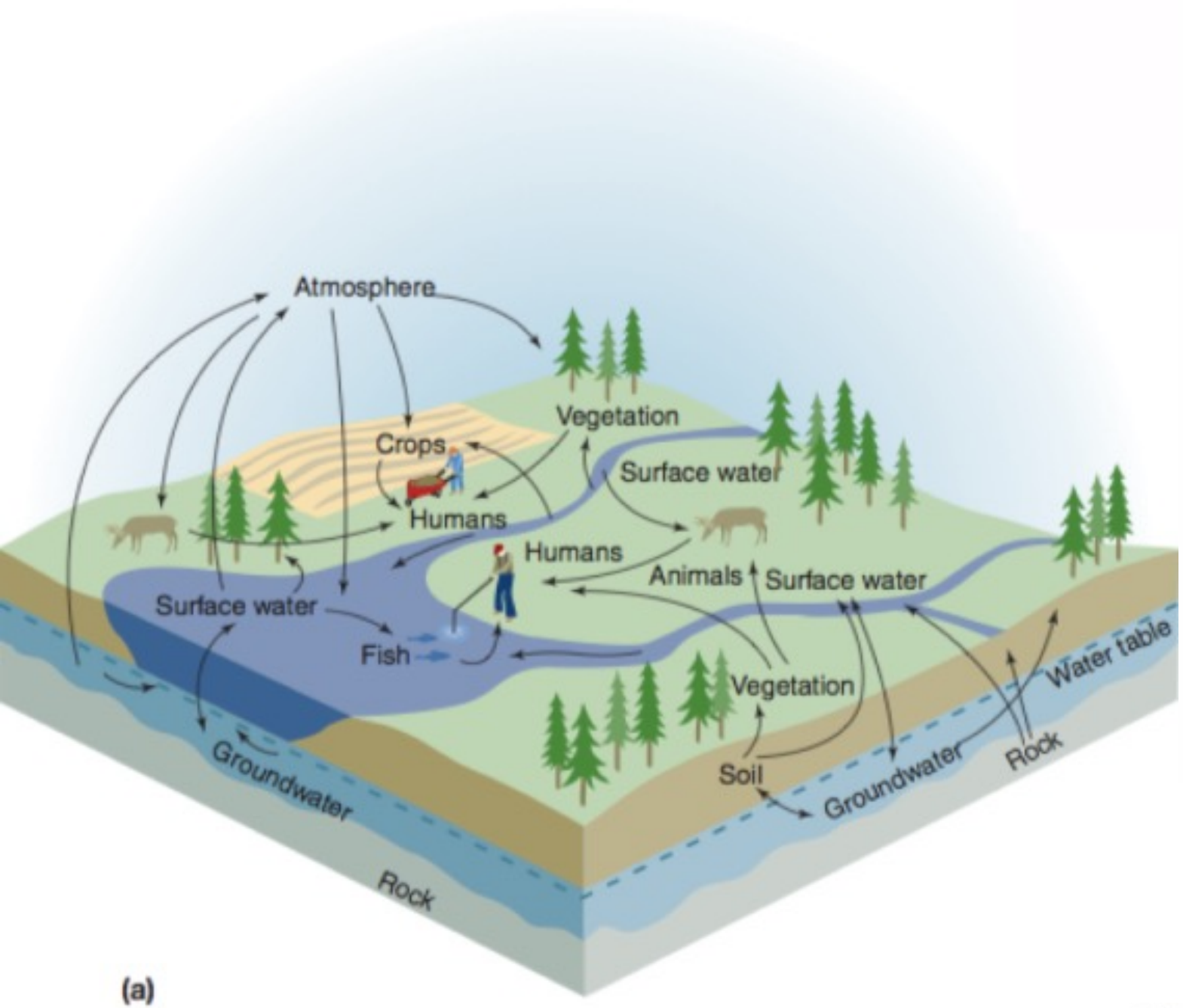


Dirangkum dari Miller & Spoolman (2016) & https://www.worldometers.info/coronavirus/

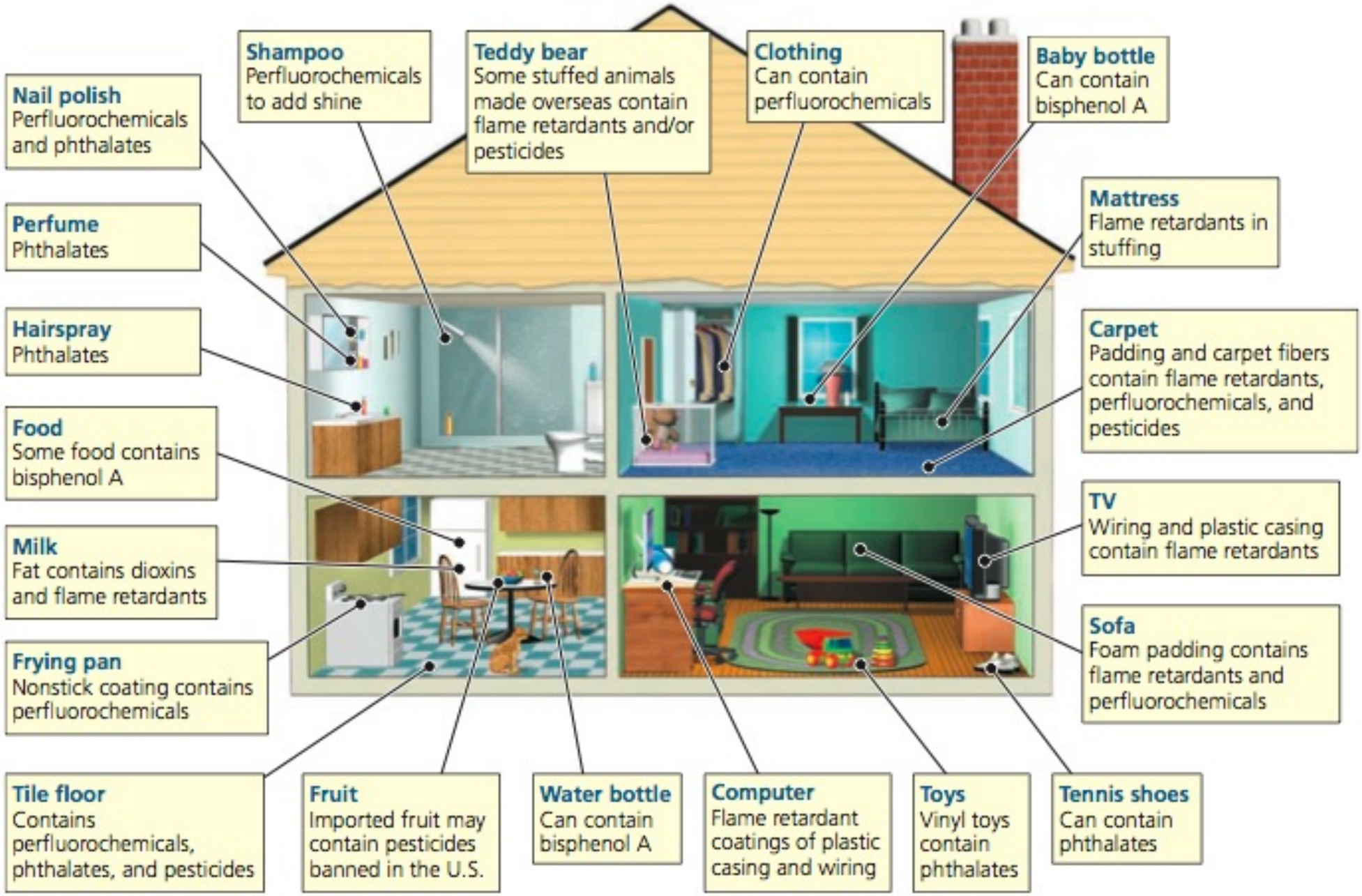
2. Chemical Hazards

- Bahan kimia tertentu dapat menyebabkan kanker dan cacat lahir serta mengganggu sistem kekebalan, saraf, dan endokrin manusia.
- **Bahan kimia beracun** (**toksik**) adalah unsur atau senyawa yang dapat menyebabkan kerusakan sementara atau permanen atau kematian pada manusia.

Dirangkum dari Miller & Spoolman (2016); gambar dari https://www.traconed.com/product/147112/hazard-sign---harmful-chemicals



Jalur Masuknya Bahan Kimia Beracun [*Outdoor*]



Jalur Masuknya Bahan Kimia Beracun [*Indoor*]

Table 17-1 Toxicity Ratings and Average Lethal Doses for Humans

Toxicity Rating	LD50 (milligrams per kilogram of body weight)*	Average Lethal Dose**	Examples
Supertoxic	Less than 5	Less than 7 drops	Nerve gases, botulism toxin, mushroom toxin, dioxin (TCDD)
Extremely toxic	5–50	7 drops to 1 teaspoon	Potassium cyanide, heroin, atropine, parathion, nicotine
Very toxic	50–500	1 teaspoon to 1 ounce	Mercury salts, morphine, codeine
Moderately toxic	500–5,000	1 ounce to 1 pint	Lead salts, DDT, sodium hydroxide, sodium fluoride, sulfuric acid, caffeine, carbon tetrachloride
Slightly toxic	5,000–15,000	1 pint to 1 quart	Ethyl alcohol, Lysol, soaps
Essentially nontoxic	15,000 or greater	More than 1 quart	Water, glycerin, table sugar

*Dosage that kills 50% of individuals exposed.

**Amounts of substances in liquid form at room temperature that are lethal when given to a 70-kilogram (150-pound) human.

Table 10.3 EFFECTS OF POLLUTANTS ON WILDLIFE

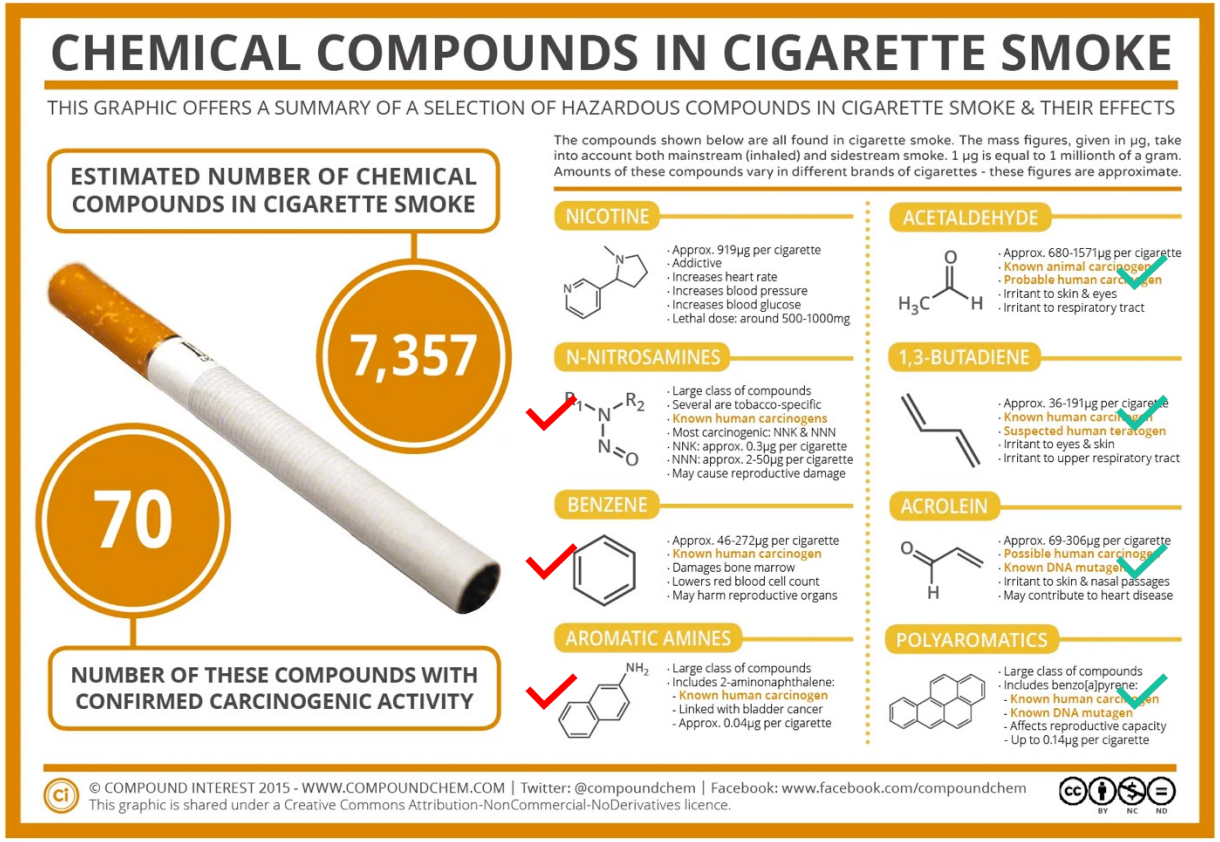
EFFECT ON POPULATION	EXAMPLES OF POLLUTANTS
Changes in abundance	Arsenic, asbestos, cadmium, fluoride, hydrogen sulfide, nitrogen oxides, particulates, sulfur oxides, vanadium, POPs[a]
Changes in distribution	Fluoride, particulates, sulfur oxides, POPs
Changes in birth rates	Arsenic, lead, POPs
Changes in death rates	Arsenic, asbestos, beryllium, boron, cadmium, fluoride, hydrogen sulfide, lead, particulates, selenium, sulfur oxides, POPs
Changes in growth rates	Boron, fluoride, hydrochloric acid, lead, nitrogen oxides, sulfur oxides, POPs

[a] Pesticides, PCBs, hormonally active agents, dioxin, and DDT are examples (see Table 10.1).

Source: J.R. Newman, *Effects of Air Emissions on Wildlife*, U.S. Fish and Wildlife Service, 1980. Biological Services Program, National Power Plant Team, FWS/OBS-80/40, U.S. Fish and Wildlife Service, Washington, DC.

Chemical Hazard 1: Karsinogen

- **Karsinogen** adalah bahan kimia, beberapa jenis radiasi, dan virus tertentu yang dapat menyebabkan atau memicu kanker.
- Contoh: arsenik, benzena, formaldehida, radiasi gamma, radiasi UV, vinil klorida, dan bahan kimia tertentu dalam asap tembakau [perhatikan gambar di samping].

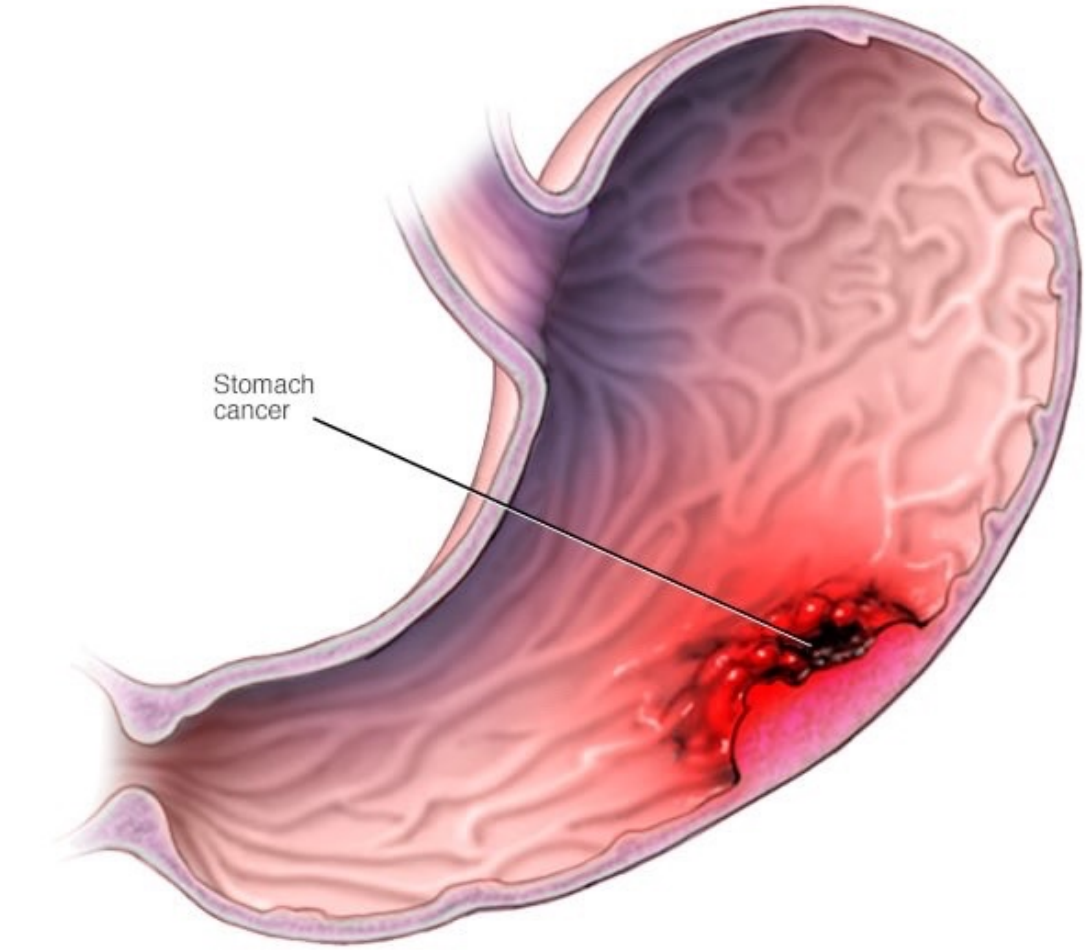


Catatan: Efek yang muncul pada organisme tergantung pada dosis & lamanya paparan

Dirangkum dari Miller & Spoolman (2016);
gambar dari https://i1.wp.com/www.compoundchem.com/wp-content/uploads/2014/05/Cigarette-Smoke-Compounds-March-15.png?ssl=1

Chemical Hazard 2: Mutagen

- **Mutagen** adalah bahan kimia atau bentuk radiasi yang menyebabkan atau meningkatkan frekuensi mutasi DNA
- Contoh: asam nitrit (HNO_2) yang dibentuk oleh pencernaan pengawet makanan nitrit (NO_{2-}) → peningkatan kanker lambung jika dikonsumsi berlebihan
- Mutasi berbahaya yang terjadi pada sel kelamin (gamet) dapat diturunkan ke keturunan dan generasi mendatang.



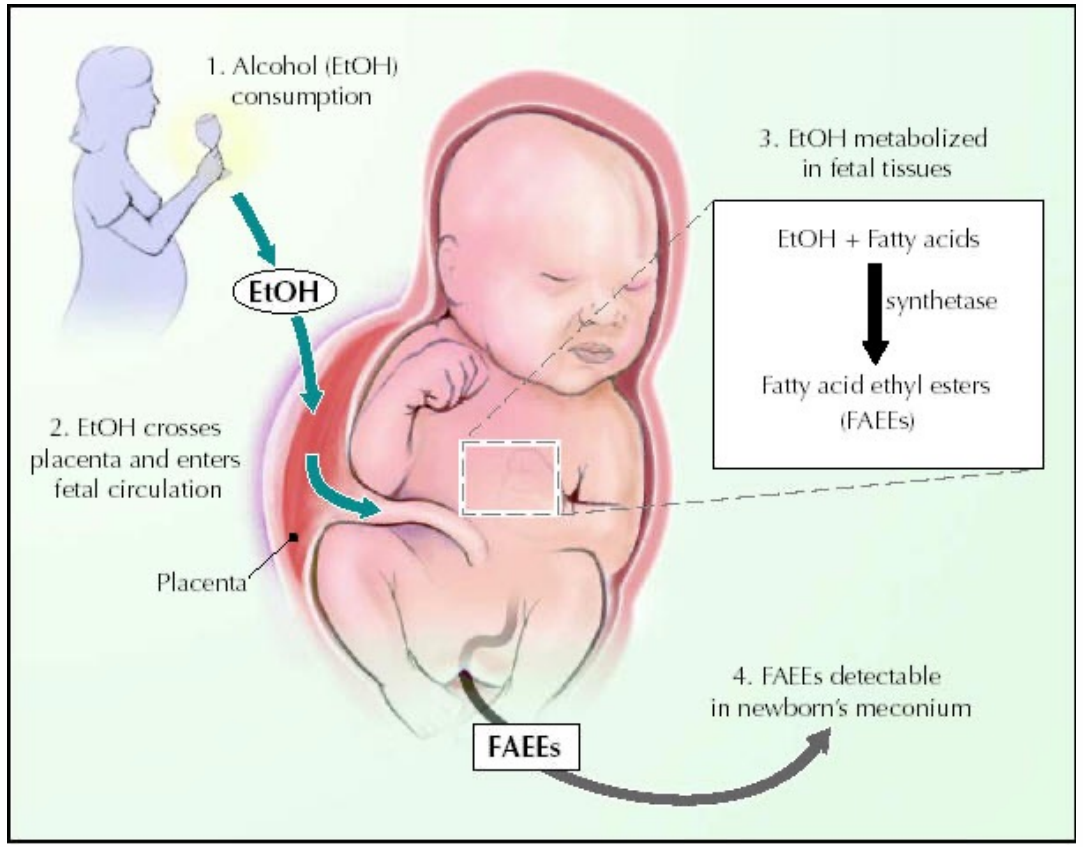
Catatan: Efek yang muncul pada organisme tergantung pada dosis & lamanya paparan

Dirangkum dari Miller & Spoolman (2016); gambar dari https://www.mayoclinic.org/diseases-conditions/stomach-cancer/symptoms-causes/syc-20352438

Chemical Hazard 3: Teratogen

- **Teratogen** adalah bahan kimia yang membahayakan atau menyebabkan cacat lahir pada janin.
- Contoh: etil alkohol, merkuri, timbal, formaldehida, benzene, polychlorinated biphenyls (PCBs), dsb.
- Wanita yang minum minuman beralkohol selama kehamilan meningkatkan risiko memiliki bayi dengan berat badan lahir rendah dan sejumlah masalah fisik, perkembangan, perilaku, dan mental.

Fetal Alcohol Syndrome



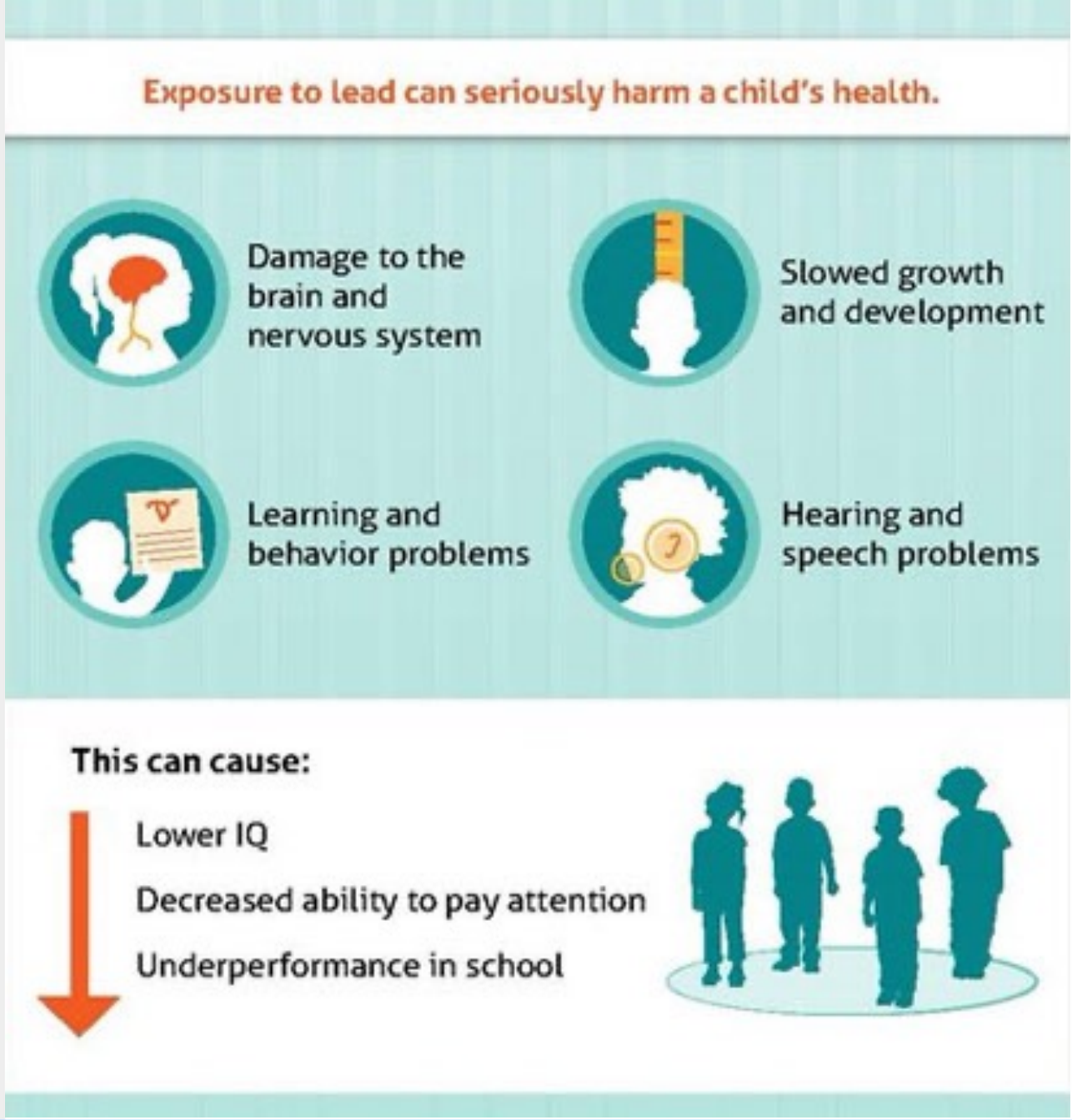
Catatan: Efek yang muncul pada janin tergantung pada dosis, waktu & lamanya paparan

Dirangkum dari Miller & Spoolman (2016); gambar dari https://people.uwec.edu/piercech/fas/fas...htm

Chemical Hazard 4: Neurotoksin

- **Neurotoksin** mencakup beragam bahan kimia alami dan sintetis di lingkungan yang dapat membahayakan sistem saraf manusia (otak, sumsum tulang belakang, dan saraf tepi).
- Efek dapat mencakup perubahan perilaku, ketidakmampuan belajar, *attention-deficit disorder*, kelumpuhan, dan kematian.
- Contoh: PCBs, arsenik, timbal, dan pestisida tertentu.

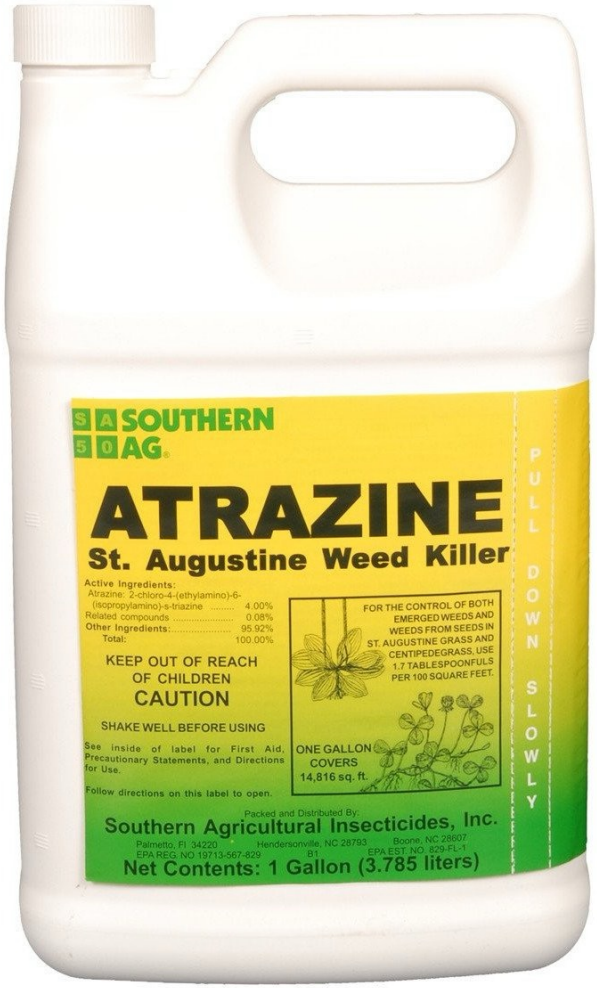
Catatan: Efek yang muncul pada organisme tergantung pada dosis & lamanya paparan



Dirangkum dari Miller & Spoolman (2016); gambar dari https://www.cdc.gov/nceh/lead/prevention/infographic-lead-exposure.htm

Chemical Hazard 5: Endocrine disruptors

- ***Hormonally active agents*** (HAAs) / ***endocrine disruptors*** adalah bahan kimia tertentu yang memiliki struktur mirip hormon alami sehingga dapat menempel pada molekul hormon alami dan mengganggu sistem endokrin pada manusia dan beberapa hewan lain.
- Contoh: ***Atrazine*** dan berbagai herbisida-pestisida lain, dioksin, timbal, merkuri, triclosan (terdapat pada sabun & produk antibakteri)

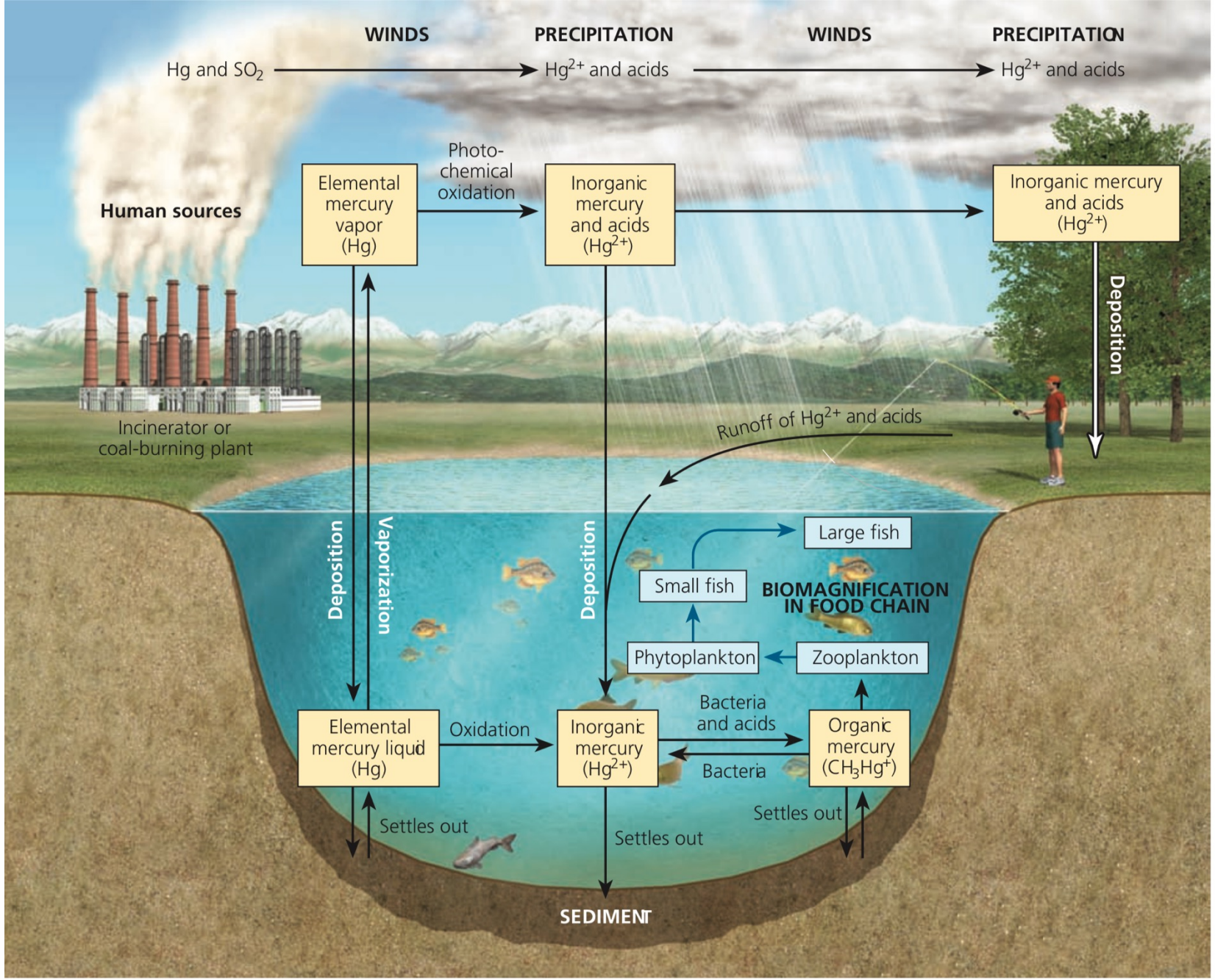


Catatan: Efek yang muncul pada janin tergantung pada dosis, waktu & lamanya paparan

Dirangkum dari Miller & Spoolman (2016); gambar dari https://www.seedworldusa.com/products/atrazine-weed-killer-1-gallon

Merkuri sebagai *Endocrine Disruptor*

Pergerakan berbagai bentuk merkuri dari atmosfer ke ekosistem akuatik di mana merkuri secara biologis diperbesar dalam rantai makanan (biomagnifikasi).



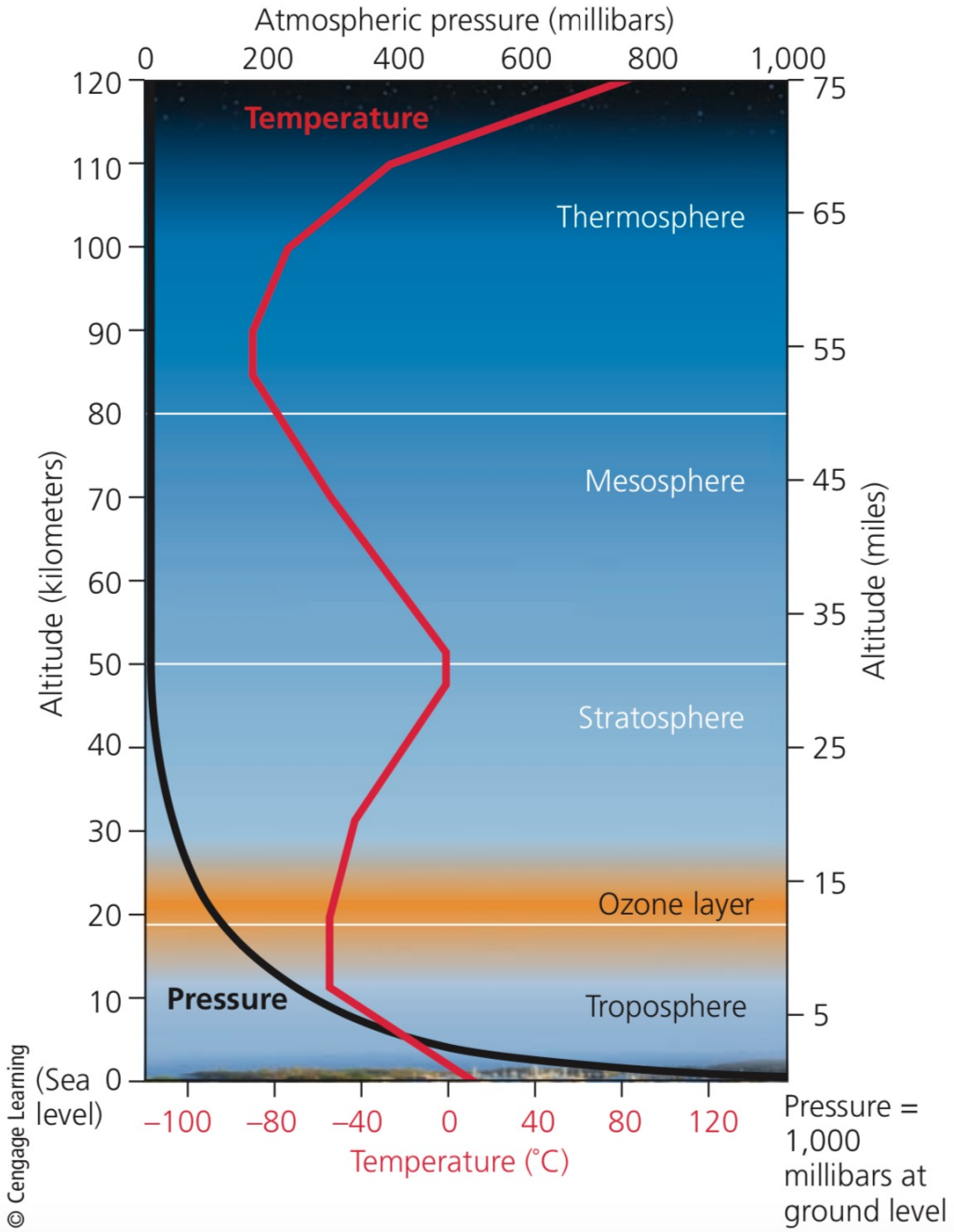
Dirangkum dari Miller & Spoolman (2016)

B. Isu Lingkungan terkait Atmosfer & Perubahan Iklim

https://commons.wikimedia.org/wiki/File:Climate_change_adaptation_icon.png

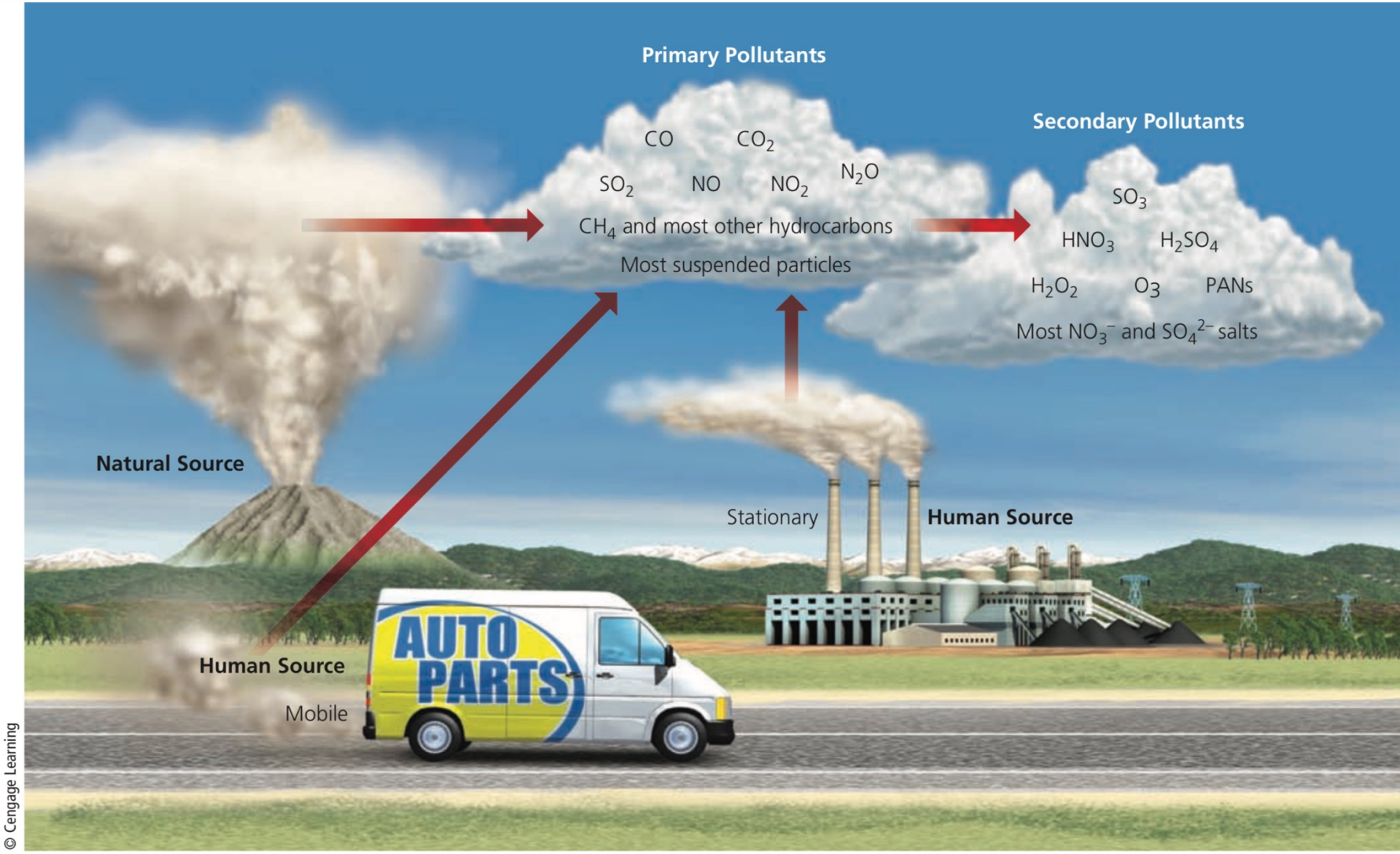
Mengingat Kembali: Atmosfer

- **Troposfer** merupakan lapisan Atmosfer dimana sebagian besar proses iklim berlangsung.
- **Stratosfer** merupakan lapisan Atmosfer yang memiliki lapisan Ozon yang penting dalam filtrasi radiasi matahari.
- Masuknya polusi udara dari zat kimia berbahaya ke dua lapisan ini dapat menyebabkan perubahan tren iklim serta secara langsung juga mempengaruhi kesehatan organisme termasuk manusia.

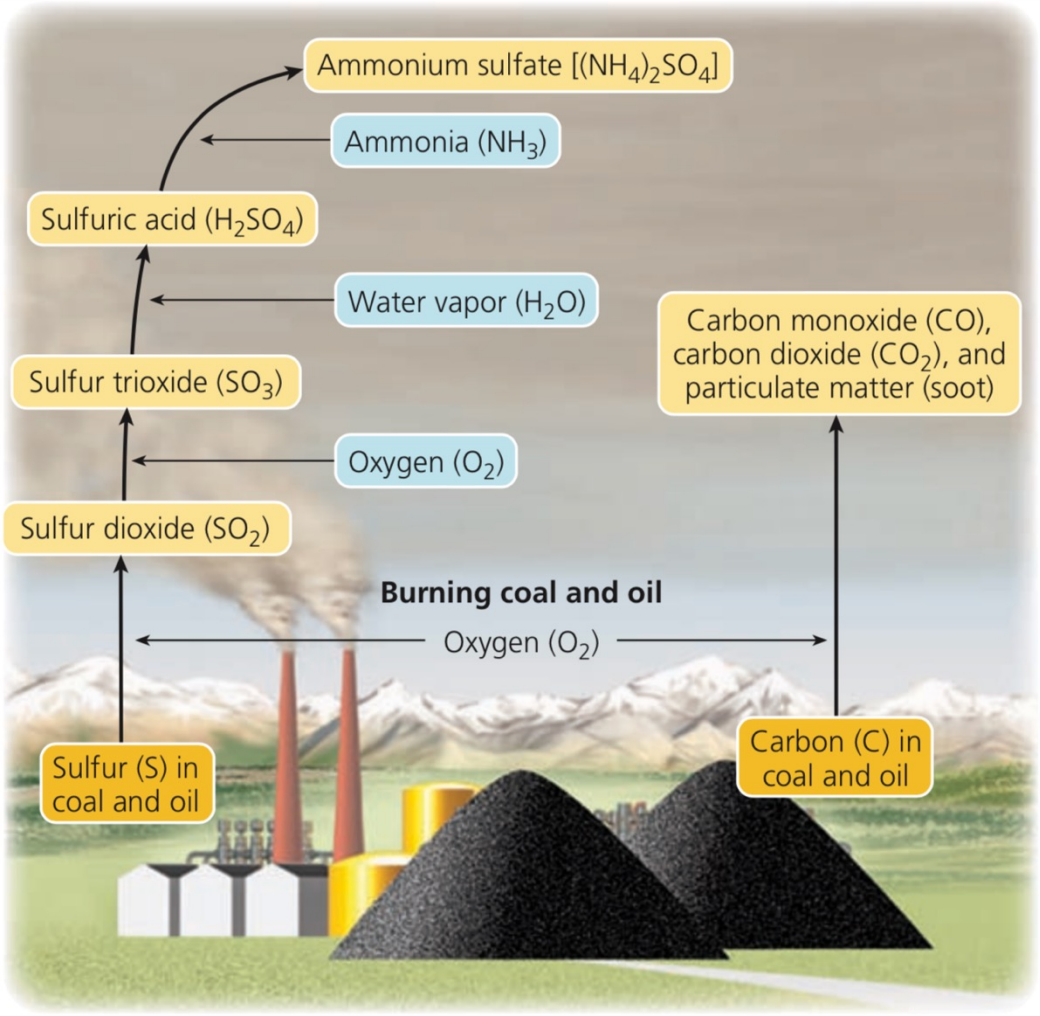


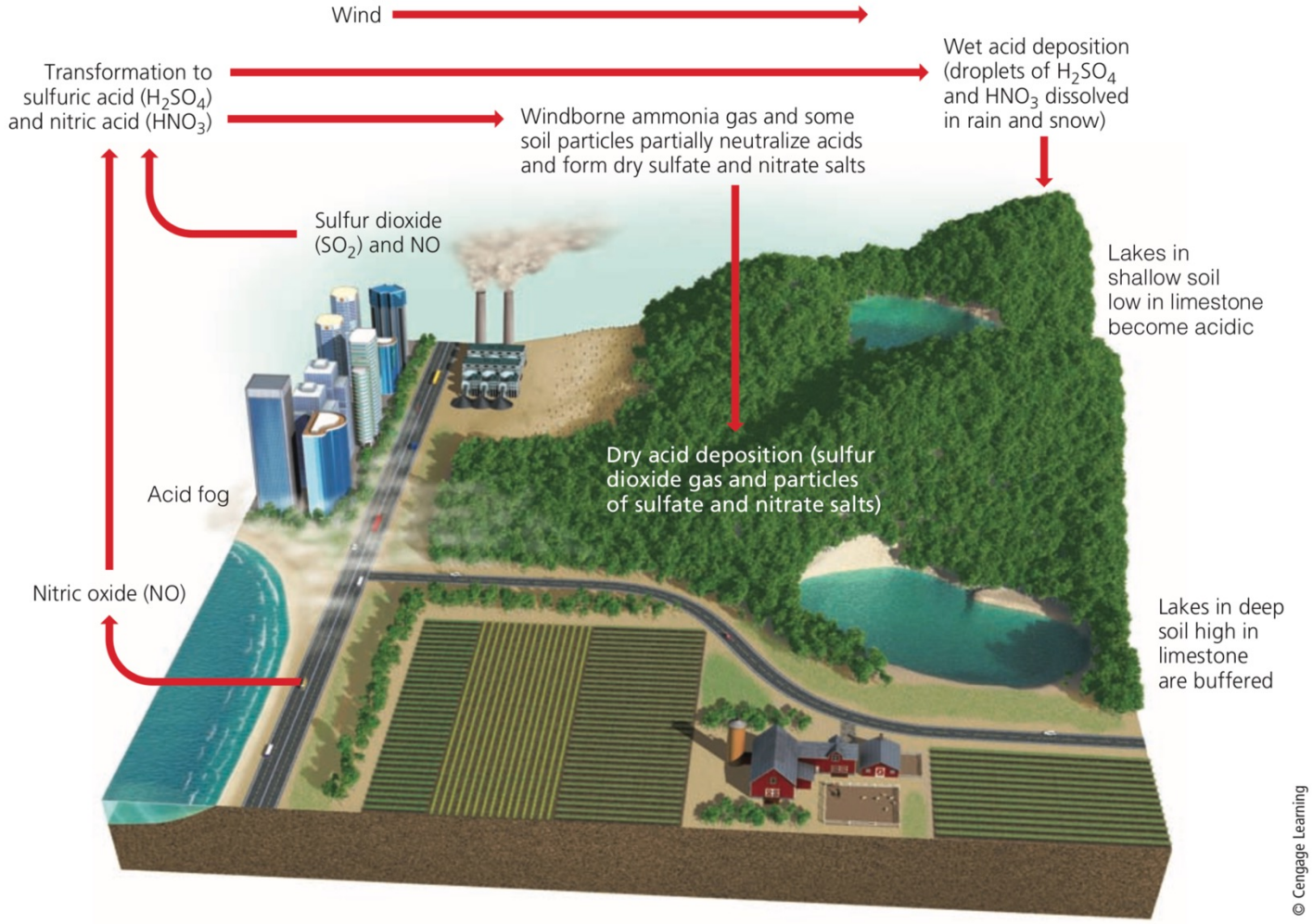
Polusi Udara

- Polutan udara dihasilkan aktivitas manusia melalui sumber bergerak (seperti mobil) dan sumber tidak bergerak (seperti industri, listrik, dan pabrik semen).
- Beberapa polutan udara primer bereaksi satu sama lain dan dengan bahan kimia lain di udara untuk membentuk polutan udara sekunder.



Dirangkum dari Miller & Spoolman (2016)





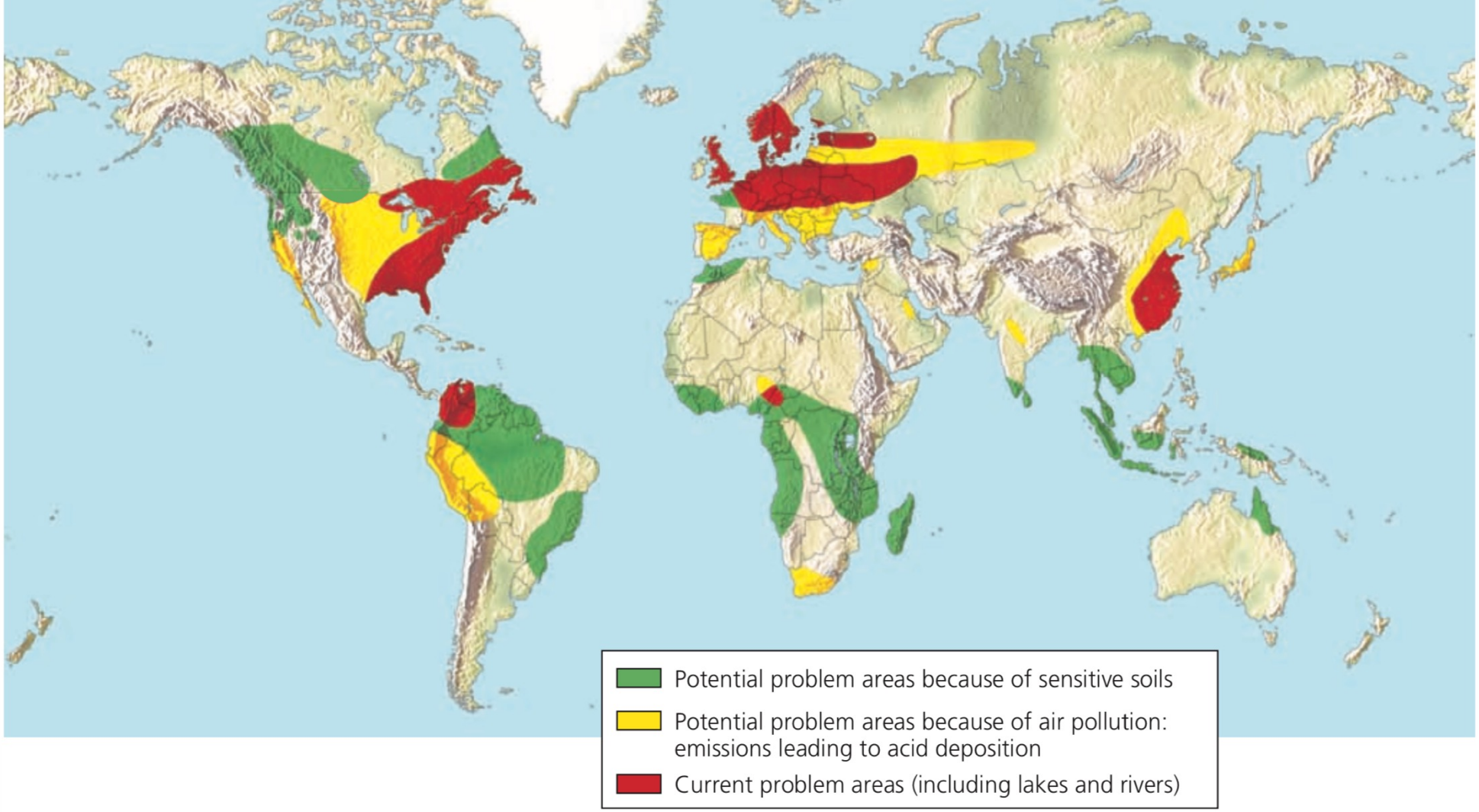
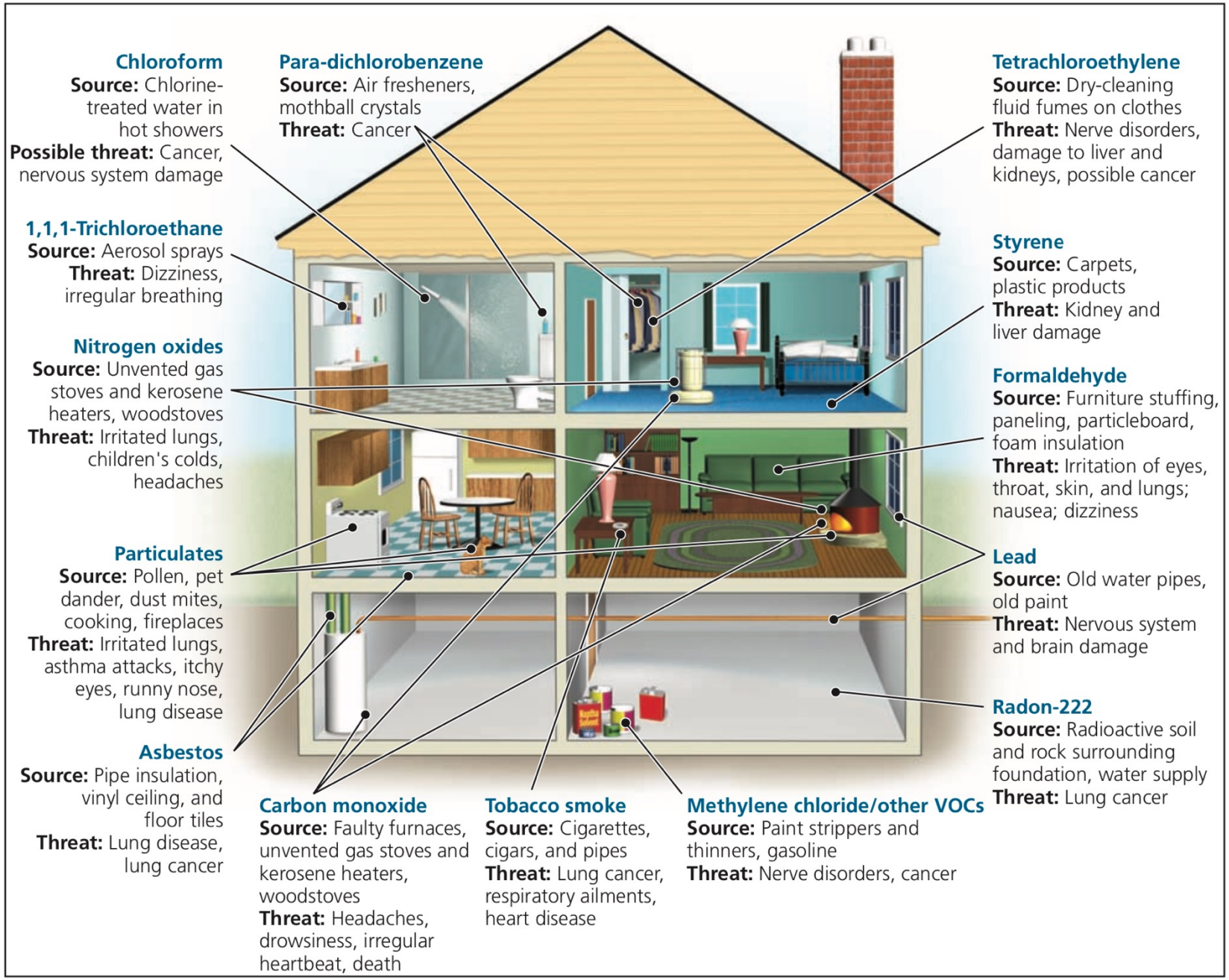
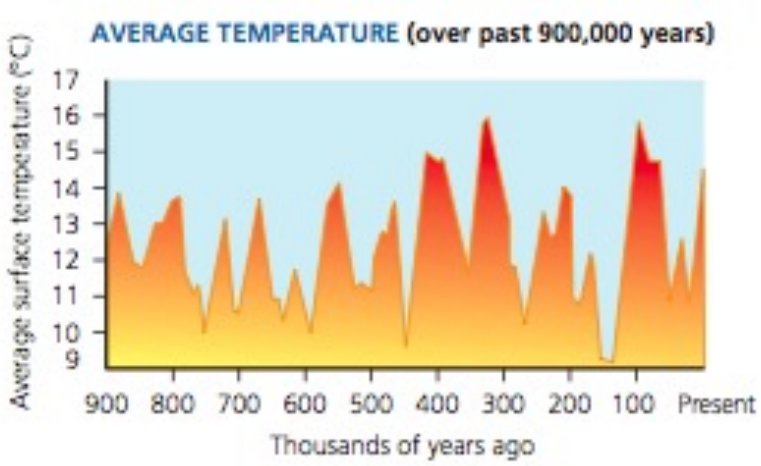


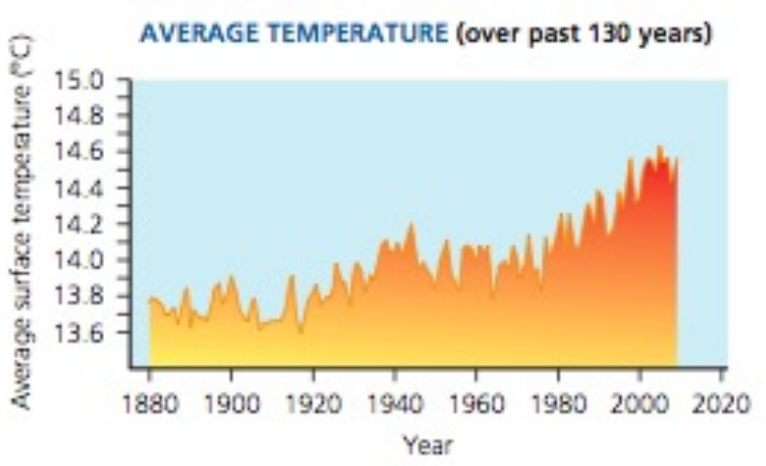
FIGURE 18.12 This map shows regions where acid deposition is now a problem and regions with the potential to develop this problem. Such regions have large inputs of air pollution (mostly from power plants, industrial facilities, and ore smelters) or are sensitive areas with naturally acidic soils and bedrock that cannot neutralize (buffer) additional inputs of acidic compounds. ***Critical thinking:*** Do you live in or near an area that is affected by acid deposition or an area that is likely to be affected by acid deposition in the future?

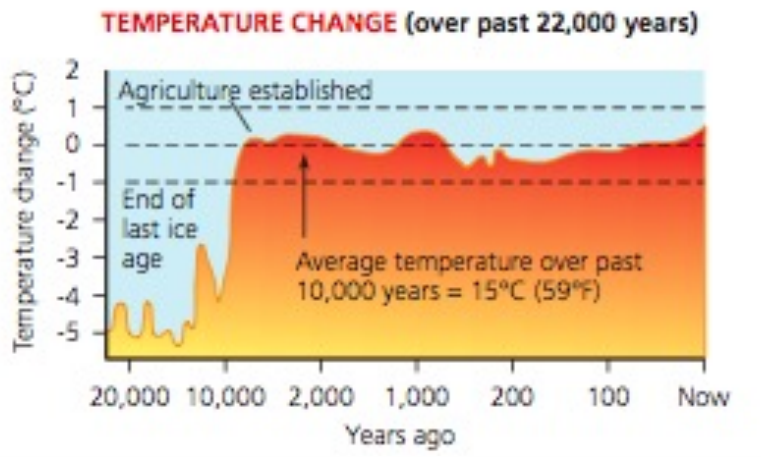


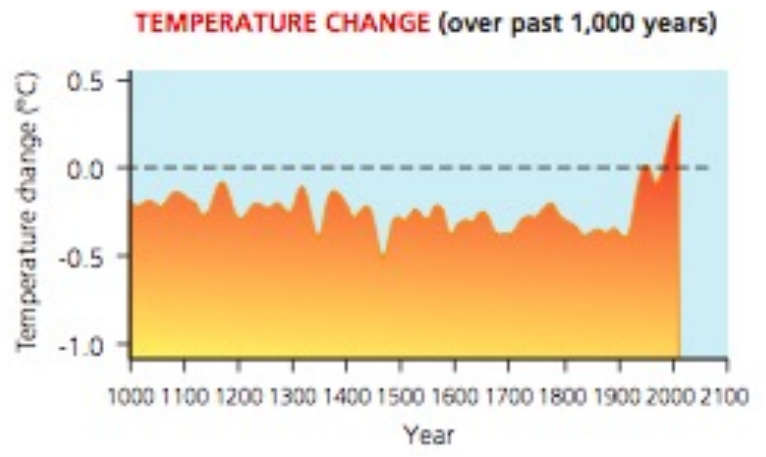
Dirangkum dari Miller & Spoolman (2016)

Pemanasan Global& Perubahan Iklim









Dirangkum dari Miller & Spoolman (2016)

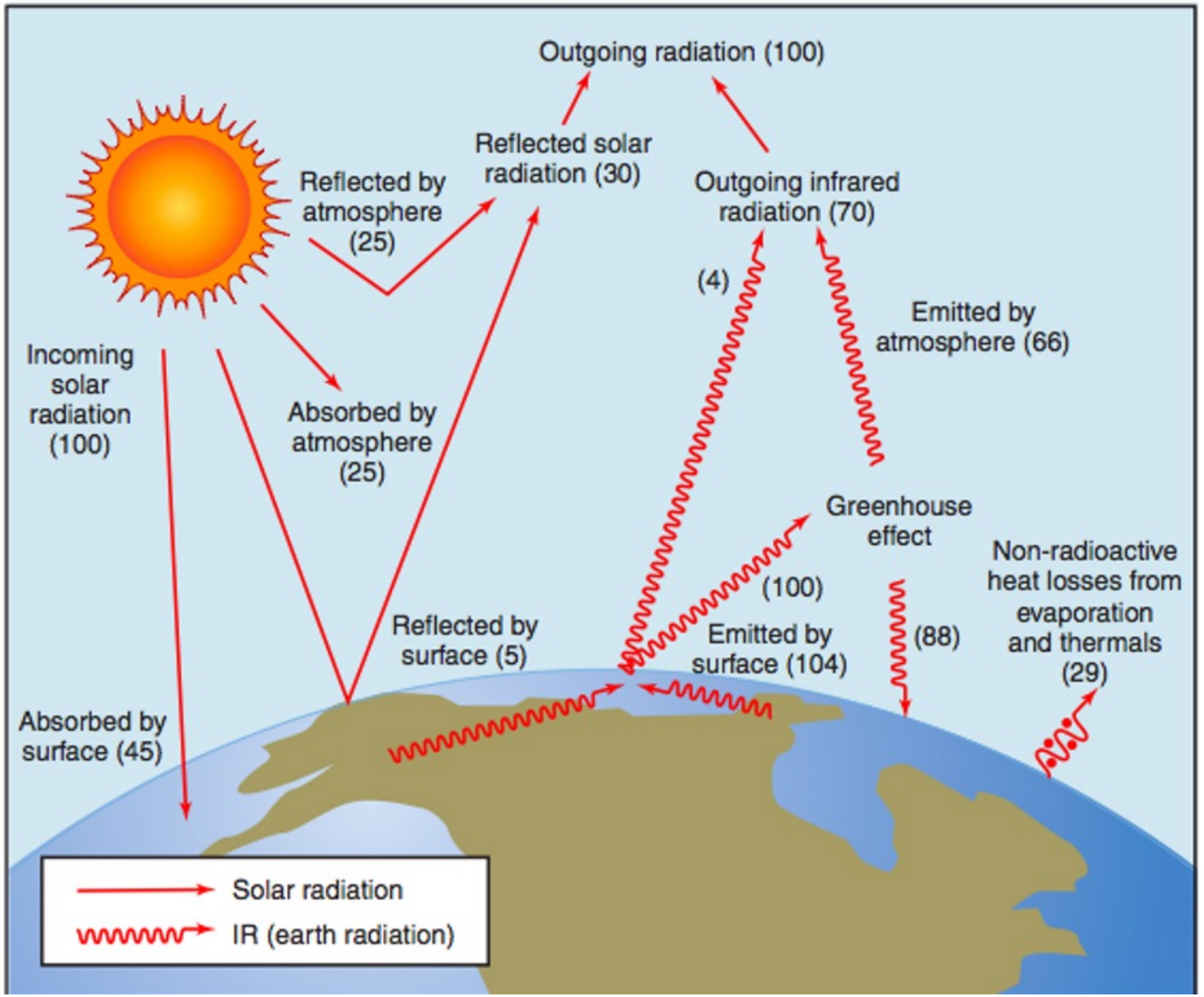


FIGURE 20.17 Idealized diagram showing Earth's energy balance and the greenhouse effect. Incoming solar radiation is arbitrarily set at 100 units, and this is balanced by outgoing radiation of 100 units. Notice that some of the fluxes (rates of transfer) of infrared radiation (IR) are greater than 100, reflecting the role of the greenhouse effect. Some of these fluxes are explained in the diagram. (*Source*: Modified from D.I. Hartmann, *Global Physical Climatology, International Geophysics Series*, vol. 56 [New York: Academic Press. 1994] and S. Schneider, "Climate Modeling," *Scientific American* 256 No. 5.)

Table 20.1 MAJOR GREENHOUSE GASES

TRACE GASES	RELATIVE CONTRIBUTION (%)	GROWTH RATE (%/YR)
CFC	15[a]-25[b]	5
CH_4	12[a]-20[b]	0.4[c]
O_3(troposphere)	8[d]	0.5
N_2O	5[d]	0.2
Total	40–50	
Contribution of CO_2	50–60	0.3[e]–0.5[d,f]

[a]W. A. Nierenberg, "Atmospheric CO_2: Causes, Effects, and Options," *Chemical Engineering Progress* 85, no.8 (August 1989): 27

[b]J. Hansen, A. Lacis, and M. Prather, "Greenhouse Effect of Chlorofluorocarbons and Other Trace Gases," *Journal of Geophysical Research* 94 (November 20, 1989): 16, 417.

[c]Over the past 200 yrs.

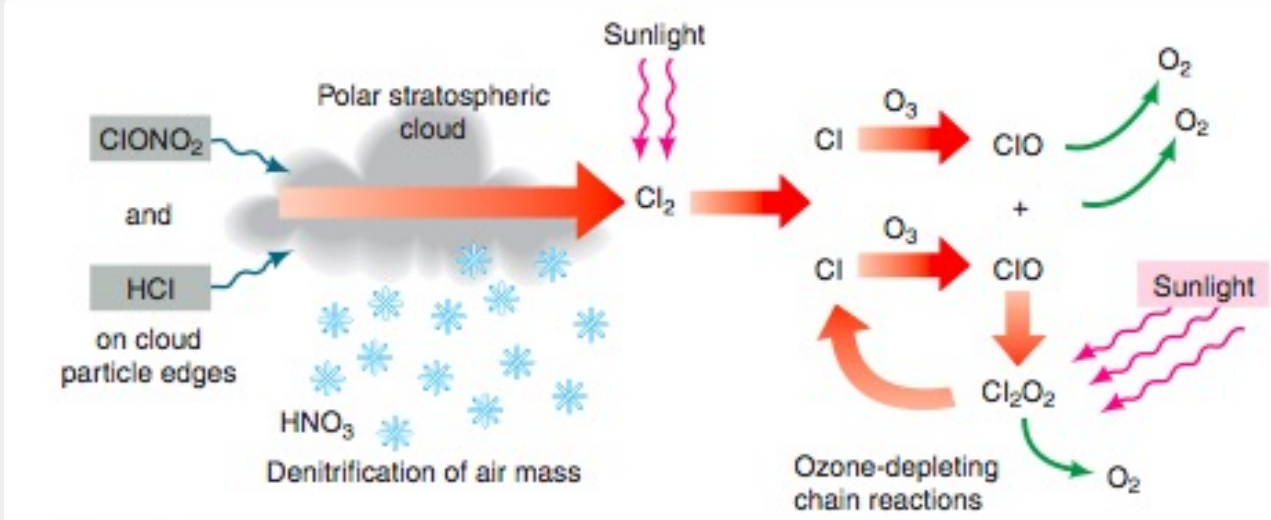
[d]H. Rodha, "A Comparison of the Contribution of Various Gases to the Greenhouse Effect," *Science* 248 (1990): 1218, Table 2.

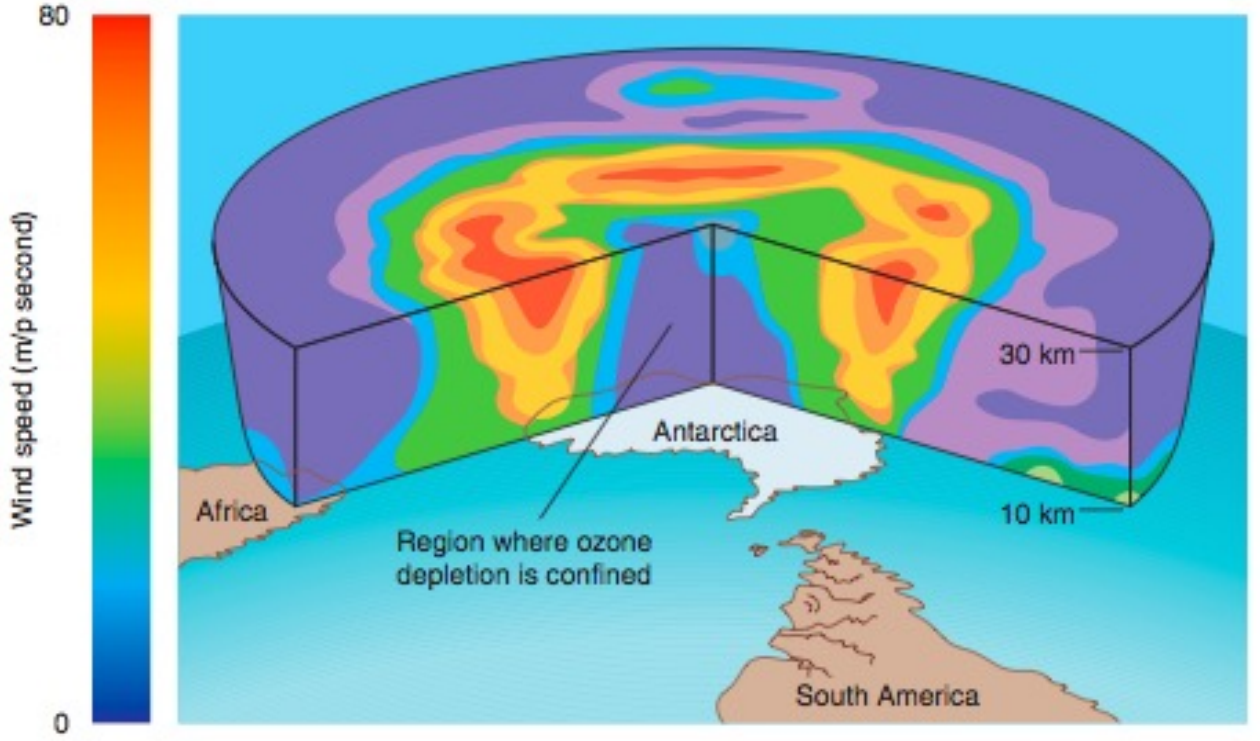
[e]W. W. Kellogg, "Economic and Political Implications of Climate Change," paper presented at Conference on Technology-based Confidence Building: Energy and Environment, University of California, Los Alamos National Laboratory, July 9–14, 1989.

[f]H. Abelson, "Uncertainties about Global Warming," *Science* 247 (March 30,1990): 1529.

Deplesi Ozon

- Penggunaan bahan kimia tertentu secara luas telah mengurangi tingkat ozon di Stratosfer,
- Hal ini memungkinkan radiasi ultraviolet yang berbahaya mencapai permukaan bumi.





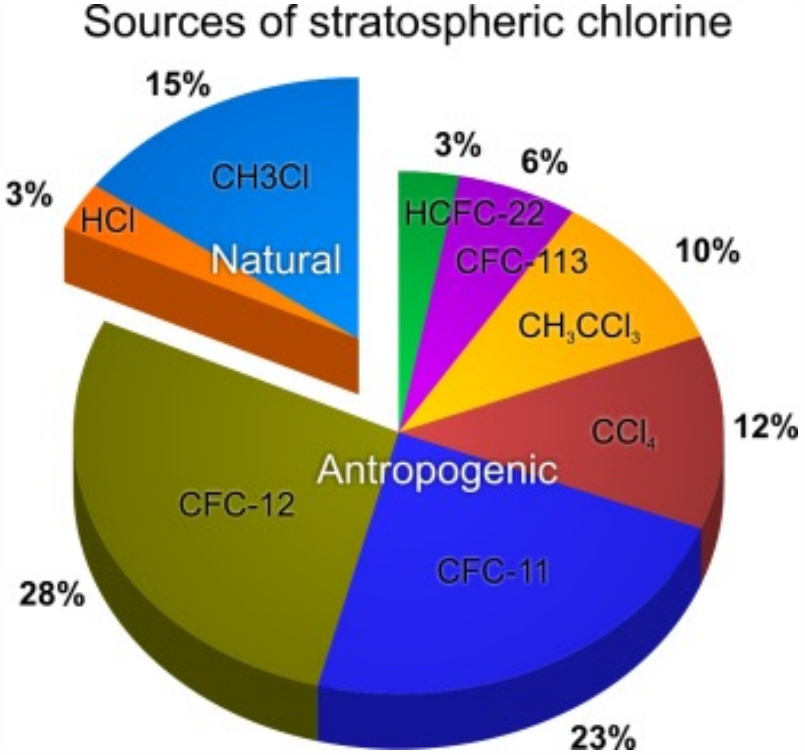
Dirangkum dari Miller & Spoolman (2016

Table 21.5 ULTRAVIOLET (UV) INDEX FOR HUMAN EXPOSURE

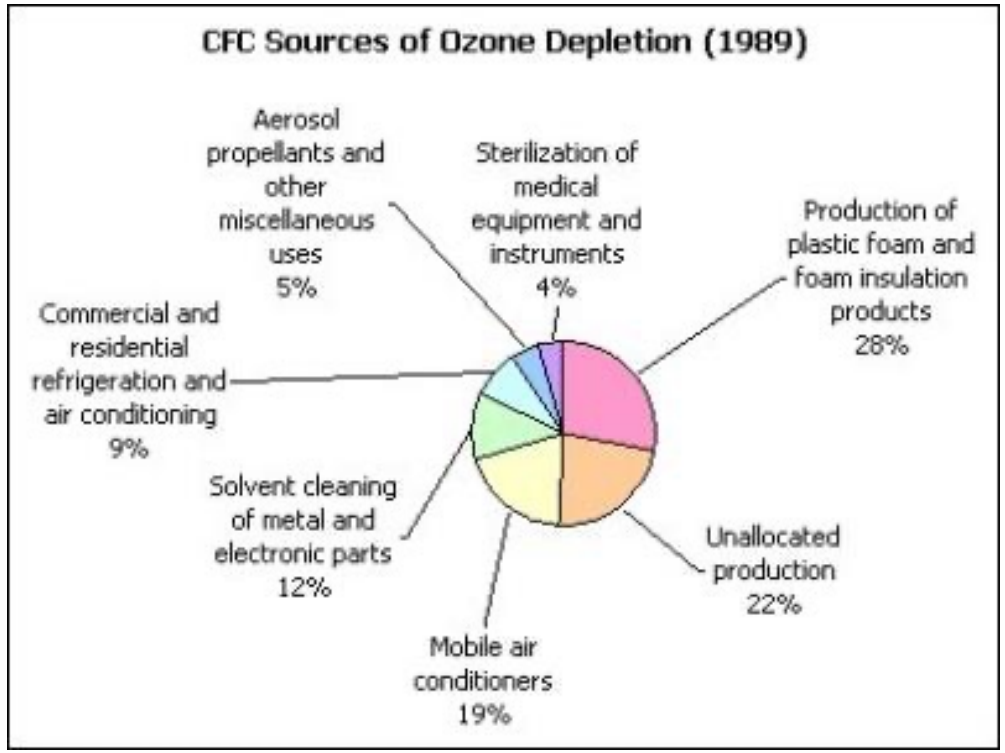
EXPOSURE CATEGORY	UV INDEX	COMMENT
Low	< 2	Sunblock recommended for all exposure
Moderate	3 to 5	Sunburn can occur quickly
High	6 to 7	Potentially hazardous
Very high	8 to 10	Potentially very hazardous
Extreme	11	Potentially very hazardous

Note: At moderate exposure to UV, sunburn can occur quickly, at high exposure, fair-skinned people may burn in 10 minutes or less of exposure.

Source: Modified after U.S. Environmental Protection Agency 2004 (with the National Weather Service). Accessed June 16, 2004 at www.epa.gov.


Sources of stratospheric chlorine
15%
CH3Cl
3%
HCl
Natural
3%
6%
HCFC-22
CFC-113
10%
CH_3CCl_3
12%
CCl_4
Antropogenic
CFC-12
CFC-11
28%
23%


Ozone-depleting Substances
Chlorofluorocarbons
Hydrochlorofluorocarbons
Volatile organic compounds


CFC Sources of Ozone Depletion (1989)
Aerosol propellants and other miscellaneous uses 5%
Sterilization of medical equipment and instruments 4%
Production of plastic foam and foam insulation products 28%
Commercial and residential refrigeration and air conditioning 9%
Solvent cleaning of metal and electronic parts 12%
Unallocated production 22%
Mobile air conditioners 19%

Natural Capital Degradation

Effects of Ozone Depletion

Human Health

- Worse sunburns
- More eye cataracts and skin cancers
- Immune system suppression

Food and Forests

- Reduced yields for some crops
- Reduced seafood supplies from reduced phytoplankton
- Decreased forest productivity for UV-sensitive tree species

Climate Change

- While in troposphere, CFCs act as greenhouse gases

Wildlife

- Increased eye cataracts in some species
- Decreased populations of aquatic species sensitive to UV radiation
- Reduced populations of surface phytoplankton
- Disrupted aquatic food webs from reduced phytoplankton

Air Pollution and Materials

- Increased acid deposition
- Increased photochemical smog
- Degradation of outdoor paints and plastics

C. Solusi Berkelanjutan

1. Penyakit Menular

Solutions

Infectious Diseases

- Increase research on tropical diseases and vaccines
- Reduce poverty and malnutrition
- Improve drinking water quality
- Reduce unnecessary use of antibiotics
- Sharply reduce use of antibiotics on livestock
- Immunize children against major viral diseases
- Provide oral rehydration for diarrhea victims
- Conduct global campaign to reduce HIV/AIDS

Dirangkum dari Miller & Spoolman (2016); https://www.biospectrumasia.com/analysis/37/4731/hope-floats-for-neglected-tropical-diseases.html

2. Senyawa Toksik

Kita dapat mengurangi risiko utama yang kita hadapi dengan menjadi terinformasi, berpikir kritis tentang risiko, dan membuat pilihan yang cermat.

Figure 17-17 *Global outlook:* This figure compares key risks that people can face, expressed in terms of an estimated shorter average life span (**Concept 17-5**). Excepting poverty and gender, the greatest risks people face come mostly from the lifestyle choices they make. These are merely generalized relative estimates. Individual responses to these risks differ because of factors such as genetic variation, family medical history, emotional makeup, stress, and social ties and support. **Question:** Which three of these factors are most likely to shorten your life span? (Data from Bernard L. Cohen)

Dirangkum dari Miller & Spoolman (2016); gambar dari https://www.britannica.com/topic/smoking-tobacco

3. Polusi Udara

Solutions

Stationary Source Air Pollution

Prevention

Burn low-sulfur coal or remove sulfur from coal

Convert coal to a liquid or gaseous fuel

Switch from coal to natural gas and renewables

Reduction or Dispersal

Disperse emissions (which increase downwind pollution) using tall smokestacks

Remove pollutants from smokestack gases

Tax each unit of pollution produced

Solutions

Motor Vehicle Air Pollution

Prevention

Walk or bike or use mass transit

Improve fuel efficiency

Get older, polluting cars off the road

Reduction

Require emission control devices

Inspect car exhaust systems twice a year

Set strict emission standards

Solutions

Indoor Air Pollution

Prevention

Ban indoor smoking

Set stricter formaldehyde emissions standards for carpet, furniture, and building materials

Prevent radon infiltration

Use naturally based cleaning agents, paints, and other products

Reduction and Dilution

Use adjustable fresh air vents for work spaces

Circulate air more frequently

Circulate a building's air through rooftop greenhouses

Use solar cookers and efficient, vented wood-burning stoves

4. Gangguan Iklim

Trade-Offs

Carbon and Energy Taxes

Advantages

Simple to administer

Clear price on carbon

Covers all emitters

Predictable revenues

Disadvantages

Tax laws can get complex

Vulnerable to loopholes

Doesn't guarantee lower emissions

Politically unpopular

Figure 19-17 Using carbon and energy taxes or fees to help reduce greenhouse gas emissions has advantages and disadvantages. **Question:** Which two advantages and which two disadvantages do you think are the most important and why?

Trade-Offs

Cap and Trade Policies

Advantages

Clear legal limit on emissions

Rewards cuts in emissions

Record of success

Low expense for consumers

Disadvantages

Revenues not predictable

Vulnerable to cheating

Rich polluters can keep polluting

Puts variable price on carbon

Figure 19-18 Using a cap-and-trade policy to help reduce greenhouse gas emissions has advantages and disadvantages. **Question:** Which two advantages and which two disadvantages do you think are the most important and why?

Solutions

Slowing Climate Disruption

Prevention

Cut fossil fuel use (especially coal)

Shift from coal to natural gas

Improve energy efficiency

Shift to renewable energy resources

Transfer energy efficiency and renewable energy technologies to developing countries

Reduce deforestation

Use more sustainable agriculture and forestry

Put a price on greenhouse gas emissions

Reduce poverty

Slow population growth

Cleanup

Remove CO_2 from smokestack and vehicle emissions

Store (sequester) CO_2 by planting trees

Sequester CO_2 in soil by using no-till cultivation and taking cropland out of production

Sequester CO_2 deep underground (with no leaks allowed)

Sequester CO_2 in the deep ocean (with no leaks allowed)

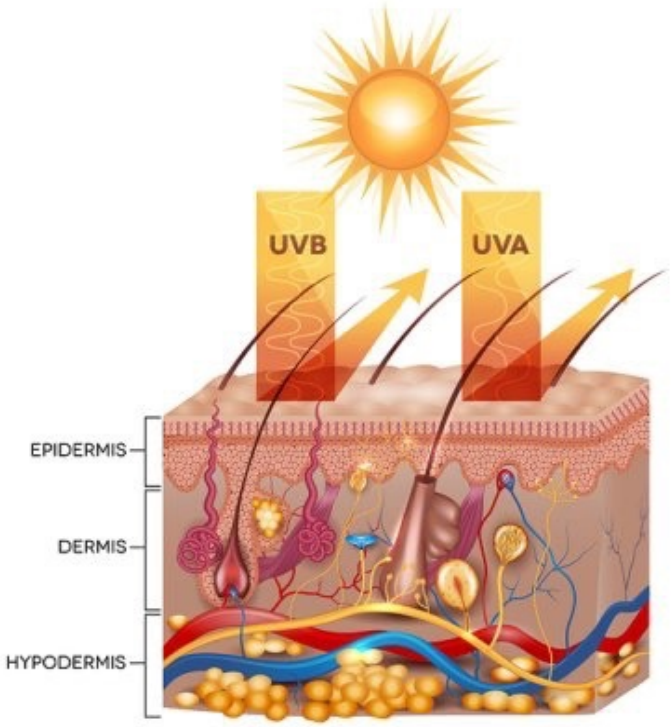
Repair leaky natural gas pipelines and facilities

Use animal feeds that reduce CH_4 emissions from cows (belching)

Dirangkum dari Miller & Spoolman (2016)

5. Deplesi Ozon

PROTECTED SKIN
WITH A SUNSCREEN LOTION



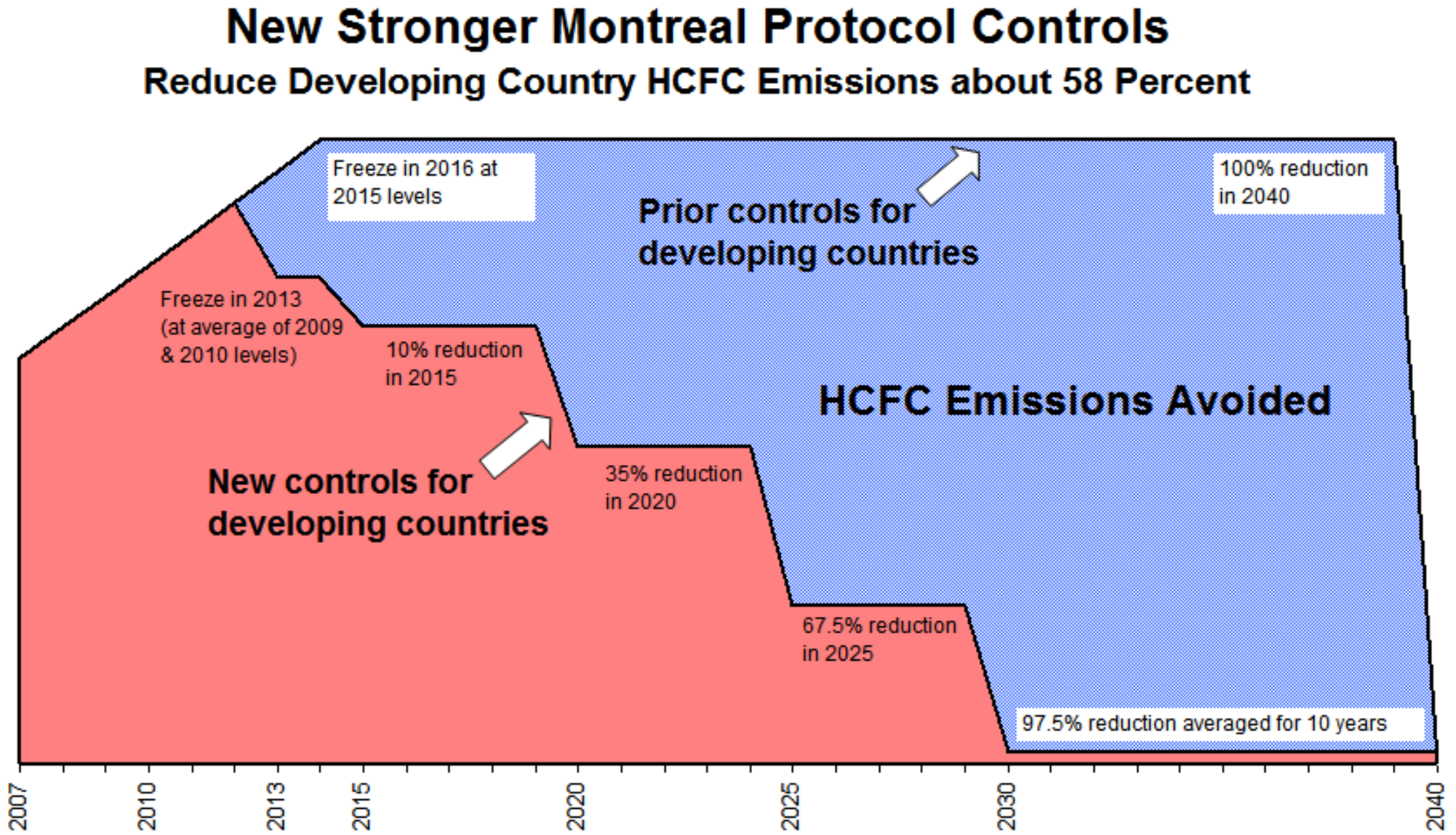
What Can You Do?

Reducing Exposure to UV Radiation

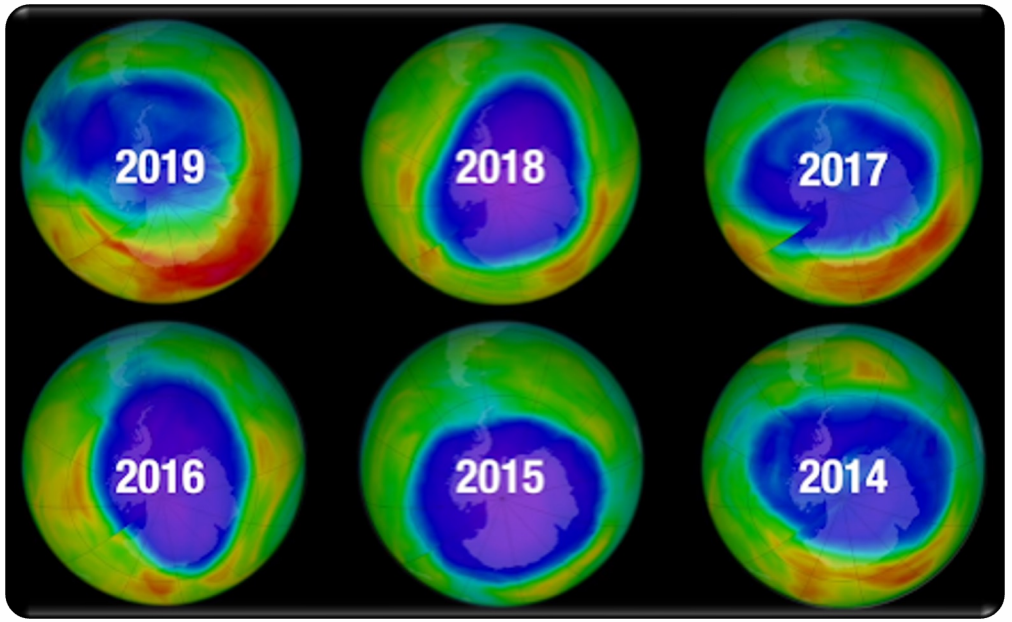
- Stay out of the sun, especially between 10 A.M. and 3 P.M.
- Do not use tanning parlors or sunlamps.
- When in the sun, wear protective clothing and sunglasses that protect against UV-A and UV-B radiation.
- Be aware that overcast skies do not protect you.
- Do not expose yourself to the sun if you are taking antibiotics or birth control pills.
- When in the sun, use a sunscreen with a protection factor of at least 15.
- Examine your skin and scalp at least once a month for moles or warts that change in size, shape, or color and sores that do not heal. If you observe any of these signs, consult a doctor immediately.

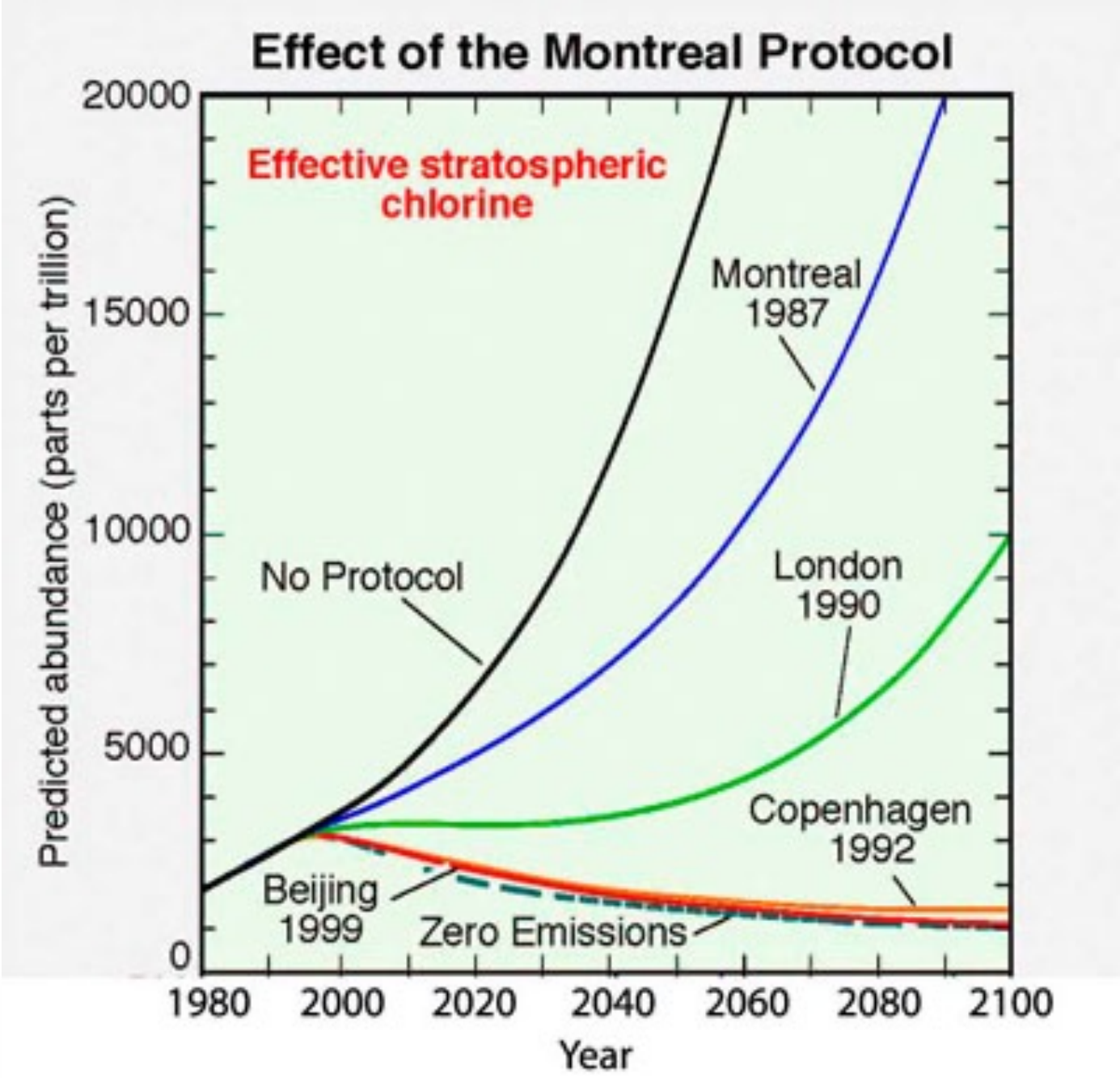
Dirangkum dari Miller & Spoolman (2016); https://www.dwoseth.com/blog/different-types-of-uv-rays/

Untuk membalikkan penipisan ozon, kita harus berhenti memproduksi bahan kimia perusak ozon dan mematuhi perjanjian internasional yang melarang bahan kimia tersebut.



Dirangkum dari Miller & Spoolman (2016)





https://www.ladbible.com/news/news-earths-ozone-layer-appears-to-continue-to-heal-20200326