

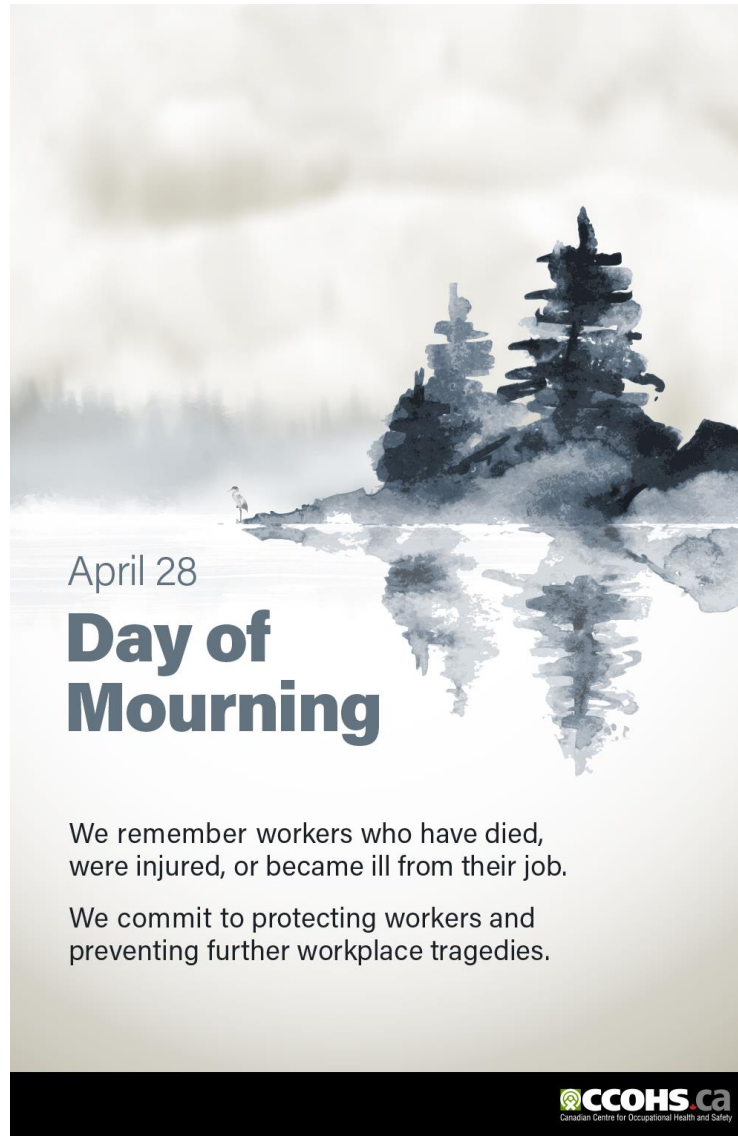


# Three Strikes to Cancer

## Occupational Carcinogen Exposure & Prevention

Ryan Campbell – B.Sc., CIH, ROH, CRSP





April 28

# Day of Mourning

We remember workers who have died, were injured, or became ill from their job.

We commit to protecting workers and preventing further workplace tragedies.



## In memory of the 161 people in Alberta who died from workplace injury or illness in 2022

Donald, 86, occupational disease • Herbert, 87, occupational disease • Paul, 58, trauma • Farron, 65, trauma • Dellon, 62, motor vehicle accident • Harvey, 71, motor vehicle accident • Raymond, 90, occupational disease • Hussain, 69, occupational disease • Ernest, 89, occupational disease • Rodney, 75, occupational disease • Douglas, 68, occupational disease • Dennis, 75, occupational disease • Manuel, 82, occupational disease • Roger, 84, occupational disease • Ronald, 66, occupational disease • Jack, 82, occupational disease • John, 75, occupational disease • Jack, 83, occupational disease • Gerry, 86, occupational disease • Eric, 75, occupational disease • John, 74, occupational disease • Kenneth, 81, occupational disease • Richard, 80, occupational disease • Joseph, 77, occupational disease • Larry, 80, occupational disease • Harry, 86, occupational disease • George, 84, occupational disease • Brian, 58, occupational disease • Gordon, 84, occupational disease • James, 82, occupational disease • Wayne, 76, occupational disease • Harold, 90, occupational disease • Vaughan, 85, occupational disease • Richard, 77, occupational disease • Lawrence, 73, occupational disease • Kevin, 58, occupational disease • Marshall, 80, occupational disease • Kenneth, 86, occupational disease • Donald, 78, trauma • Wayne, 79, occupational disease • Malcolm, 83, occupational disease • Gordon, 90, occupational disease • Nell, 72, occupational disease • Troy, 74, occupational disease • Luther, 79, occupational disease • Anthony, 38, trauma • Larry, 88, occupational disease • Raymond, 80, occupational disease • John, 83, occupational disease • Maurice, 73, occupational disease • Roman, 82, occupational disease • Maghar, 88, occupational disease • Lyle, 83, occupational disease • Davis, 77, occupational disease • Robert, 76, occupational disease • Dennis, 80, occupational disease • James, 68, occupational disease • David, 78, occupational disease • Peter, 85, occupational disease • Vincent, 60, occupational disease • Allen, 64, occupational disease • Alfred, 74, occupational disease • Jack, 79, occupational disease • Harold, 73, occupational disease • Roderick, 70, occupational disease • Hope, 60, occupational disease • Joseph, 68, occupational disease • Thomas, 70, occupational disease • Ronald, 72, occupational disease • Gary, 80, occupational disease • Frank, 80, occupational disease • Colleen, 63, occupational disease • Richard, 70, occupational disease • Reni, 50, occupational disease • Adrian, 68, occupational disease • Terry, 72, occupational disease

• Todd, 46, occupational disease • Stacy, 53, cardiac • Bernice, 79, trauma • Curtis, 41, occupational disease • Patrick, 68, occupational disease • Richard, 84, occupational disease • Raul, 74, occupational disease • Troy, 53, occupational disease • Les, 80, cardiac • David, 60, trauma • Michael, 52, cardiac • Edward, 88, occupational disease • Warren, 42, occupational disease • Collin, 55, occupational disease • Lisa, 44, occupational disease • Andrew, 35, trauma • Bilal, 36, trauma • Kevin, 60, motor vehicle accident • Aloysius, 56, trauma • Darrell, 73, occupational disease • Samantha, 54, occupational disease • Christopher, 51, motor vehicle accident • Daryl, 58, trauma • Scott, 37, trauma • Zachary, 18, trauma • Walter, 78, occupational disease • Neil, 55, trauma • Clifford, 73, occupational disease • Curtis, 21, motor vehicle accident • Louie, 41, motor vehicle accident • Trevor, 54, occupational disease • Sonja, 81, occupational disease • Britney, 56, motor vehicle accident • Stephen, 39, motor vehicle accident • Daniel, 57, occupational disease • Peter, 76, occupational disease • Thomas, 92, occupational disease • Bekele, 65, trauma • Gerry, 47, trauma • Remi, 89, occupational disease • Leonard, 75, occupational disease • Adam, 30, motor vehicle accident • Darryl, 39, motor vehicle accident • Robert, 68, occupational disease • Jonathan, 23, trauma • Nicholas, 43, trauma • William, 68, occupational disease • Wayne, 75, occupational disease • Wayne, 52, occupational disease • Hung, 64, trauma • Eugene, 53, trauma • Nell, 65, trauma • Robert, 67, occupational disease • Ray, 80, occupational disease • Phillip, 73, occupational disease • Howard, 68, occupational disease • Josh, 19, trauma • Brandon, 26, trauma • Phillip, 39, motor vehicle accident • Orin, 61, trauma • Robert, 92, occupational disease • Merle, 79, occupational disease • Gregory, 65, motor vehicle accident • Derrick, 39, motor vehicle accident • Charlie, 51, trauma • Corey, 53, motor vehicle accident • Omar, 38, trauma • Dallas, 51, motor vehicle accident • Daan, 20, motor vehicle accident • Adam, 39, motor vehicle accident • Jaspinder, 31, motor vehicle accident • Prince, 33, trauma • Jaden, 22, motor vehicle accident • Brian, 23, motor vehicle accident • Kaled, 57, motor vehicle accident • Gurkirat, 47, motor vehicle accident • Terrance, 55, trauma • Navjot, 29, motor vehicle accident • Darcy, 47, trauma • Gregory, 29, trauma • Shaun, 38, trauma • Naveed, 29, motor vehicle accident • Jesse, 41, motor vehicle accident • Loriel, 40, motor vehicle accident • Pete, 42, motor vehicle accident

## Reflecting on the memories we shared



Day of Mourning  
April 28



We can make a difference by working together to make workplaces safer.



# Fatalities - 2022




## Fatalities - 2022

Cardiac	3



## Fatalities - 2022

Cardiac	3
Motor Vehicle Accident	27



## Fatalities - 2022

Cardiac	3
Motor Vehicle Accident	27
Trauma	30



## Fatalities - 2022

Cardiac	3
Motor Vehicle Accident	27
Trauma	30
Occupational Disease	101



## Fatalities - 2022

Cardiac	3 (1.9%)
Motor Vehicle Accident	27 (16.8%)
Trauma	30 (18.6%)
Occupational Disease	101 (62.7%)
<b>Total</b>	<b>161</b>



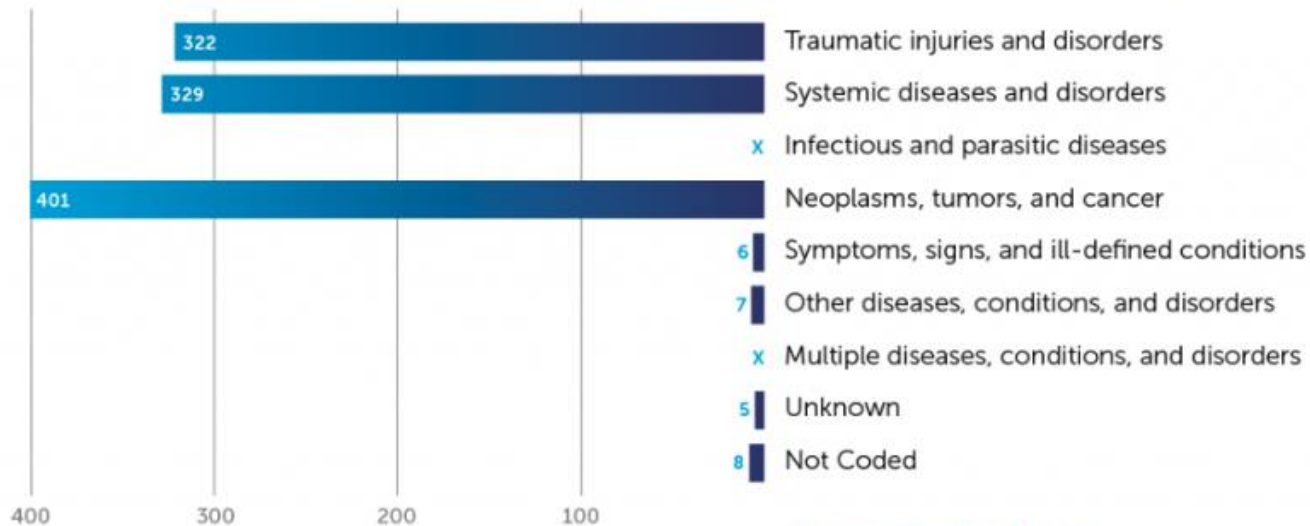


# 2021 Fatalities in Canada



CANADA TOTAL: 1,081

BY NATURE OF INJURY OR DISEASE



AN "X" INDICATES A VALUE OF 3 OR LESS

Need more information?



MORE

Each category above can be broken down into further detail. If interested, [Request Customized Lost Time Injury, Disease and Fatality Data.](#)

<https://awcbc.org/en/statistics/#fatalities>





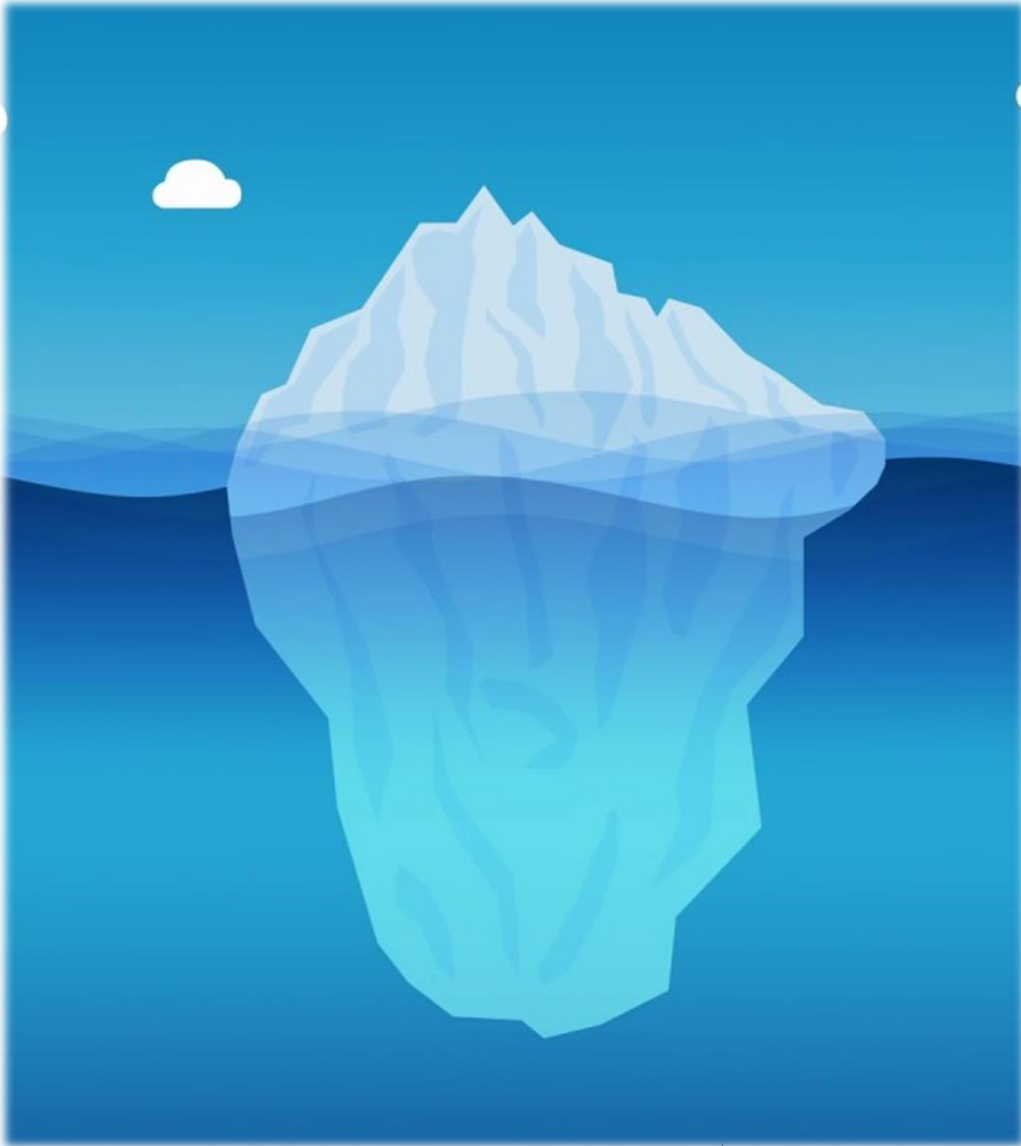
<b>Year</b>	<b>Total Fatalities</b>	<b>Illness</b>	<b>Injury</b>
<b>2021</b>	<b>1,081</b>	<b>743</b>	<b>322</b>
<b>2020</b>	<b>924</b>	<b>611</b>	<b>313</b>
<b>2019</b>	<b>925</b>	<b>590</b>	<b>335</b>
<b>2018</b>	<b>1,027</b>	<b>665</b>	<b>362</b>
<b>2017</b>	<b>951</b>	<b>625</b>	<b>326</b>

[https://www.uregina.ca/business/faculty-staff/faculty/tucker\\_sean.html](https://www.uregina.ca/business/faculty-staff/faculty/tucker_sean.html)



## Reasons for Underestimate

- Long latency
- Not counted – self employed, agriculture
- Lack of disease/work connection
- WCB

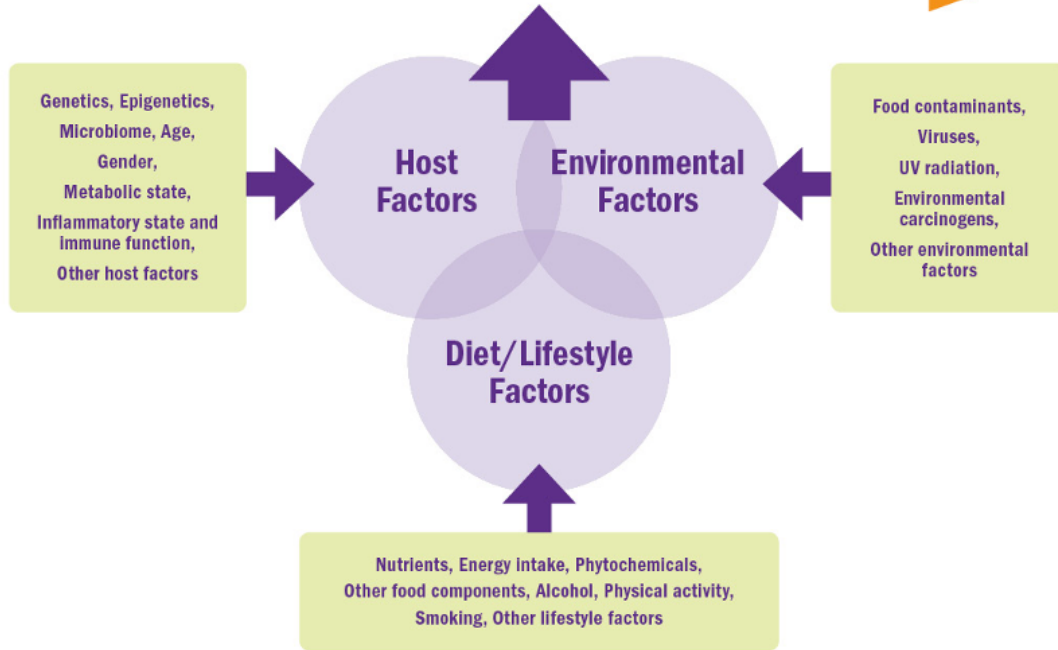
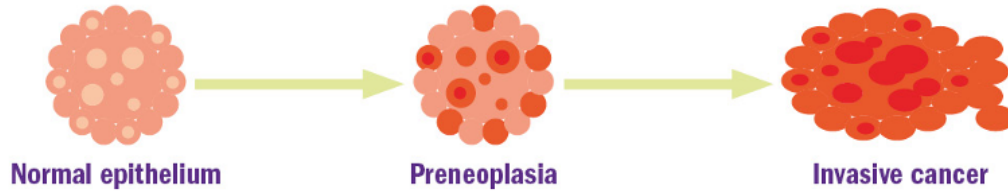


“We estimate that the number of work-related fatalities in Canada is at least ten to thirteen times higher than the ~900-1,000 annual average fatalities reported by the AWCBC”

Steven Bittle, Ashley Chen, and Jasmine Hébert, “Work-Related Deaths in Canada,” *Labour/Le Travail* 82 (Fall 2018): 159–187.

- Alberta Health 3-11%
- OCRC 20-30% of “blue-collar” cancers

**Diet, nutrition and physical activity, other environmental exposures and host factors interact to affect the cancer process**



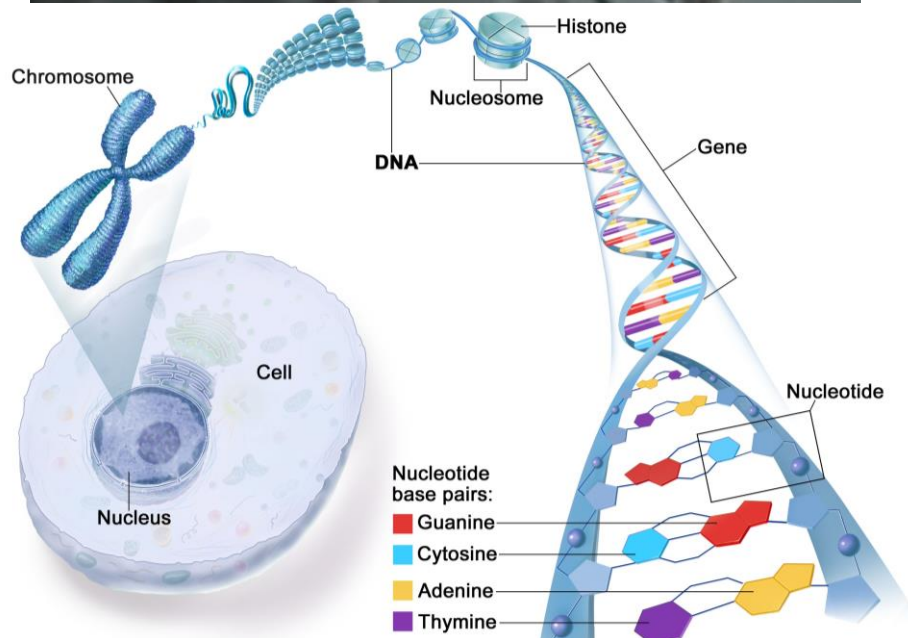
© World Cancer Research Fund International [dietandcancerreport.org](http://dietandcancerreport.org)



# DNA

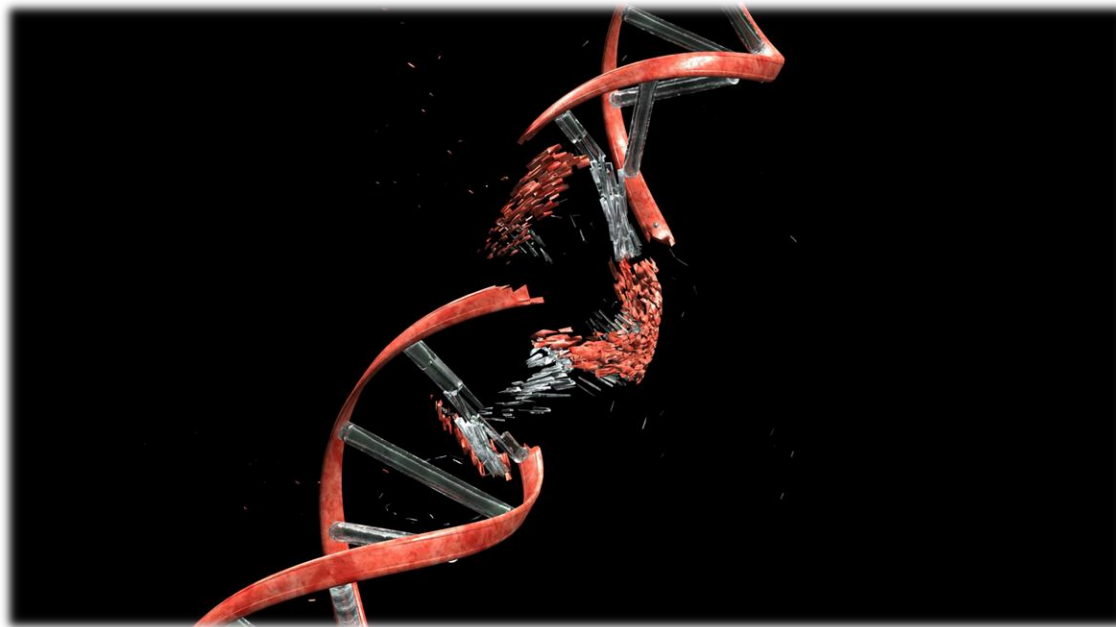
The molecule inside cells that contains the genetic information responsible for the development and function of an organism.

National Cancer Institute

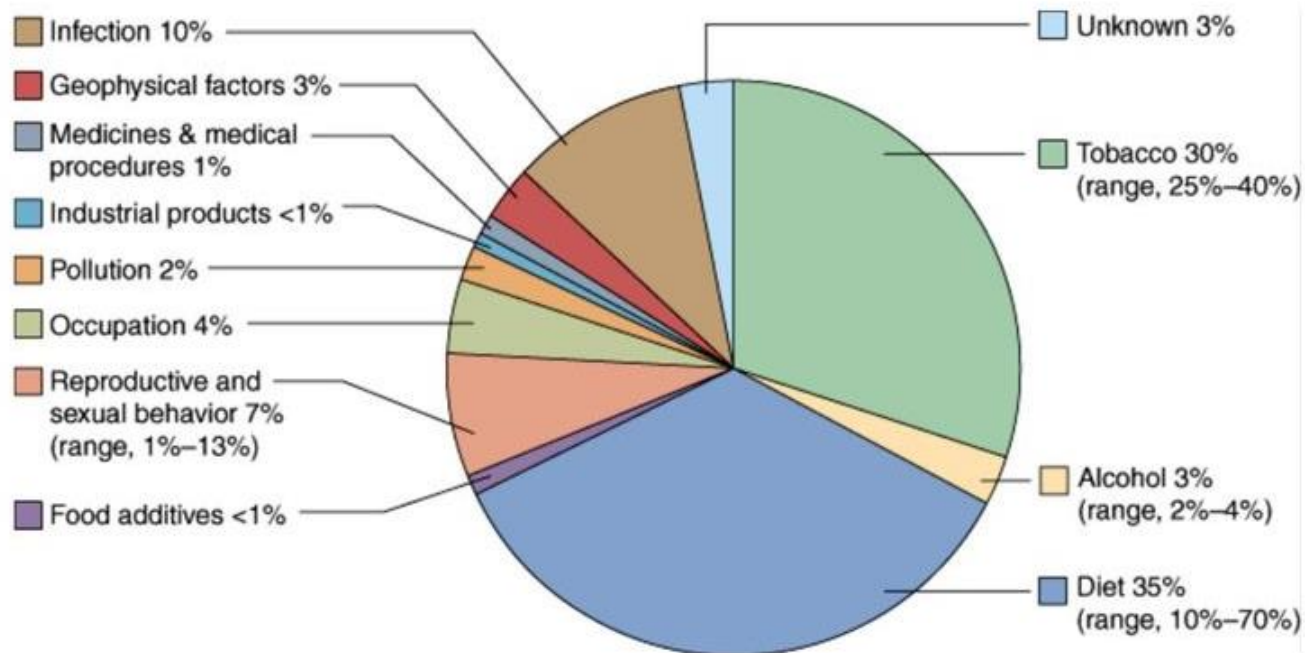


# Carcinogen: a physical or chemical agent that causes or induces autonomous growth of tissue

Casarett & Doull's Toxicology







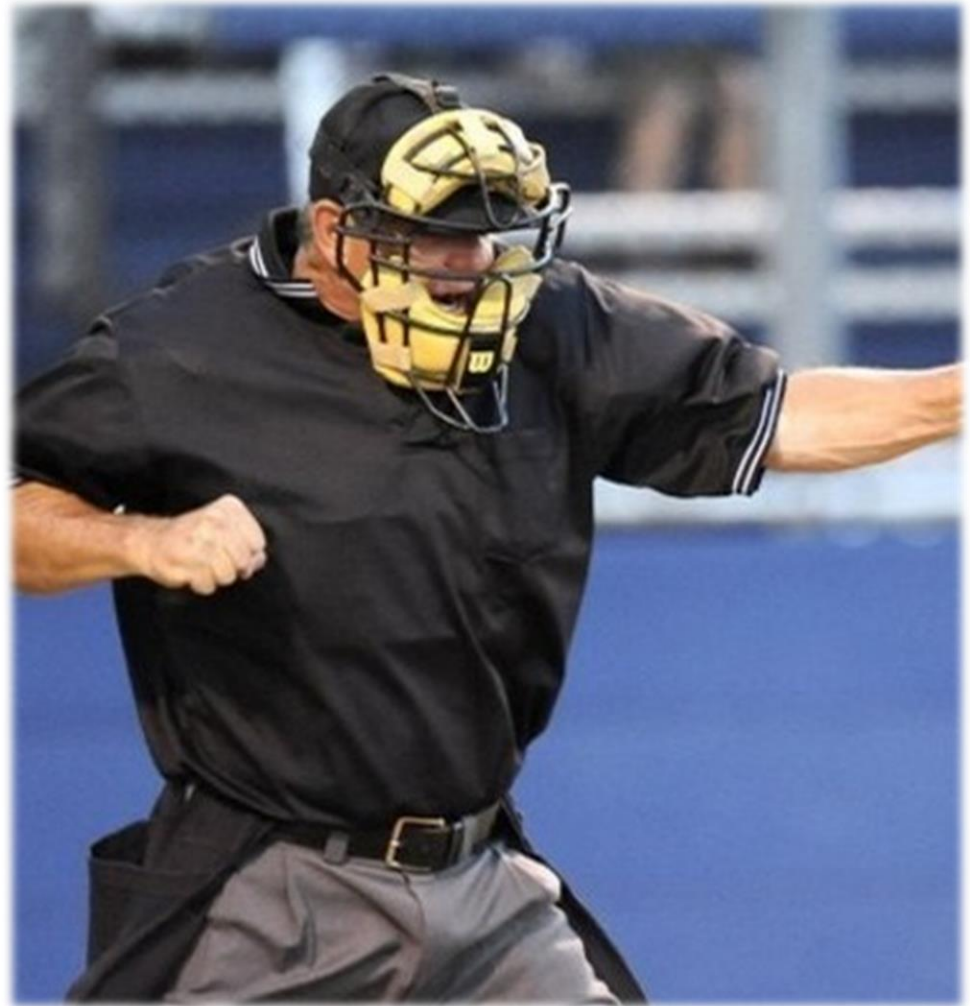
Proportions of human cancer deaths attributed to various factors. (Reproduced with permission from [no authors listed] Harvard reports on cancer prevention: causes of human cancer. Center for Cancer Prevention Harvard School of Public Health. Cancer Causes and Control. 1996;7 (Suppl 1):S3–S4, 1996.)

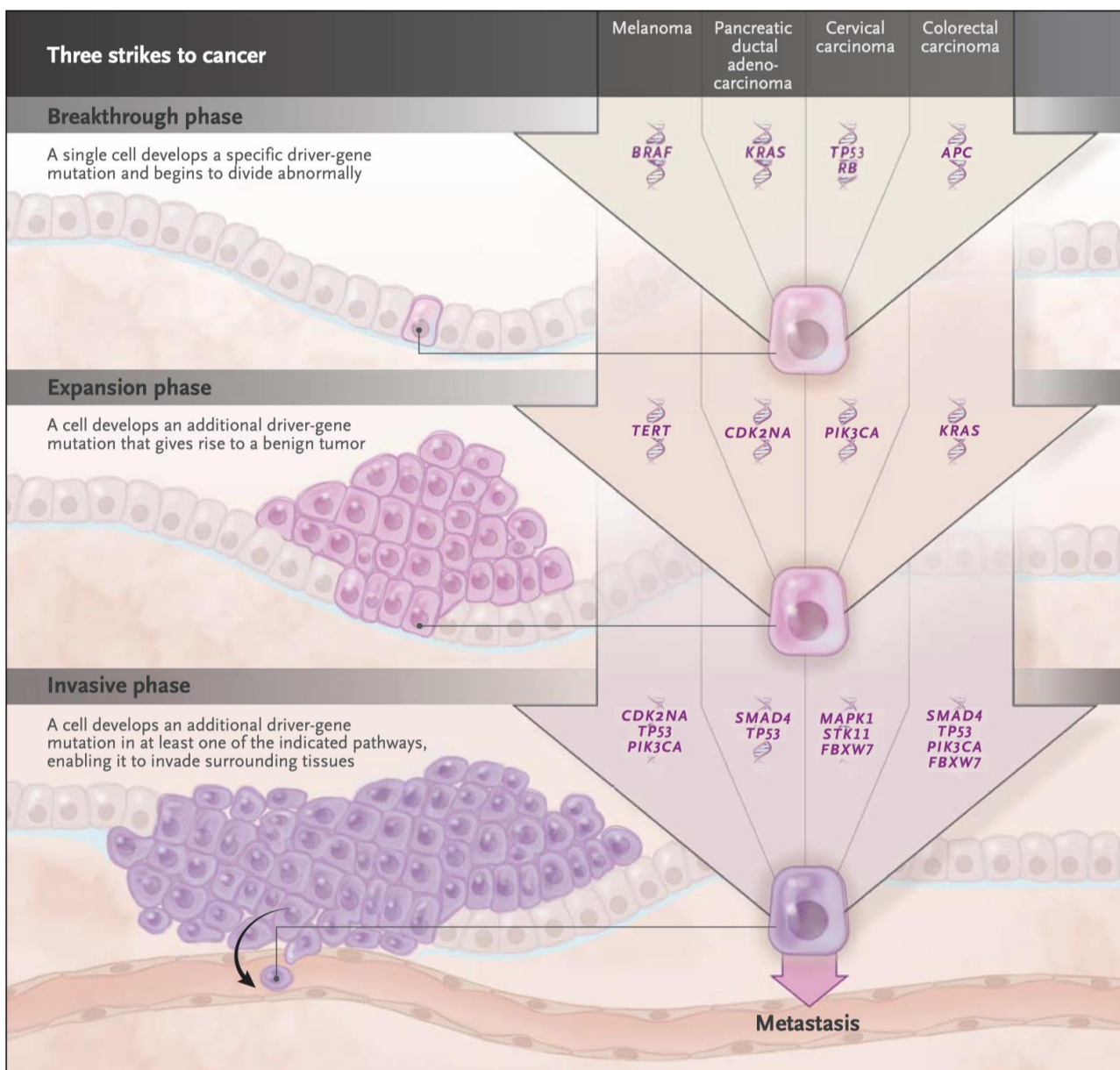


CARCINOGEN	IARC EVALUATION FOR CARCINOGENICITY	NUMBER OF CANADIAN WORKERS EXPOSED	NUMBER OF CANCERS ATTRIBUTABLE TO OCCUPATIONAL EXPOSURE (PROPORTION OF ALL CANCER CASES DUE TO OCCUPATIONAL EXPOSURE)
Solar ultraviolet radiation	Definite	1,476,000	4,600 non-melanoma skin (6.3%)
Asbestos	Definite	152,000	1,900 lung (8.0%) 430 mesothelioma (80.5%) 45 larynx (3.7%) 15 ovarian (0.5%)
Diesel engine exhaust	Definite	897,000	560 lung (2.4%) 200 bladder (2.7%)
Silica (crystalline)	Definite	382,000	570 lung (2.4%)
Welding fumes <sup>a</sup>	Definite	333,000	310 lung (1.3%)
Nickel compounds	Definite	117,000	170 lung (0.7%)
Chromium (VI)	Definite	104,000	50 lung (0.2%)
Radon	Definite	188,000	190 lung (0.8%)
Second-hand smoke	Definite	520,000	130 lung (0.6%) 35 pharynx (2.4%) 20 larynx (1.6%)
Night shift work	Probable	1.9 million	470-1,200 breast (2.0-5.2%)
Polycyclic aromatic hydrocarbons (PAHs)	Definite, probable, possible, unclassifiable	350,000	130 lung (0.6%) 80 bladder (1.1%) 50 skin (0.07%)
Arsenic	Definite	25,000	60 lung (0.3%)
Benzene	Definite	374,000	20 leukemia (0.5%) 5 multiple myeloma (0.2%)

# Three Strikes

- Breakthrough
- Expansion
- Invasive

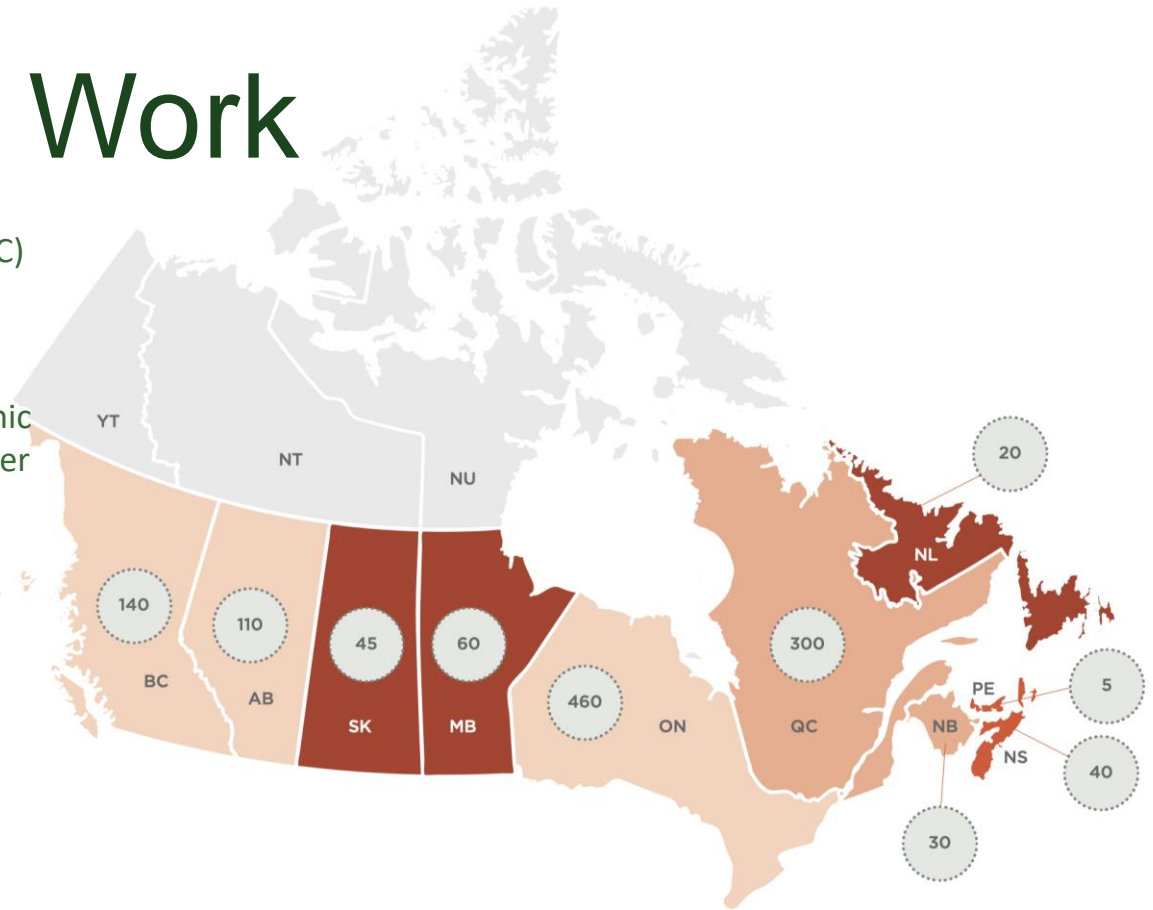




Vogelstein B, Kinzler KW. N Engl J Med 2015;373:1895-1898.

# Night Shift Work

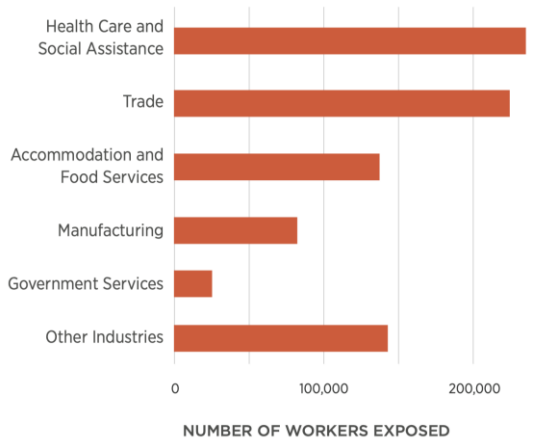
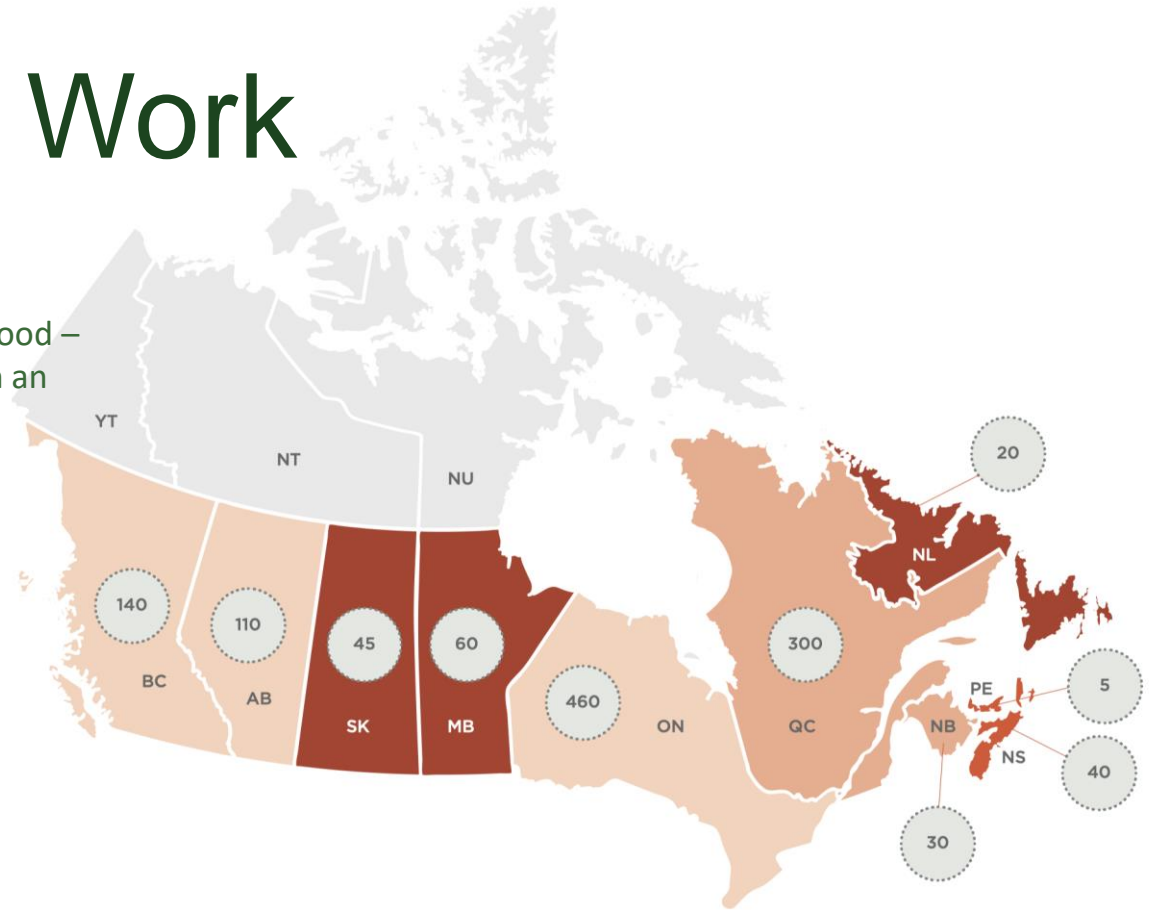
- Probable = sufficient evidence of cancer in humans & limited evidence in humans (IARC)
- Increased risk of breast cancer
- Changing light/dark schedule leads to chronic inflammation, immunosuppression and other contributors to cancer.
- 12% of working Canadians work night shifts
- More research needed as to mechanism to improve control options



Occupational Cancer Research Centre. Burden of occupational cancer in Canada: Major workplace carcinogens and prevention of exposure. Toronto, ON: 2019  
<https://www.occupationalcancer.ca/burden/>

# Night Shift Work

- Elimination doesn't seem possible, likely administrative controls
- Circadian rhythm disruption poorly understood – are short rotations of night shift better than an extended?
- Fatigue management programs

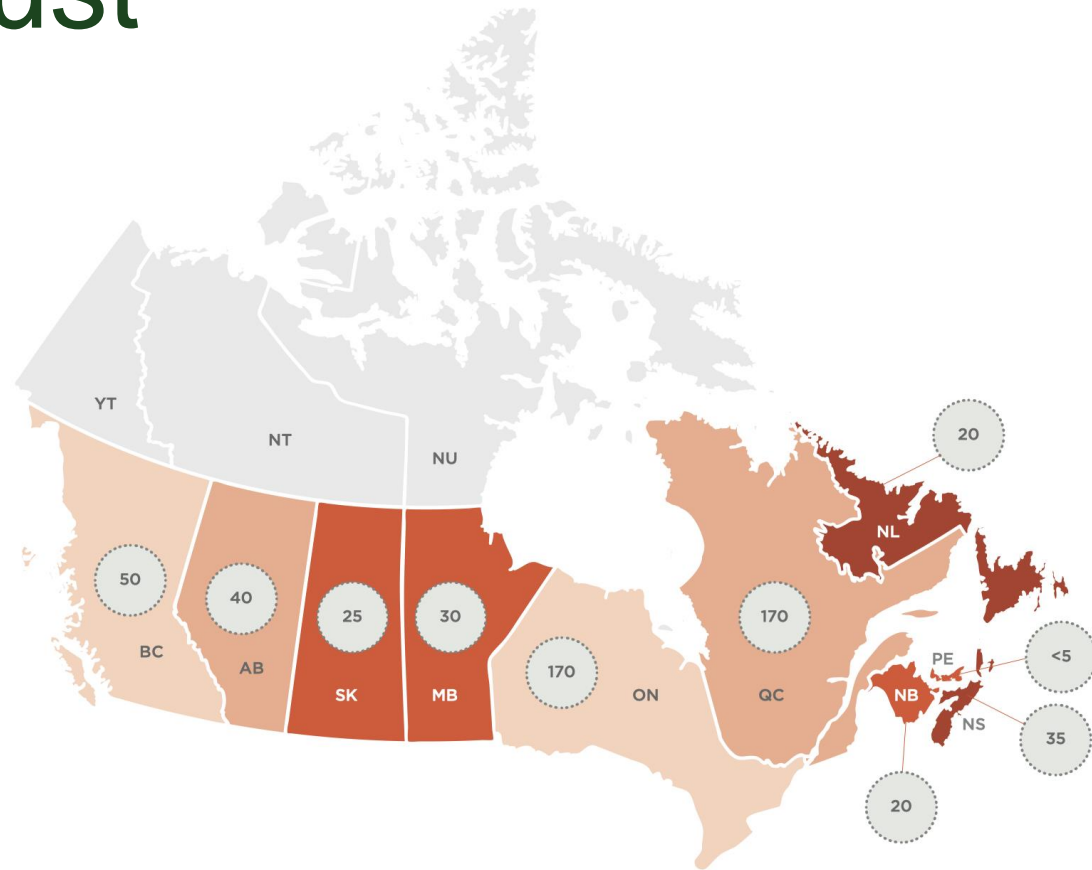


Occupational Cancer Research Centre. Burden of occupational cancer in Canada: Major workplace carcinogens and prevention of exposure. Toronto, ON: 2019  
<https://www.occupationalcancer.ca/burden/>



# Diesel Exhaust

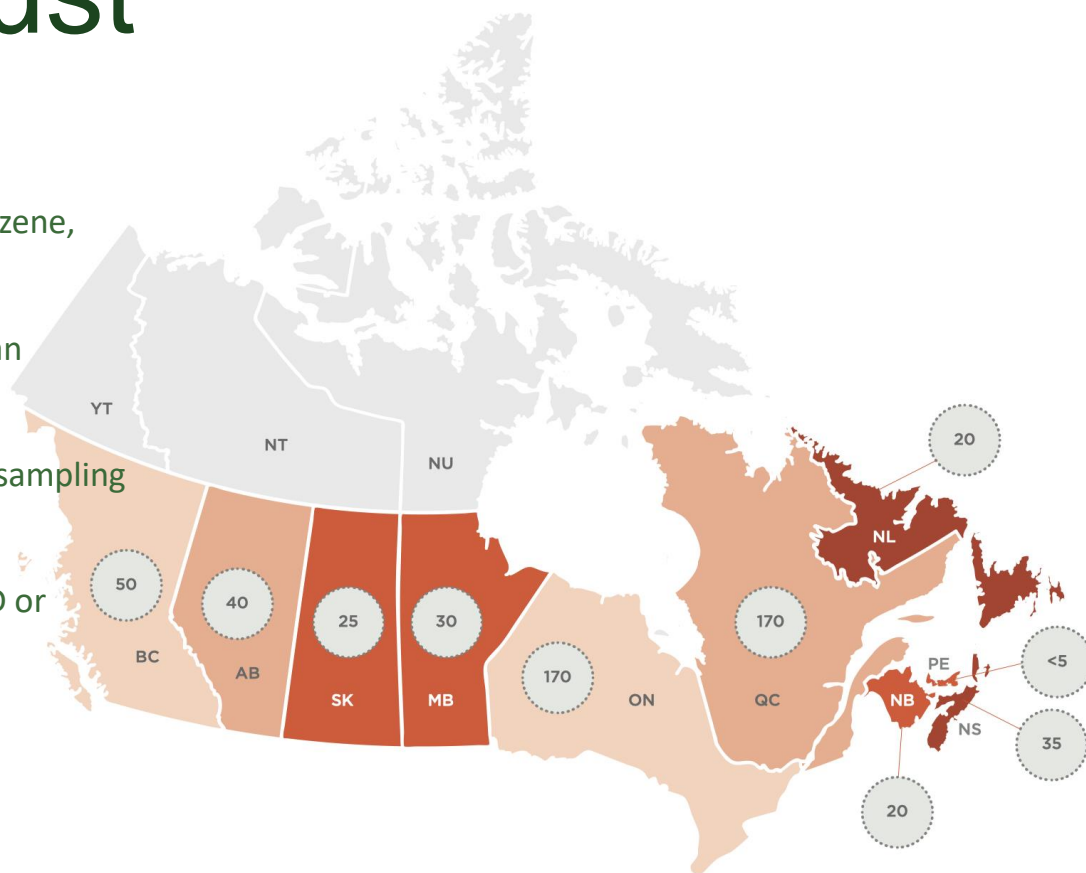
- Mining has the highest exposures
- Diesel exhaust is a mix of contaminants – gases & particulates
- CAREX estimates that 5% of Canadian workforce are exposed to diesel exhaust. Mainly at “low” levels



Occupational Cancer Research Centre. Burden of occupational cancer in Canada: Major workplace carcinogens and prevention of exposure. Toronto, ON: 2019  
<https://www.occupationalcancer.ca/burden/>

# Diesel Exhaust

- Complex mix of substances including: soot, benzene, PAHs, CO, NO<sub>x</sub>, SO<sub>2</sub> and mostly respirable sizes
- Diesel exhaust as “elemental carbon” & adopt an exposure limit of 5 µg/m<sup>3</sup>
- Exposure assessment usually done via “active” sampling – i.e. with a pump and sampling media.
- Possible to do a qualitative assessment with PID or particulate monitor; not hugely useful for firm occupational exposure data.



Occupational Cancer Research Centre. Burden of occupational cancer in Canada: Major workplace carcinogens and prevention of exposure. Toronto, ON: 2019  
<https://www.occupationalcancer.ca/burden/>

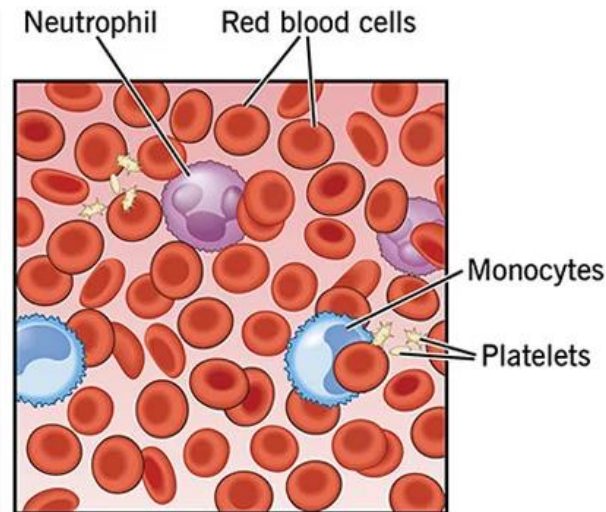
# Benzene

Volatile aromatic hydrocarbon

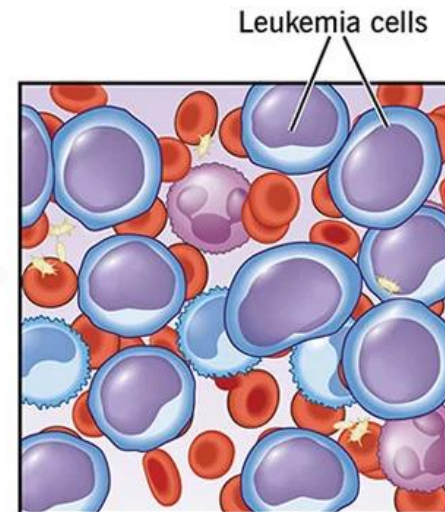
Present in gasoline, cigarette smoke, solvents, paints.

Bone marrow depression

First case of benzene-induced leukemia in 1928

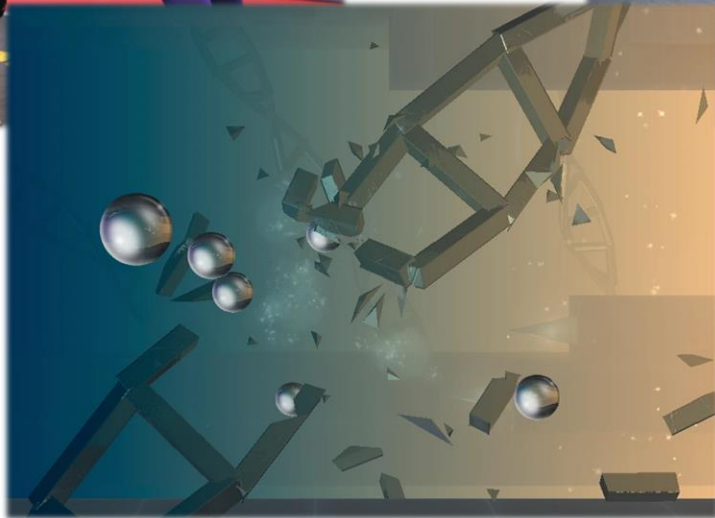
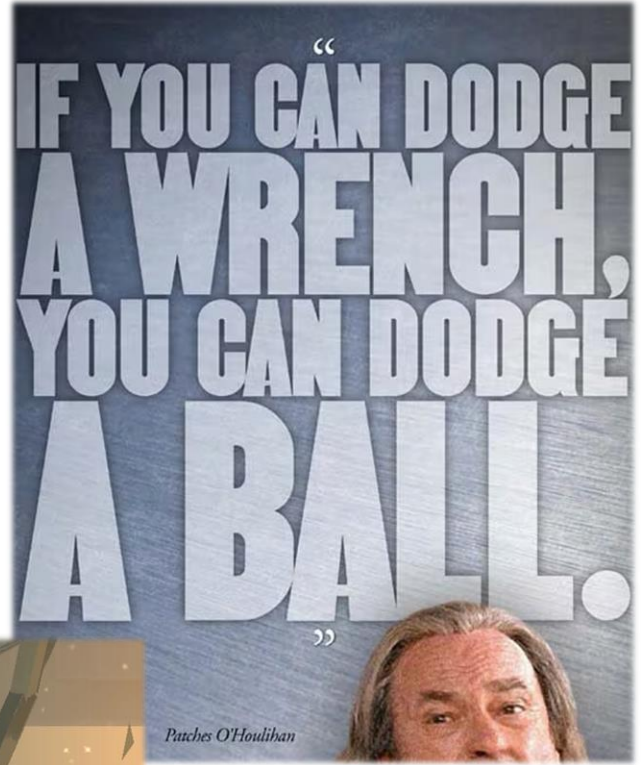


Normal Blood



Leukemia





# Present Bias

## Value Now

- Getting the work done
- Time saved
- Pressure

## Value Later



- Disease?
- Health
- Family

## Potential worker exposure

**21(1)** If a worker may be exposed to a harmful substance at a work site, an employer must

- (a) identify the health hazards associated with the exposure and assess the worker's exposure, and
- (b) establish procedures that minimize the worker's exposure to the harmful substance.

**21(2)** The employer must ensure that a worker who may be exposed to a harmful substance at a work site

- (a) is informed of the health hazards associated with exposure to that substance,
- (b) is informed of measurements made of airborne concentrations of harmful substances at the work site,
- (c) is trained in procedures established by the employer under subsection (1)(b), and
- (d) uses the procedures appropriately.

**21(3)** A worker who is provided with training under subsection (2) must use the procedures appropriately and apply the training.

Shameless marketing plug:

**22(2)** If a worker is exposed to more than the occupational exposure limit of a substance, the employer must immediately

- (a) identify the cause of the overexposure,
- (b) protect the worker from any further exposure,
- (c) control the situation so that no other workers are exposed to the substance at airborne concentrations that are more than the occupational exposure limit, and
- (d) explain to the worker the nature and extent of the overexposure.

### Multiples Substance Common Health Effects

- a) Burn
- b) Eye irritation
- c) Breathing difficulty
- d) Confusion
- e) Sleepiness
- f) Rapid pulse
- g) Loss of consciousness
- h) Anemia
- i) Damage to the nervous system
- j) Kidney Damage
- k) A rise in blood pressure
- l) Miscarriages and subtle abortions
- m) Disruption of nervous systems
- n) Brain damage
- o) Declined fertility of men through sperm damage
- p) Suppression of the immune system
- q) Death

Any worker who may be exposed to a harmful substance at a work site:

- a) Will be informed of the health hazards associated with exposure to that substance,
- b) Will be informed of measurements made of airborne concentrations of harmful substances at the work site, and
- c) Will be trained in procedures developed by the Company to minimize the worker's exposure to harmful substances and understands the procedures.

Task	Hazards
Exposure to harmful substances such as airborne contaminants (H2S etc.)	<ul style="list-style-type: none"><li>• Exposure to environment with excess concentrations of airborne contaminants</li><li>• Atmosphere lacking oxygen resulting in loss of consciousness</li><li>• Injury which requires first aid beyond the ability of worker</li></ul>

Diesel exhaust as “elemental carbon”  
& adopt an exposure limit of 5 µg/m<sup>3</sup>

Mortality statistics and disease names alone do not give a complete picture of the burden of disease borne by individuals.

## DALY

- disability-adjusted life year, combines years of life lost due to premature mortality and years of life lost due to time lived in less than full health, or years of healthy life lost due to disability

## QALY

- quality-adjusted life-year is a measure of the value of health outcomes. Health is a function of length of life and quality of life, the QALY is an attempt to combine the value of these into a single number



# DALY

Disability Adjusted Life Years measure the overall burden of disease, expressed as the cumulative number of years lost due to ill-health, disability or early death.

$$= \text{YLD} + \text{YLL}$$

Years Lived with Disability + Years Life Lost



Source : Wiki Commons

# Acute Myeloid Leukemia (benzene exposure)

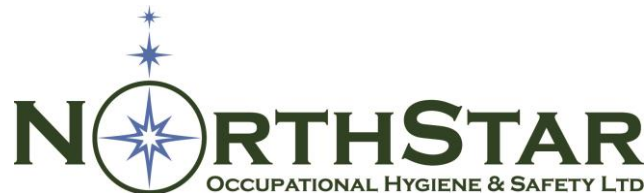
Age Group	5-year survival
15-44	62%
45-54	42%
55-64	25%
65-74	10%
>74	2%

<https://cancer.ca/en/cancer-information/cancer-types/acute-myeloid-leukemia-aml/prognosis-and-survival/survival-statistics>

# Mesothelioma (asbestos exposure)

- In Canada, the 5-year net survival for mesothelioma is 7%. This means about 7% of people diagnosed with mesothelioma will survive for at least 5 years.

<https://cancer.ca/en/cancer-information/cancer-types/mesothelioma/prognosis-and-survival/survival-statistics>



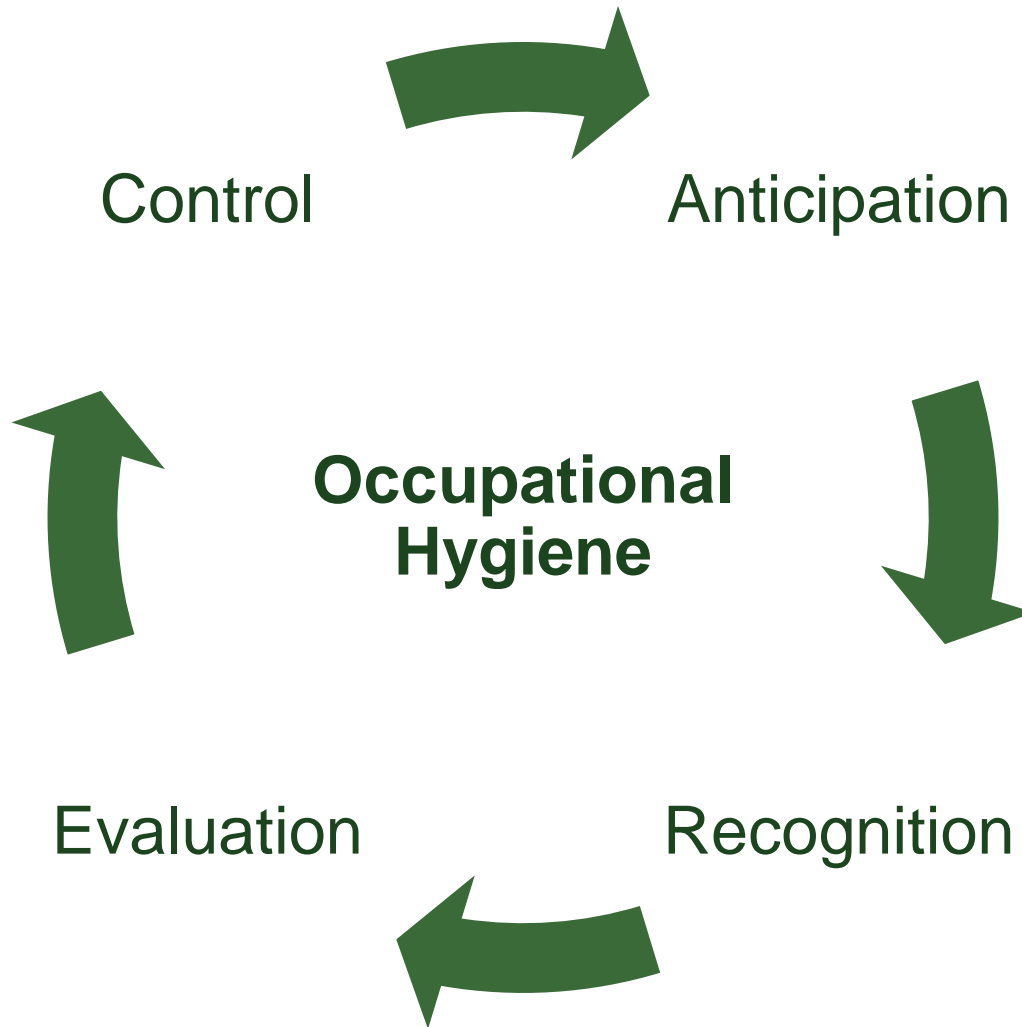


# Lung cancer

(various exposures contribute)

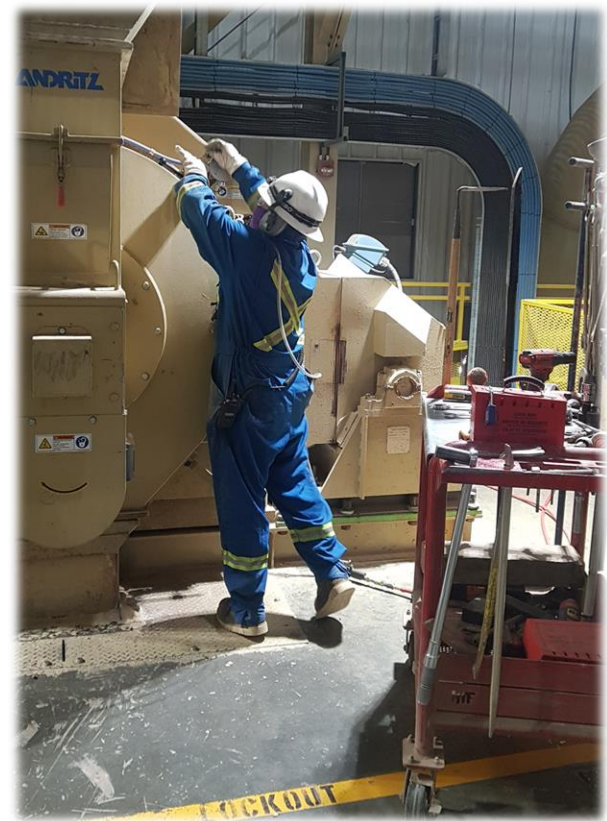
- In Canada, the 5-year net survival for lung cancer is 22%. This means that, on average, about 22% of people diagnosed with lung cancer will live for at least 5 years. This net survival includes both non–small cell and small cell lung cancer, there are no separate net survival statistics for each type.

<https://cancer.ca/en/cancer-information/cancer-types/lung/prognosis-and-survival/small-cell-lung-cancer-survival-statistics>



# Anticipation

- Work process
- Design
- SDS Review
- Work tasks
  - How should they?
  - How are they?
- Worker population
  - age
  - sex



Control

Anticipation

Evaluation

Recognition

# Health Hazard Recognition

BURDEN OF OCCUPATIONAL CANCER IN CANADA

Major Workplace Carcinogens and Prevention of Exposure

SEPTEMBER 2019

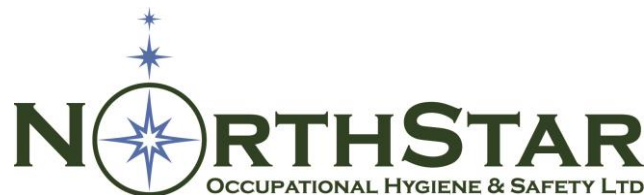


Occupational Cancer Research Centre  
[occupationalcancer.ca](http://occupationalcancer.ca)



**CAREX**  
CANADA

CARcinogen EXposure  
[carexcanada.ca](http://carexcanada.ca)



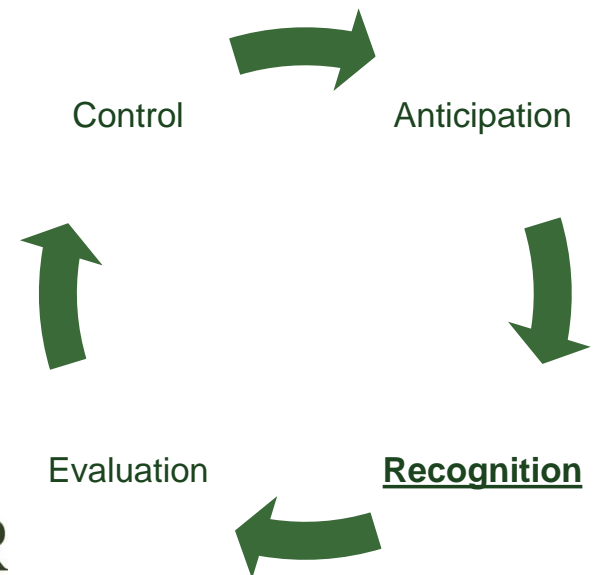
## Schedules

### Schedule 1 Chemical Substances

#### Table 1 Substances and processes requiring a code of practice

[See section 26(1)]

- Arsenic and arsenic compounds
- Asbestos
- Benzene
- Beryllium
- 1,3 Butadiene
- Cadmium
- Coal tar pitch volatiles
- 1,2 Dibromoethane (Ethylene dibromide)
- Ethylene oxide
- Hexachlorobutadiene
- Hydrazines
- Hydrogen sulphide
- Isocyanates
- Lead and lead compounds
- Methyl bromide
- Methyl hydrazine
- Perchlorates
- Silica crystalline, respirable
- Styrene in styrene resin fabrication
- Vinyl chloride (Chloroethylene)
- Zinc chromate



Control

Anticipation

Evaluation

Recognition

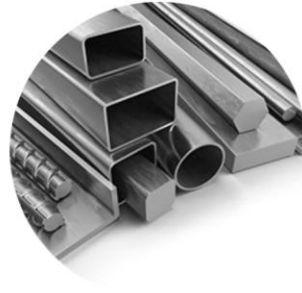
# CAREX



UV Radiation, Artificial



UV Radiation, Solar



Vanadium Pentoxide



Vinyl Chloride



Welding Fumes



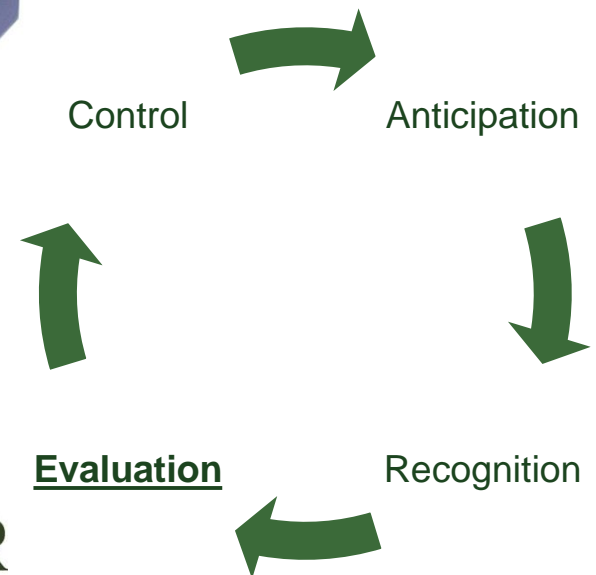
Wood Dust

- Carcinogen profiles
- Exposure reduction strategies
- Industry summaries
  - construction
  - health care
  - mining



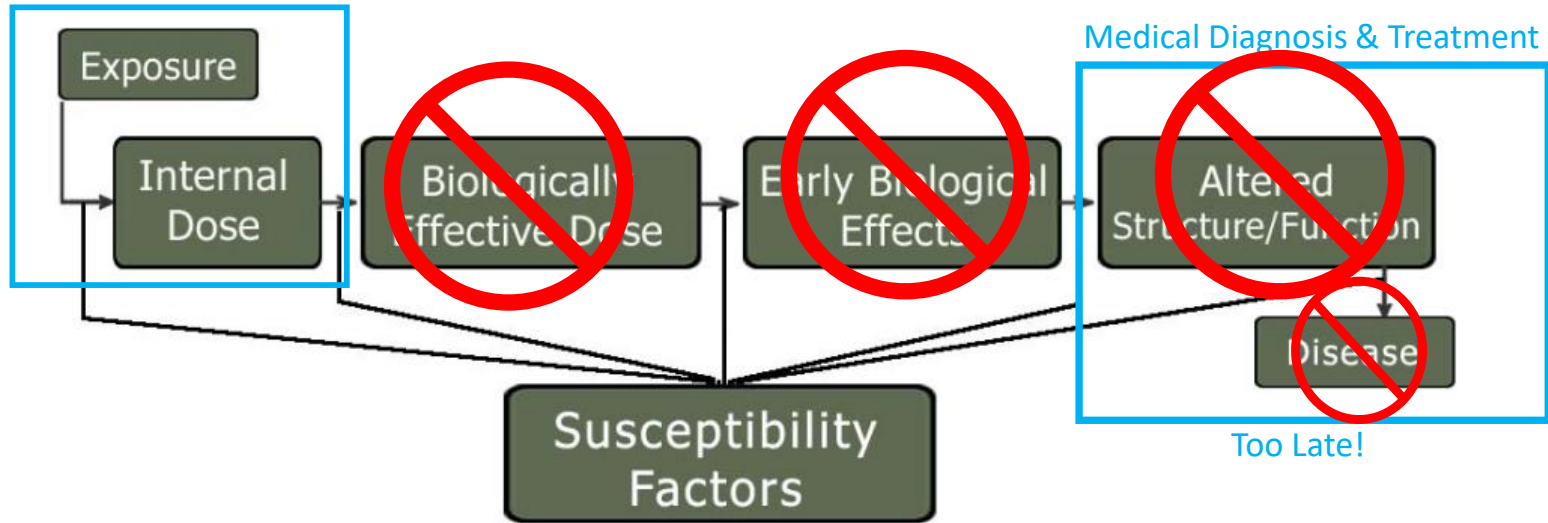
# Evaluation

- Workplace monitoring
- Occupational / Area
- Similar exposure groups
- IH Stats



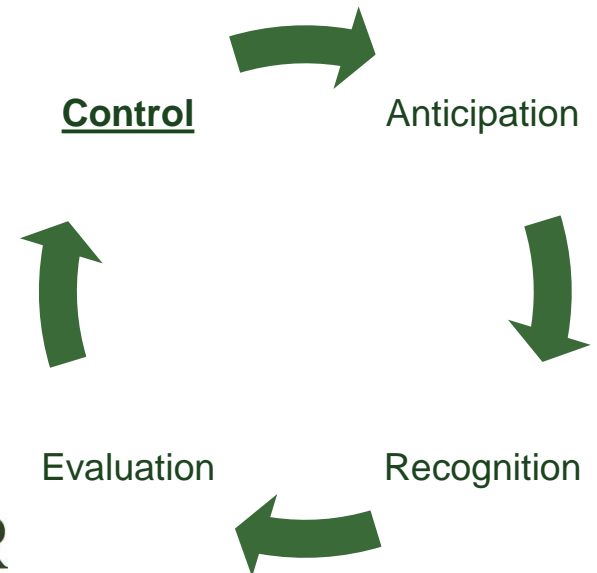
# Toxicological Paradigm

Safety & Occupational Hygiene

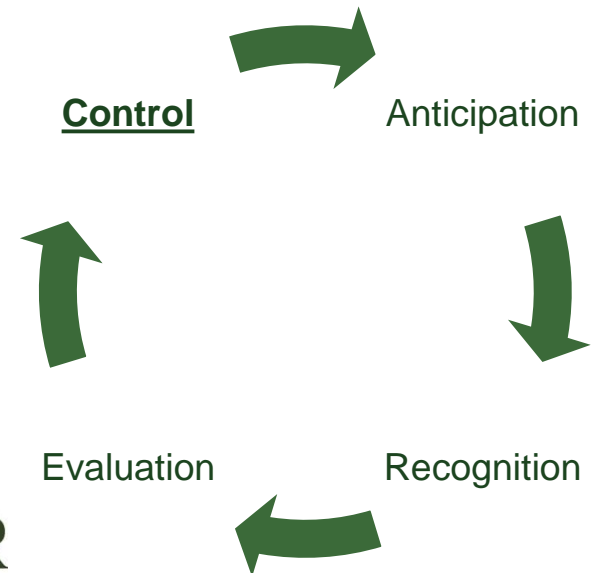
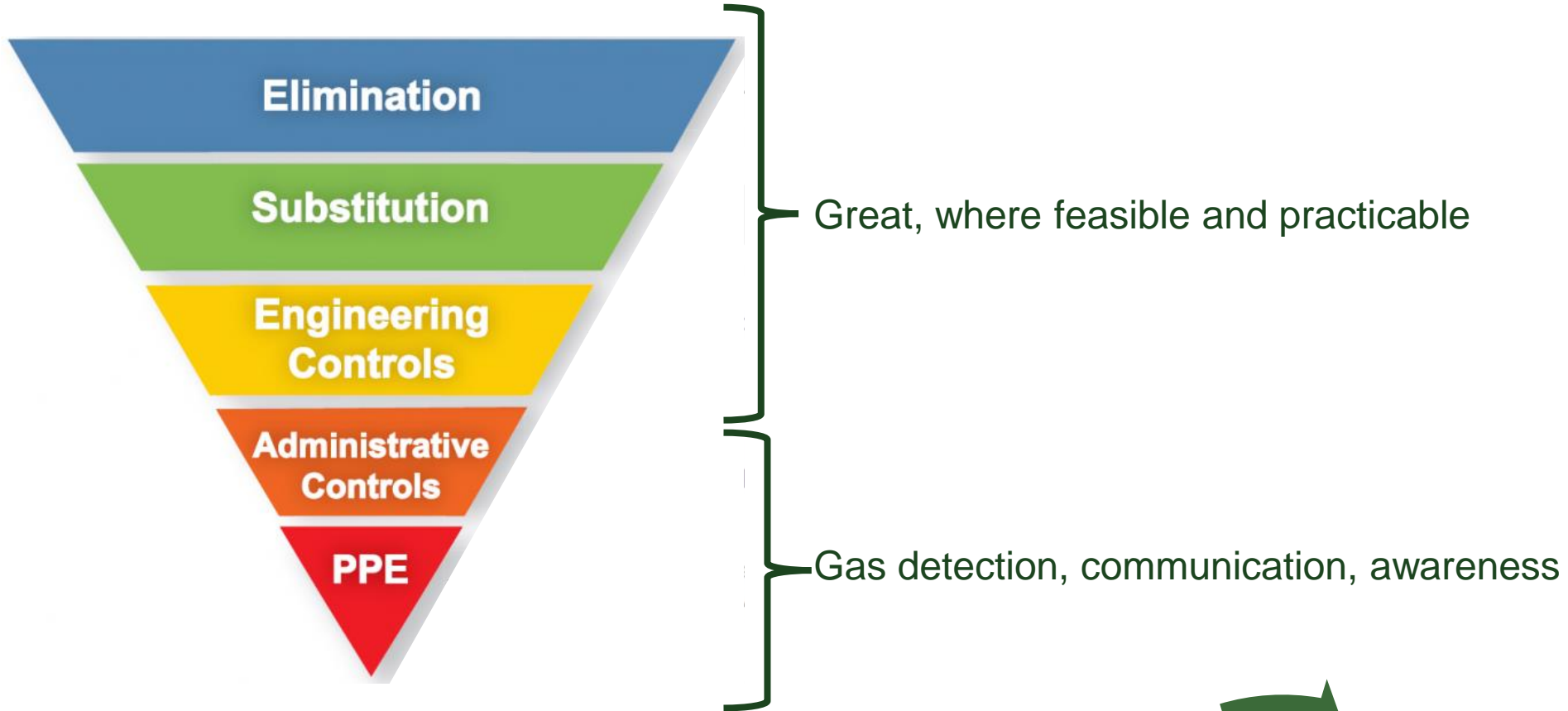


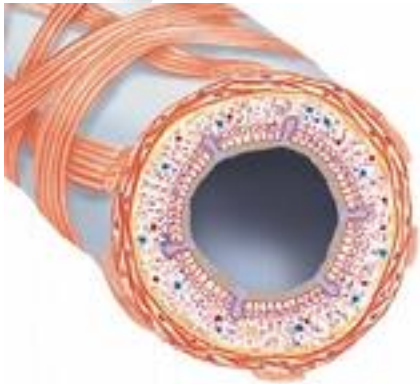
Control

Anticipation





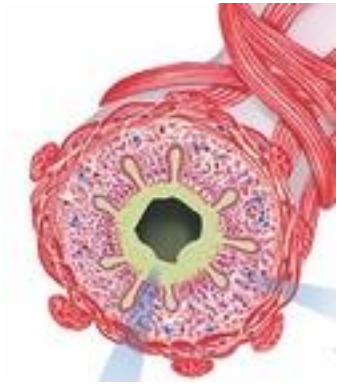




+



=



3,840L

$$3.84m^3 \times 0.025mg/m^3 = 0.096 \text{ mg}$$

Control

Anticipation



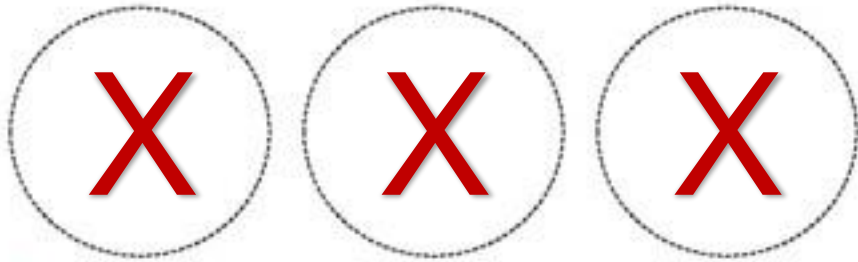
Evaluation

Recognition

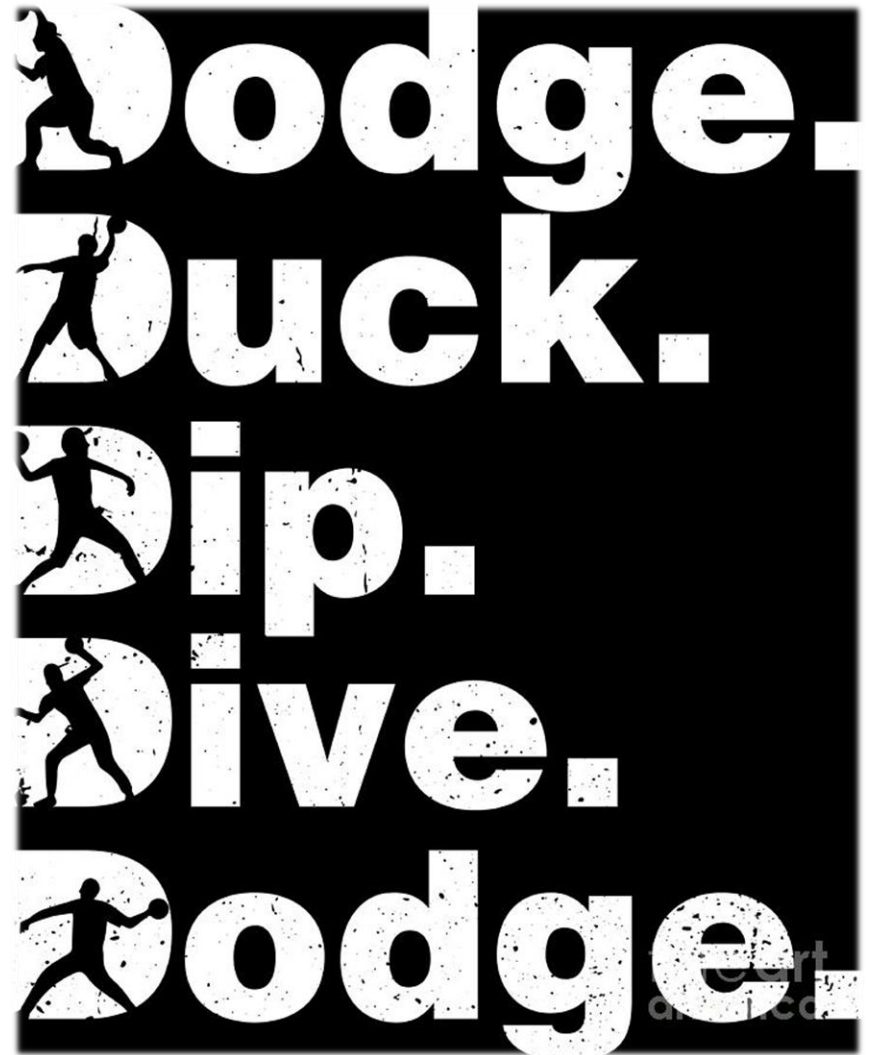


<b>Year</b>	<b>Total Fatalities</b>	<b>Illness</b>	<b>Injury</b>
<b>2027</b>	<b>?</b>	<b>?</b>	<b>?</b>
<b>2026</b>	<b>?</b>	<b>?</b>	<b>?</b>
<b>2025</b>	<b>?</b>	<b>?</b>	<b>?</b>
<b>2024</b>	<b>?</b>	<b>?</b>	<b>?</b>
<b>2023</b>	<b>?</b>	<b>?</b>	<b>?</b>

*Three Strikes and You're Out!*



*Consequence:* Not good!



**The absence of injury is not an  
indication of the presence of safety.**

**Thank You**

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