Health Effects of Radiation: 5 Themes

Effects on Fetuses and Hereditary Effects

Here, we explain radiation exposure and its hereditary effects on fetuses and future generations, based on the views of specialist organizations and on the findings of surveys related to the Chernobyl accident.

2022 Edition

Effects on Fetuses and Hereditary Effects　Relationship Diagram

Assessment of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS

What are the effects of radiation exposure?

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Effects on fetuses and hereditary effects

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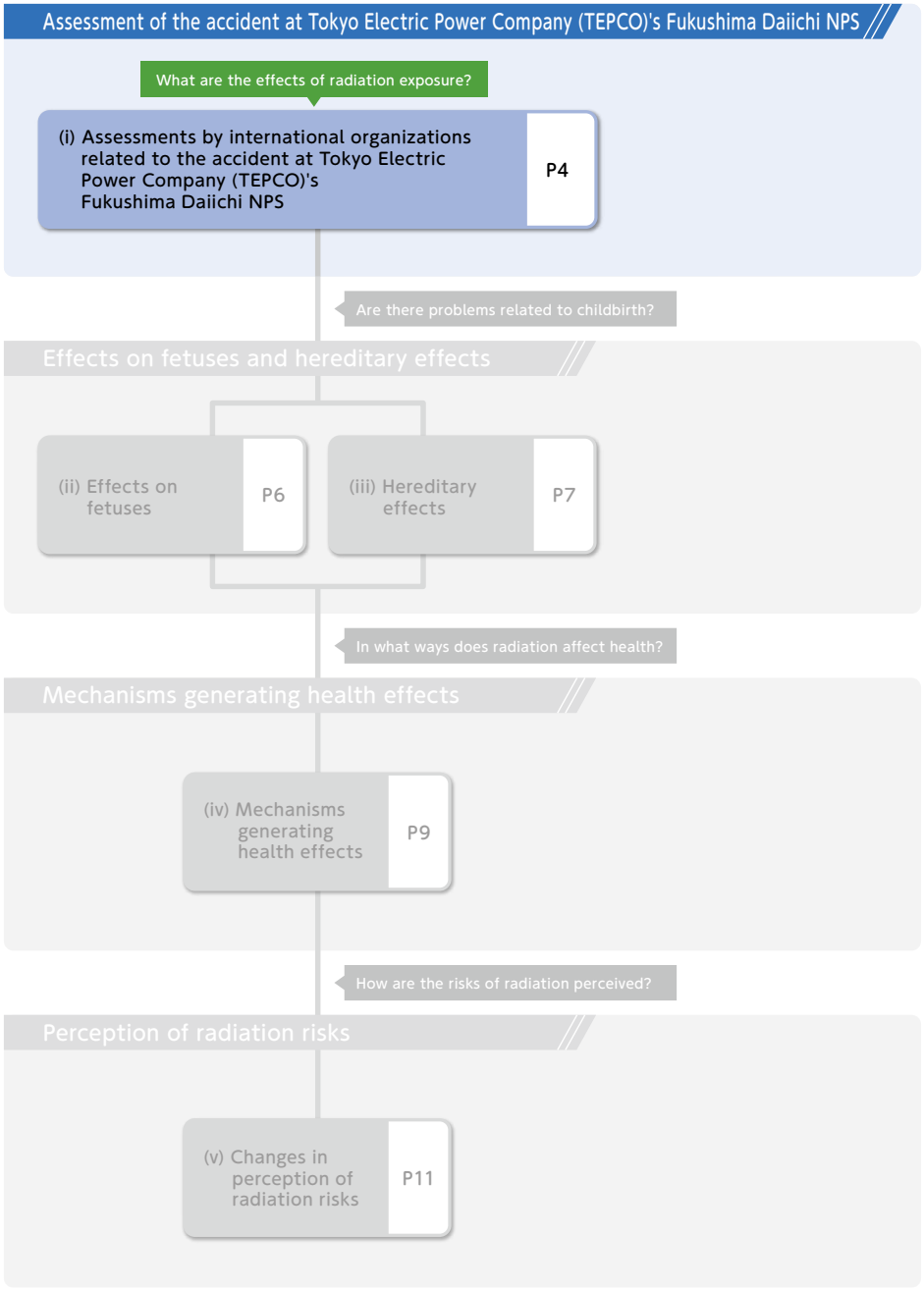
Health Effects of Radiation: 5 Themes | Effects on Fetuses and Hereditary Effects

Theme: Assessment of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS

In this section, you can learn about the assessments of the health effects of radiation exposure following the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS conducted by international organizations.



(i) Assessments by international organizations related to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS

What kind of viewpoints have international organizations expressed on the health effects of radiation exposure resulting from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS?

◉ Assessment of the Effects of Atomic Radiation by the United Nations Scientific Committee (UNSCEAR)

The 2020 and 2021 reports by UNSCEAR evaluate public health effects as follows, based on exposure dose evaluations.

- In the years since the UNSCEAR 2013 Report, there has been no documentation claiming adverse health effects on residents of Fukushima Prefecture directly caused by radiation exposure from the accident at TEPCO's Fukushima Daiichi NPS.
- Acute health effects caused by radiation exposure have not been reported.
- Currently available methods are not expected to be able to demonstrate an increase in irradiation-related incidence rates in future disease statistics.
- It is suggested that identification of an excessive risk of thyroid cancer, inferred from radiation exposure, will be highly unlikely in any of the observed age groups.
- It is suggested that the increase in the incidence of thyroid cancer observed in thyroid examinations following the nuclear accident may have been due to overdiagnosis (i.e., detection of thyroid cancer that would not have been detected without screening and that would not have resulted in symptoms or death during the individuals' lifetimes).

In addition, there has been no confirmation of reliable evidence for radiation exposure-related excessive congenital disorders, stillbirths, premature births, or low birth weight. An increase in the incidence of cardiovascular disease and metabolic abnormalities was observed in persons who evacuated following the accident, but this is believed to be an effect of social and lifestyle changes, and has been ruled to be not due to radiation exposure.

For more information about the UNSCEAR 2013 Report, see page 198 of Vol. 1, FY2022 edition (available in Japanese only).

Source: Fukushima Prefecture resident health survey results

● What has become clear from survey of expecting and nursing mothers

Radiation effects on newborn babies had been worried about, but percentages of premature births, low birth-weight babies, and congenital abnormalities or anomalies in Fukushima Prefecture after the earthquake were found to be almost the same as generally available data, including Vital Statistics collected nationally. This survey of pregnant women ended with the 2020 survey.

For more information about pregnancy and birth surveys, see page 161 of Vol. 2, FY2022 edition.

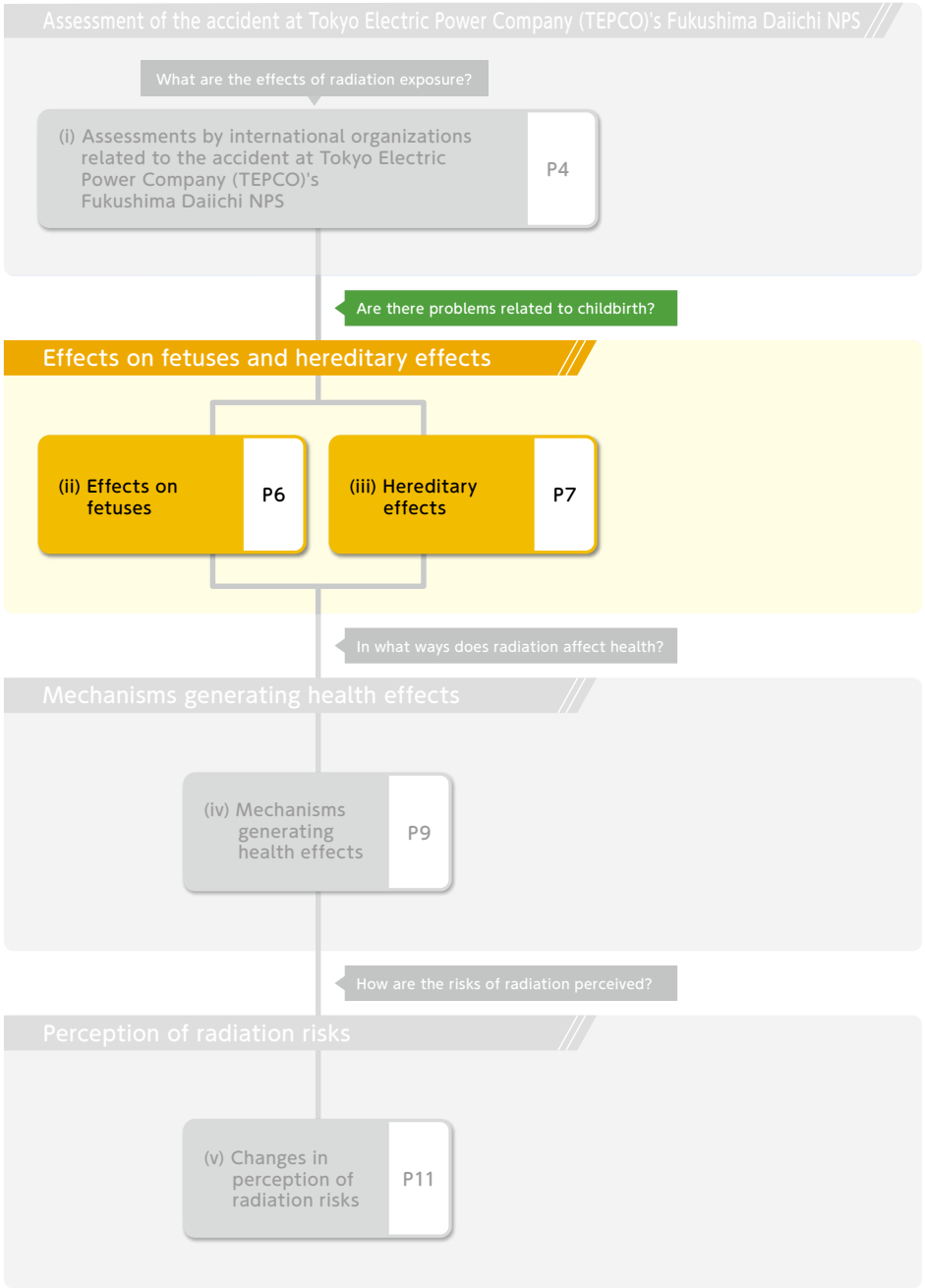
● Findings related tochildhood thyroidcancer

Although internal exposure dose due to radioactive iodine is said to be at a lower level than Chernobyl in Fukushima Prefecture, thyroid examinations have been continued under the framework of the Fukushima Health Management Survey with the aim of ascertaining children's current thyroid status and promoting their health into the future. In June 2019, the thyroid examination evaluation working group under the Fukushima Health Management Survey Oversight Committee released a summary indicating no observation of a link between thyroid cancer found in full-scale examinations (the second round of examinations) and radiation exposure caused by the accident at TEPCO's Fukushima Daiichi NPS.

For more information about surveys related to thyroid cancer in children, see page 144 of Vol. 2, FY2022 edition.

Theme: Effects on fetuses and hereditary effects

This section considers the effects of radiation on fetuses when pregnant mothers are exposed and the hereditary effects on the next generation. Survey results from the Chernobyl accident are also included as a reference.

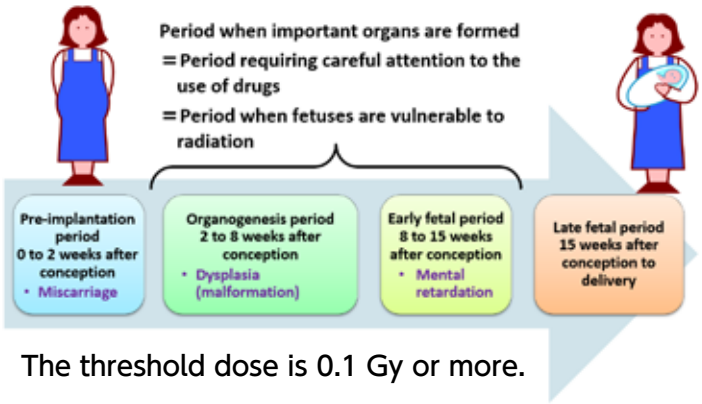


(ii) Effects on fetuses

There are two types of health effects radiation can cause related to pregnancy problems. The first is effects on the fetus at the time of exposure during pregnancy and the second is hereditary effects on children born in the future. Research has been carried out regarding these effects since even before the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. First of all, let's look at effects on fetuses.

◉ Deterministic effects and differences depending on the timing of exposure

When a pregnant woman is exposed to radiation and radiation passes through her womb or radioactive materials migrate into her womb, the fetus may also be exposed to radiation.
It is known that fetuses are highly sensitive to radiation and the incidence of effects varies depending on the timing of exposure (time specificity).



・Exposure to radiation exceeding 100 mSv* at one time is thought to be sufficient to cause the effects above on fetuses. In addition, UNSCEAR has evaluated the maximum exposure dose from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS as 13 mSv.

＊Exposure to radiation exceeding 100 mSv at one time is equivalent to 0.1 Gy of γ -ray or X-ray exposure.

For more information about deterministic effects and differences caused by exposure time periods, see page 104 of Vol. 1, FY2022 edition.

◉ Results of surveys related to the Chernobyl accident

Surveys of the effects on fetuses in the surrounding area continued to be conducted even after the Chernobyl accident.

Comparison of the European malformation and twin registration database before and after the Chernobyl accident.	
European Surveillance of Congenital Anomalies (EUROCAT): 18 regions in 9 countries:	No change in incidence of malformations before and after the accident
Finland, Norway, Sweden:	No change in incidence of malformations before and after the accident
Belarus:	Although there was an increase in the registration of malformations of aborted fetuses regardless of whether from the contaminated areas or not, this could be caused by reporting bias *1
Ukraine: participated in EUROCAT in this century	Although there was an increase in neural tube defects in an isolated Polish community in the Rivne province, the influence of factors such as folate deprivation, alcoholism, consanguineous marriage must also be evaluated in addition to radiation *2

Source：*1: Stem Cells 15 (supple 1): 255, 1997　*2: Pediatrics 125:e836, 2010

For more information about reports, see page 107 of Vol. 1, FY2022 edition.

◉ Survey on children born from mothers who were pregnant at the time of the Chernobyl accident

It is considered that radiation exposure during pregnancy does not directly affect intelligence quotients of fetuses and children after growth.

For more information about survey results, see page 106 of Vol. 1, FY2022 edition.

(iii) Hereditary effects

Next, let's take a look at the results of hereditary effects research.
There has been no evidence to prove that parents' radiation exposure increases hereditary diseases in their offspring in the case of human beings.

◉ Results of the next-generation health effect studies of the children of atomic bomb survivors

Surveys of health effects on children of atomic bomb survivors examine incidence rates of serious congenital disorders, gene mutations, chromosome aberrations, and cancer, as well as mortality rates from cancer or other diseases. However, no significant differences were found between the survey targets and the individuals with no exposure with the same classification for attributes such as gender, age, and residence area (control group) for any of these categories.

For more information about the results of surveys of health effects on children of atomic bomb survivors, see page 109 of Vol. 1, FY2022 edition.

◉ Other epidemiological surveys of the children of atomic bomb survivors

● Deaths due to malignant tumors developing by age 20

The follow-up survey of 41,066 subjects revealed no correlation between parents' gonadal doses (0.435 Sv on average) and their children's deaths.

(Source: Y. Yoshimoto et al.: Am J Hum Genet 46: 1041-1052, 1990.)

● Cancer prevalence (1958 - 1997)

As a result of the follow-up survey of 40,487 subjects, development of solid tumors and blood tumors was found in 575 cases and 68 cases, respectively, but no correlation with parents' doses was observed (the survey is still underway).

(Sourse : S. Izumi et al.: Br J Cancer 89: 1709-13, 2003.)

● Deaths due to cancer

During the observation period of 1946 to 2009, a long-term survey of 75,327 people found 1,246 deaths due to cancer, with no correlation with radiation doses received by parents.

(Sourse : E. Grant et al.: Lancet Oncol 16: 1316-23, 2015.)

● Incidence rates of lifestyle-related diseases (2002 - 2006)

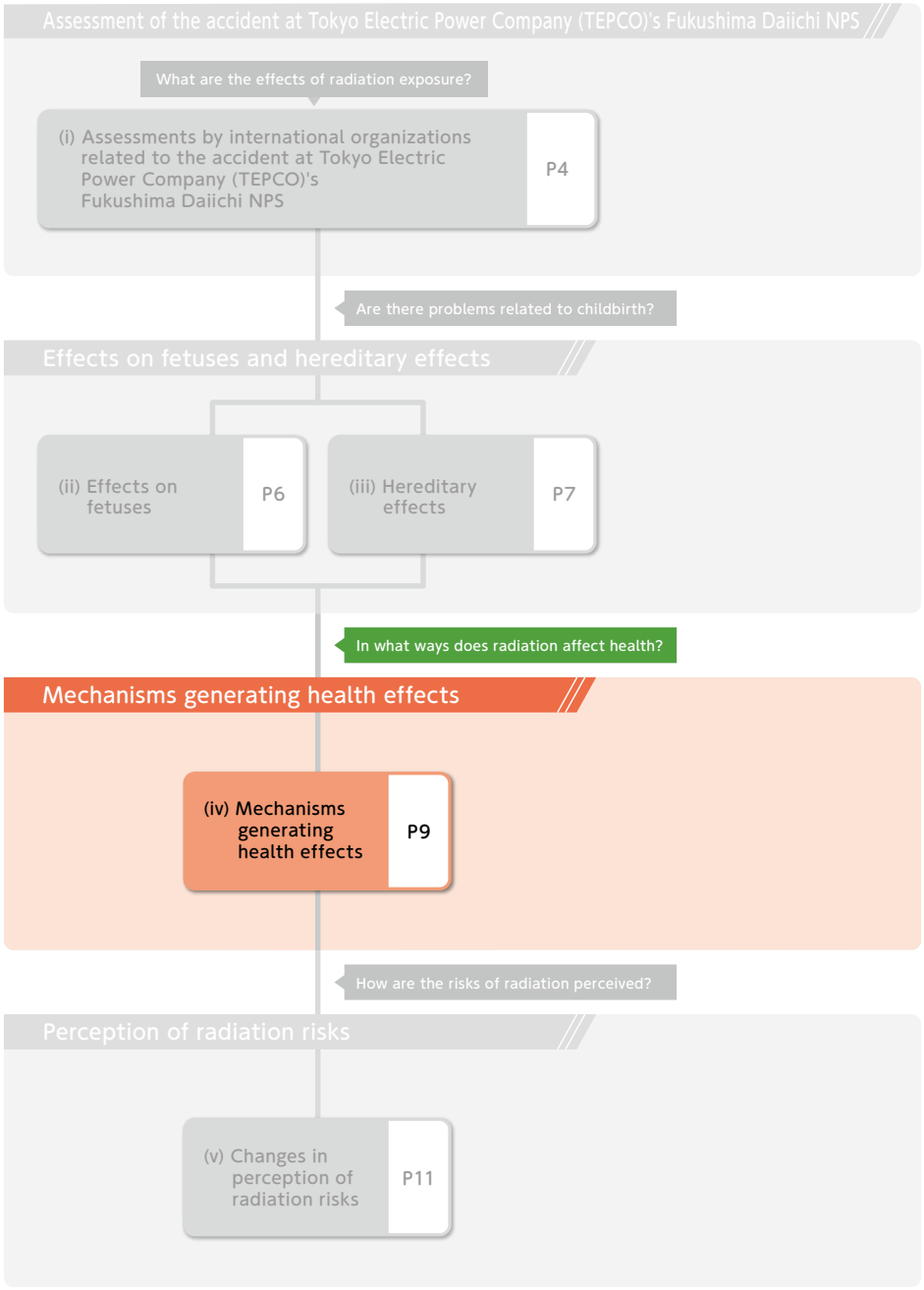
The clinical cross-sectional survey of approx. 12,000 subjects revealed no correlation between parents' doses and their children's incidence rates of lifestyle-related diseases (the survey is still underway).

(Source : S Fujiwara et al.: Radiat Res 170: 451-7, 2008.)

For more information about survey results, see page 112 of Vol. 1, FY2022 edition.

Theme: Mechanisms generating health effects

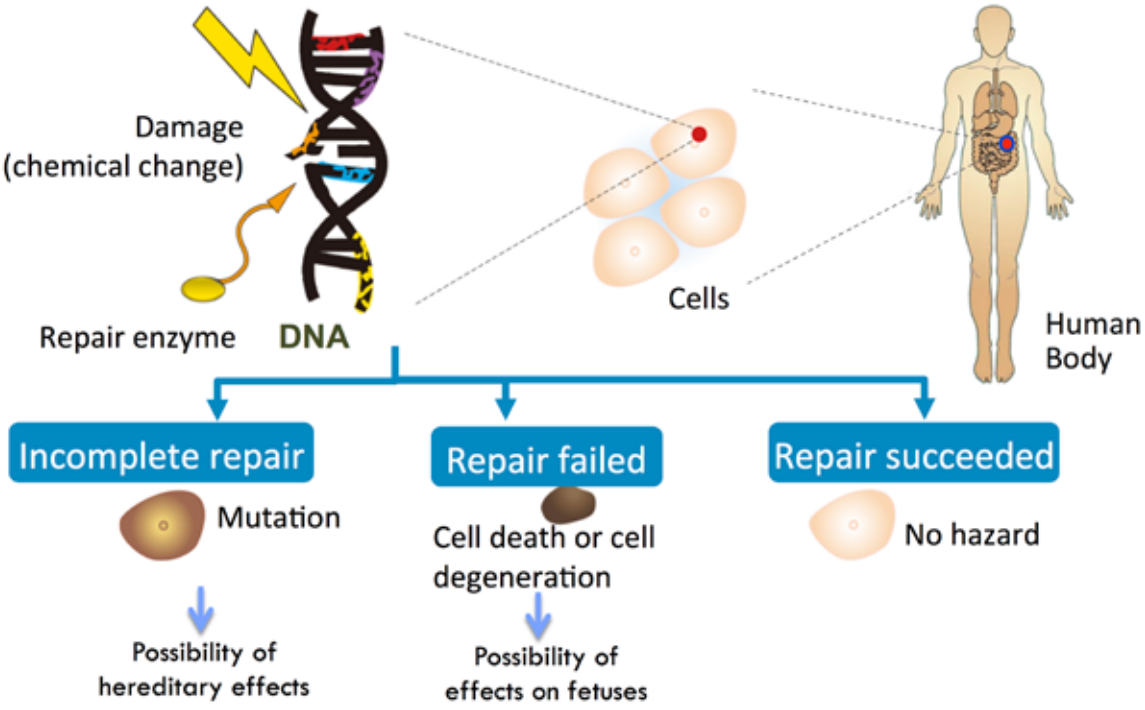
The effects of radiation exposure on the human body are caused by cell damage from the radiation. This section is a simple explanation of the mechanisms generating these effects.



(iv) Mechanisms generating health effects

We introduced research results related to the two types of effects involving problems related to childbirth, effects on fetuses and hereditary effects on future generations of children.
When examined in further detail, the effects and generation mechanisms for each of these categories differ.

◉ Generation mechanisms for effects on fetuses and hereditary effects caused by radiation



Taking a closer look at exposed areas, when radiation hits a cell, it may damage DNA (genes) inside the cell. When large numbers of cells die or degenerate, this may cause deterministic effects, including acute disorders such as hair loss, cataracts, and skin injuries as well as fetal disorders.

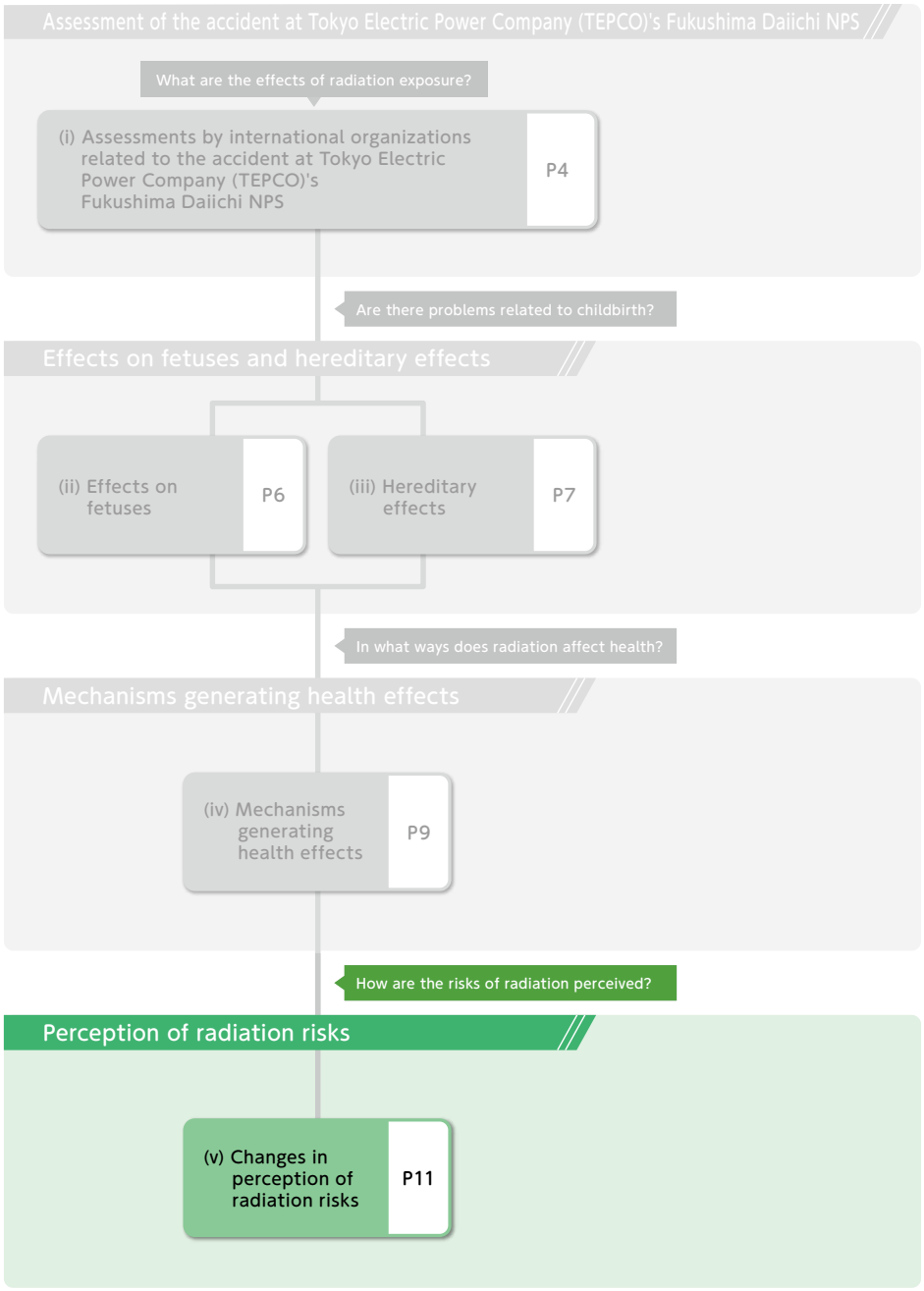
DNA is damaged not only by radiation but also by carcinogens in foods, tobacco, chemical substances in the environment, active oxygen, etc. It is said that DNA is damaged at 10,000 to 1,000,000 locations per cell every day.

DNA damage is repaired by inherent body systems. Minor damage is repaired and DNA is successfully restored. When many parts are damaged, they cannot be repaired and the cells themselves die. Even when some cells die, if other cells can replace them, dysfunction does not occur in organs and tissues.

For more information about the mechanisms generating health effects, see page 89 of Vol. 1, FY2022 edition.

Theme: Perception of radiation risks

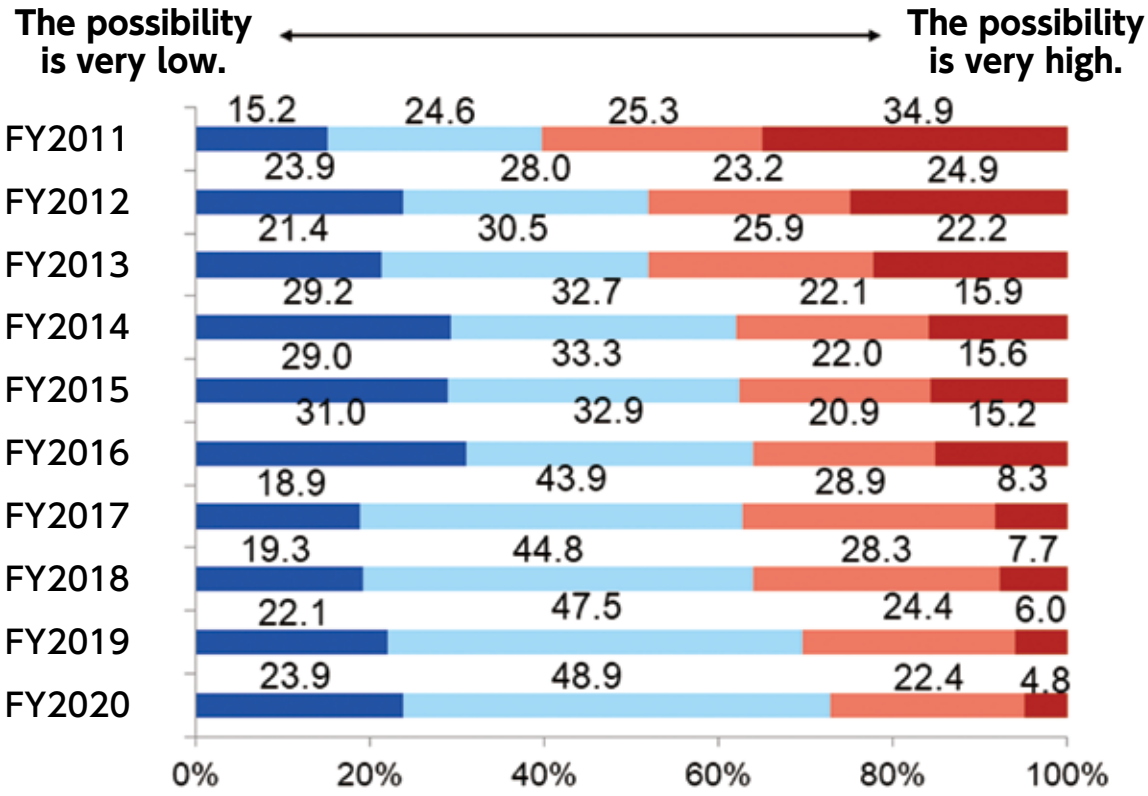
We've looked at survey results for the effects of radiation exposure on fetuses and the next generation, as well as the mechanisms generating health effects. In this section, you can learn about changes in the perception of risks related to the health effects of radiation.



(v) Changes in perception of radiation risks

Based on the information above, it can be safely said that both fetuses in their mothers' wombs at the time of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS and children in the next generation born afterward will not be affected by radiation exposure caused by the accident.
However, how many people still think that radiation exposure affects the next generation?

◉ Answers to the question of whether exposure caused by accidents affects the next generation



Prepared based on the materials of the 45st Prefectural Oversight Committee Meeting for the Fukushima Health Management Survey

The Fukushima Health Management survey examines perception of risks concerning health effects of radiation every year.
The figure shows the change over time in responses to questions about next-generation effects. Although the percentage of persons concerned over next-generation effects is gradually decreasing, nearly 40% remain concerned over the possibility.

Such worries over next-generation effects of radiation tend to cause discrimination, prejudice, and doubt about future chances of getting married or having children. It is necessary to note the sensitiveness of such worries and prejudice for disaster victims.
The Ministry of the Environment is undertaking the GuGuRu Project, which aims to achieve a society that promotes the elimination of misunderstandings that result in rumors and discrimination and that does not allow such harmful rumors to arise. The project seeks to do so by building learning and knowledge, by connecting with people, towns, and organizations, and by taking personal responsibility for transmitting knowledge, through issues related to the effects of radiation on health. More information about the GuGuRu Project is available here.
https://www.env.go.jp/chemi/rhm/portal/communicate/

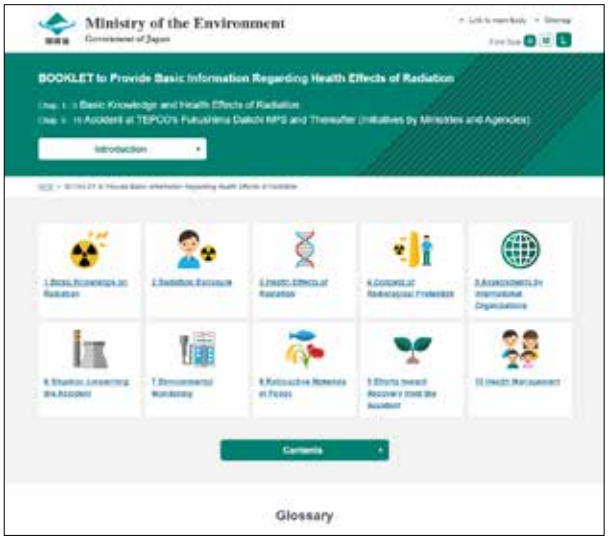
For more information about changes in perception of radiation risks, see page 152 of Vol. 1, FY2022 edition.

Portal site regarding the health effects of radiation

Additional resources such as the "BOOKLET to Provide Basic Information Regarding Health Effects of Radiation" which this digest document summarizes, Q&As, the latest information concerning the effects of radiation on health, and other related documents and articles are available in a searchable format on the portal site.

https://www.env.go.jp/en/chemi/rhm/portal/

BOOKLET to Provide Basic Information Regarding Health Effects of Radiation



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