Tutorial: Create a web API with ASP.NET Core

08/13/2020 • 47 minutes to read • +22

In this article

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This tutorial teaches the basics of building a web API with ASP.NET Core.

In this tutorial, you learn how to:

- ✓ Create a web API project.
- ✓ Add a model class and a database context.
- ✓ Scaffold a controller with CRUD methods.
- ✓ Configure routing, URL paths, and return values.
- ✓ Call the web API with Postman.

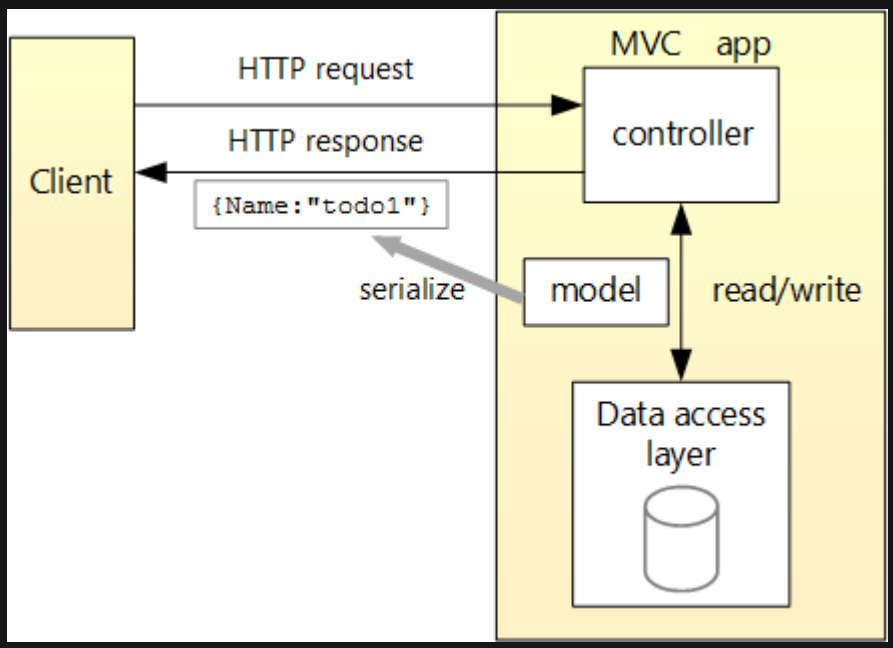
At the end, you have a web API that can manage "to-do" items stored in a database.

Overview

This tutorial creates the following API:

API	Description	Request body	Response body
`GET /api/TodoItems`	Get all to-do items	None	Array of to-do items
`GET /api/TodoItems/{id}`	Get an item by ID	None	To-do item
`POST /api/TodoItems`	Add a new item	To-do item	To-do item
`PUT /api/TodoItems/{id}`	Update an existing item	To-do item	None
`DELETE /api/TodoItems/{id}`	Delete an item	None	None

The following diagram shows the design of the app.



Prerequisites

Visual Studio | Visual Studio Code | Visual Studio for Mac

- Visual Studio 2019 16.4 or later with the **ASP.NET and web development** workload
- .NET Core 3.1 SDK or later

Create a web project

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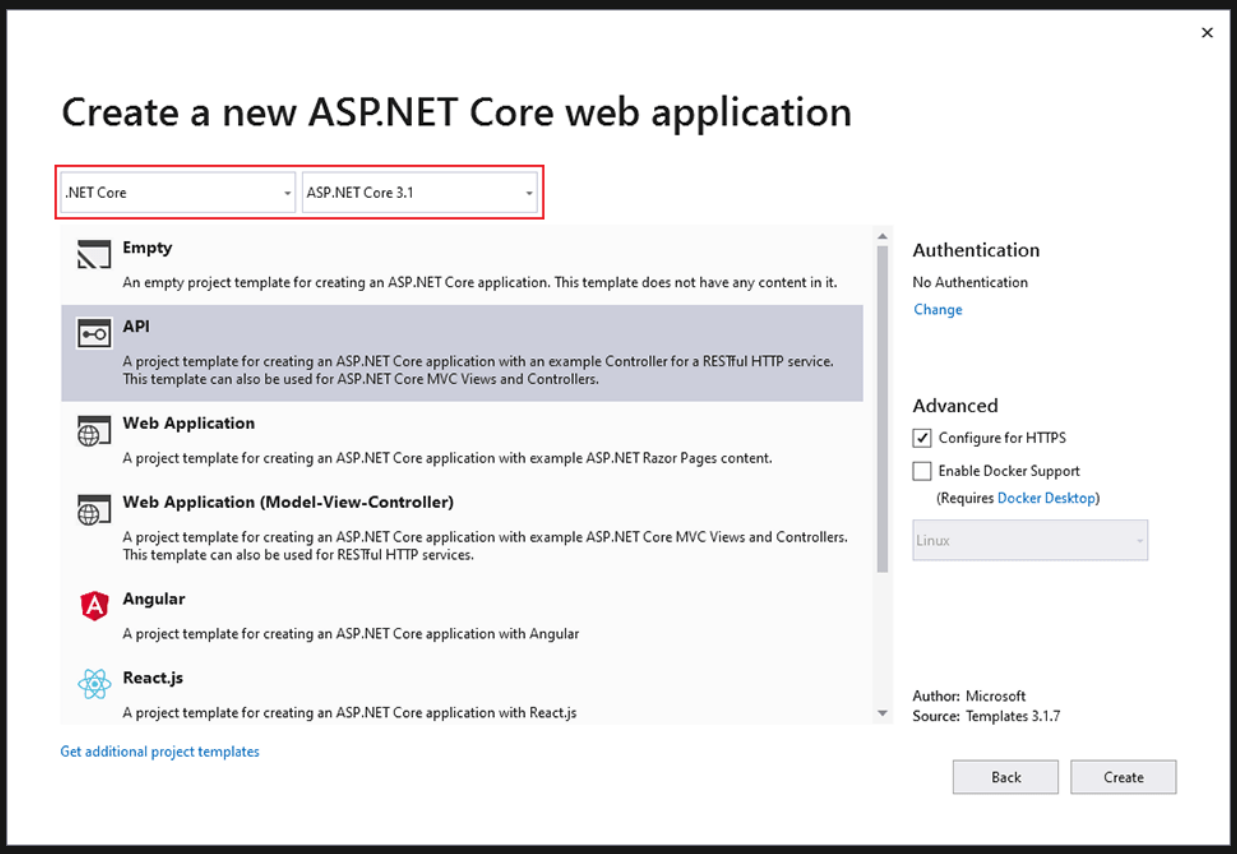
- From the **File** menu, select **New** > **Project**.
- Select the **ASP.NET Core Web Application** template and click **Next**.
- Name the project *TodoApi* and click **Create**.
- In the **Create a new ASP.NET Core Web Application** dialog, confirm that **.NET Core** and **ASP.NET Core 3.1** are selected. Select the **API** template and click **Create**.



Test the API

The project template creates a `WeatherForecast` API. Call the `Get` method from a browser to test the app.

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Press Ctrl+F5 to run the app. Visual Studio launches a browser and navigates to `https://localhost:<port>/WeatherForecast`, where `<port>` is a randomly chosen port number.

If you get a dialog box that asks if you should trust the IIS Express certificate, select **Yes**. In the **Security Warning** dialog that appears next, select **Yes**.

JSON similar to the following is returned:

JSON Copy

```
[
    {
        "date": "2019-07-16T19:04:05.7257911-06:00",
        "temperatureC": 52,
        "temperatureF": 125,
        "summary": "Mild"
    },
    {
        "date": "2019-07-17T19:04:05.7258461-06:00",
        "temperatureC": 36,
        "temperatureF": 96,
        "summary": "Warm"
    },
    {
        "date": "2019-07-18T19:04:05.7258467-06:00",
        "temperatureC": 39,
        "temperatureF": 102,
        "summary": "Cool"
    },
    {
        "date": "2019-07-19T19:04:05.7258471-06:00",
        "temperatureC": 10,
        "temperatureF": 49,
        "summary": "Bracing"
    },
    {
        "date": "2019-07-20T19:04:05.7258474-06:00",
        "temperatureC": -1,
        "temperatureF": 31,
        "summary": "Chilly"
    }
]
```

Add a model class

A *model* is a set of classes that represent the data that the app manages. The model for this app is a single `TodoItem` class.

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- In **Solution Explorer**, right-click the project. Select **Add** > **New Folder**. Name the folder *Models*.
- Right-click the *Models* folder and select **Add** > **Class**. Name the class *TodoItem* and select **Add**.
- Replace the template code with the following code:

C# Copy

```
public class TodoItem
{
    public long Id { get; set; }
    public string Name { get; set; }
    public bool IsComplete { get; set; }
}
```

The `Id` property functions as the unique key in a relational database.

Model classes can go anywhere in the project, but the *Models* folder is used by convention.

Add a database context

The *database context* is the main class that coordinates Entity Framework functionality for a data model. This class is created by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class.

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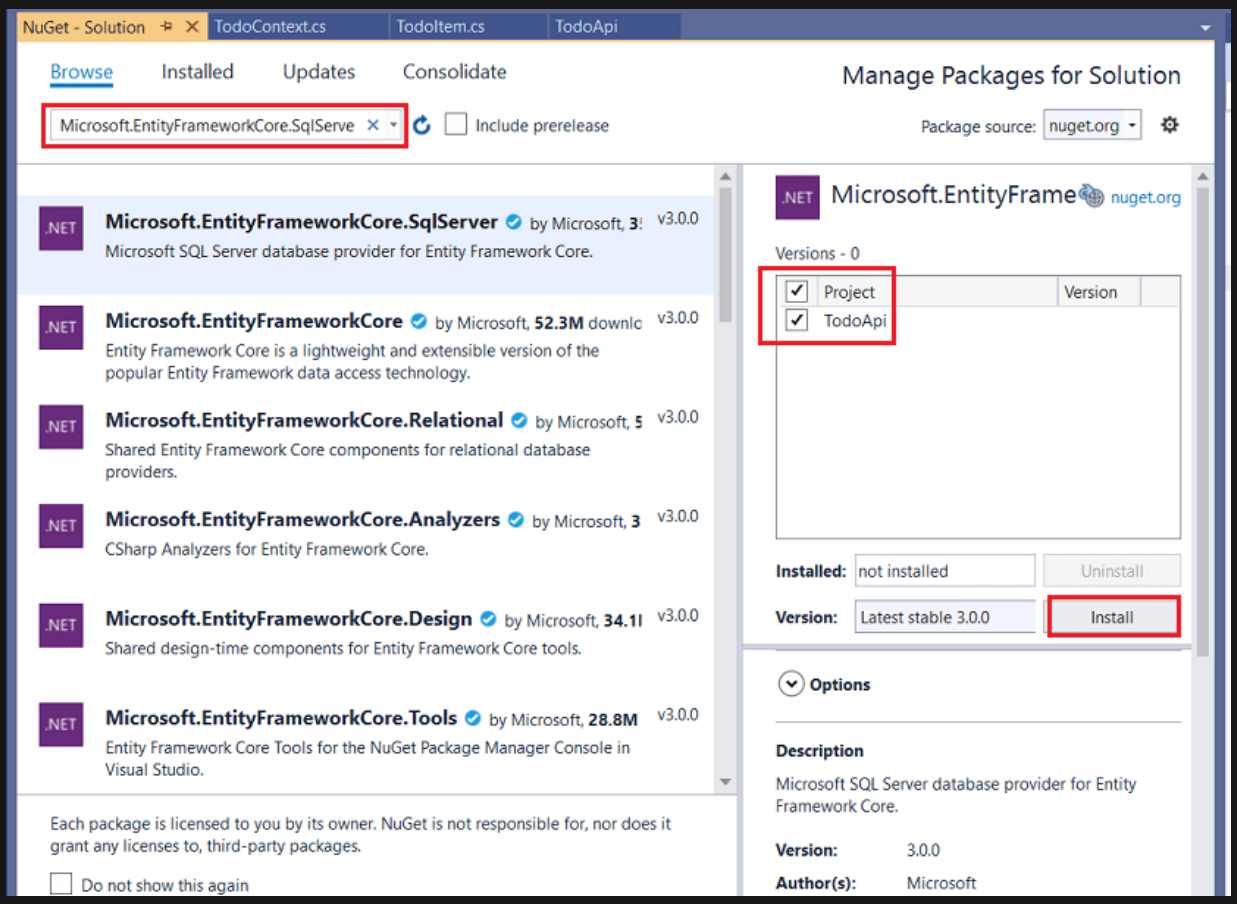
Add NuGet packages

- From the **Tools** menu, select **NuGet Package Manager** > **Manage NuGet Packages for Solution**.
- Select the **Browse** tab, and then enter **Microsoft.EntityFrameworkCore.SqlServer** in the search box.
- Select **Microsoft.EntityFrameworkCore.SqlServer** in the left pane.
- Select the **Project** check box in the right pane and then select **Install**.
- Use the preceding instructions to add the **Microsoft.EntityFrameworkCore.InMemory** NuGet package.



Add the TodoContext database context

- Right-click the *Models* folder and select **Add** > **Class**. Name the class *TodoContext* and click **Add**.

- Enter the following code:

C# Copy

```
using Microsoft.EntityFrameworkCore;
```

```
namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {
        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

Register the database context

In ASP.NET Core, services such as the DB context must be registered with the dependency injection (DI) container. The container provides the service to controllers.

Update *Startup.cs* with the following highlighted code:

C# Copy

```
// Unused usings removed
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Hosting;
using Microsoft.EntityFrameworkCore;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
               opt.UseInMemoryDatabase("TodoList"));
            services.AddControllers();
        }
```

```
        public void Configure(IApplicationBuilder app, IWebHostEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }

            app.UseHttpsRedirection();

            app.UseRouting();

            app.UseAuthorization();

            app.UseEndpoints(endpoints =>
            {
                endpoints.MapControllers();
            });
        }
    }
}
```

The preceding code:

- Removes unused `using` declarations.
- Adds the database context to the DI container.
- Specifies that the database context will use an in-memory database.

Scaffold a controller

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- Right-click the *Controllers* folder.
- Select **Add** > **New Scaffolded Item**.
- Select **API Controller with actions, using Entity Framework**, and then select **Add**.
- In the **Add API Controller with actions, using Entity Framework** dialog:
  - Select **TodoItem (TodoApi.Models)** in the **Model class**.
  - Select **TodoContext (TodoApi.Models)** in the **Data context class**.
  - Select **Add**.

The generated code:

- Marks the class with the [ApiController] attribute. This attribute indicates that the controller responds to web API requests. For information about specific behaviors that the attribute enables, see Create web APIs with ASP.NET Core.
- Uses DI to inject the database context (`TodoContext`) into the controller. The database context is used in each of the CRUD methods in the controller.

The ASP.NET Core templates for:

- Controllers with views include `[action]` in the route template.
- API controllers don't include `[action]` in the route template.

When the `[action]` token isn't in the route template, the action name is excluded from the route. That is, the action's associated method name isn't used in the matching route.

Examine the PostTodoItem create method

Replace the return statement in the `PostTodoItem` to use the nameof operator:

C# Copy

```
// POST: api/TodoItems
[HttpPost]
public async Task<ActionResult<TodoItem>> PostTodoItem(TodoItem todoItem)
{
    _context.TodoItems.Add(todoItem);
    await _context.SaveChangesAsync();

    //return CreatedAtAction("GetTodoItem", new { id = todoItem.Id },
todoItem);
    return CreatedAtAction(nameof(GetTodoItem), new { id = todoItem.Id },
todoItem);
}
```

The preceding code is an HTTP POST method, as indicated by the [HttpPost] attribute. The method gets the value of the to-do item from the body of the HTTP request.

For more information, see Attribute routing with Http[Verb] attributes.

The CreatedAtAction method:

- Returns an HTTP 201 status code if successful. HTTP 201 is the standard response for an HTTP POST method that creates a new resource on the server.
- Adds a Location header to the response. The `Location` header specifies the URI of the newly created to-do item. For more information, see 10.2.2 201 Created.
- References the `GetTodoItem` action to create the `Location` header's URI. The C# `nameof` keyword is used to avoid hard-coding the action name in the `CreatedAtAction` call.

Install Postman

This tutorial uses Postman to test the web API.

- Install Postman
- Start the web app.
- Start Postman.
- Disable **SSL certificate verification**
  - From **File** > **Settings** (**General** tab), disable **SSL certificate verification**.

> ⚠ **Warning**
>
> Re-enable SSL certificate verification after testing the controller.

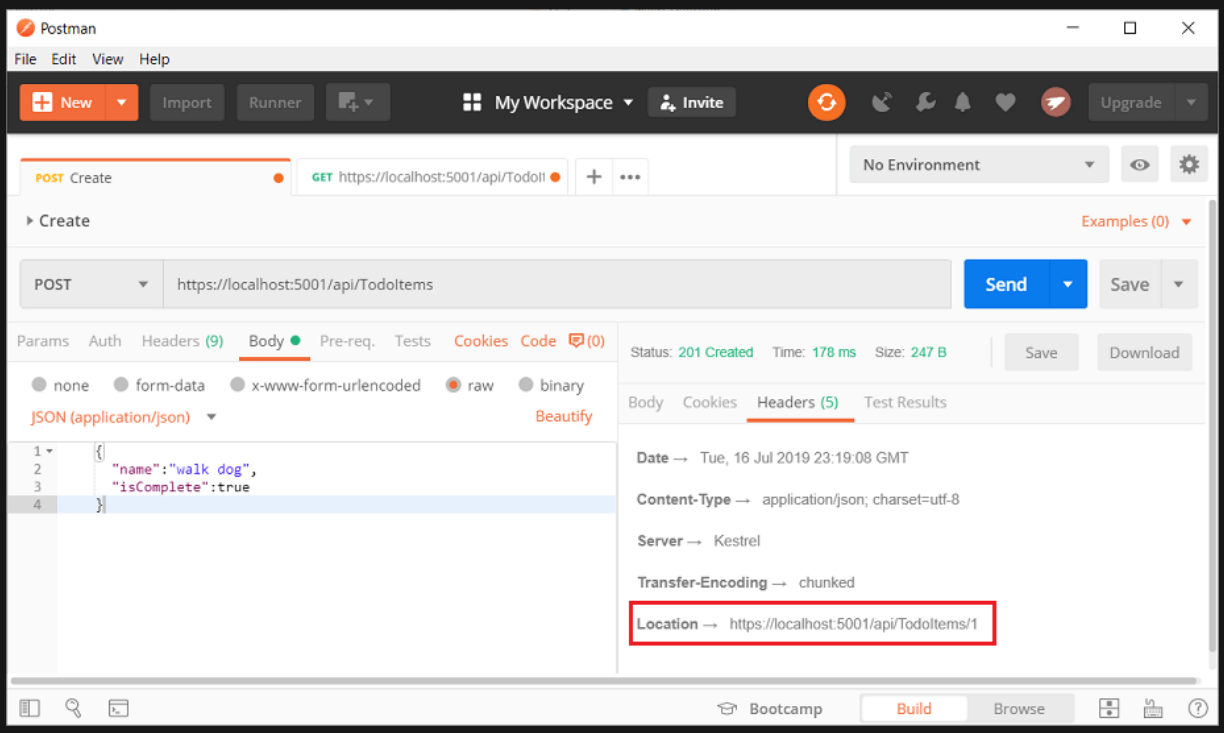
Test PostTodoItem with Postman

- Create a new request.
- Set the HTTP method to `POST`.
- Set the URI to `https://localhost:<port>/api/TodoItems`. For example, `https://localhost:5001/api/TodoItems`.
- Select the **Body** tab.
- Select the **raw** radio button.
- Set the type to **JSON (application/json)**.
- In the request body enter JSON for a to-do item:

JSON Copy

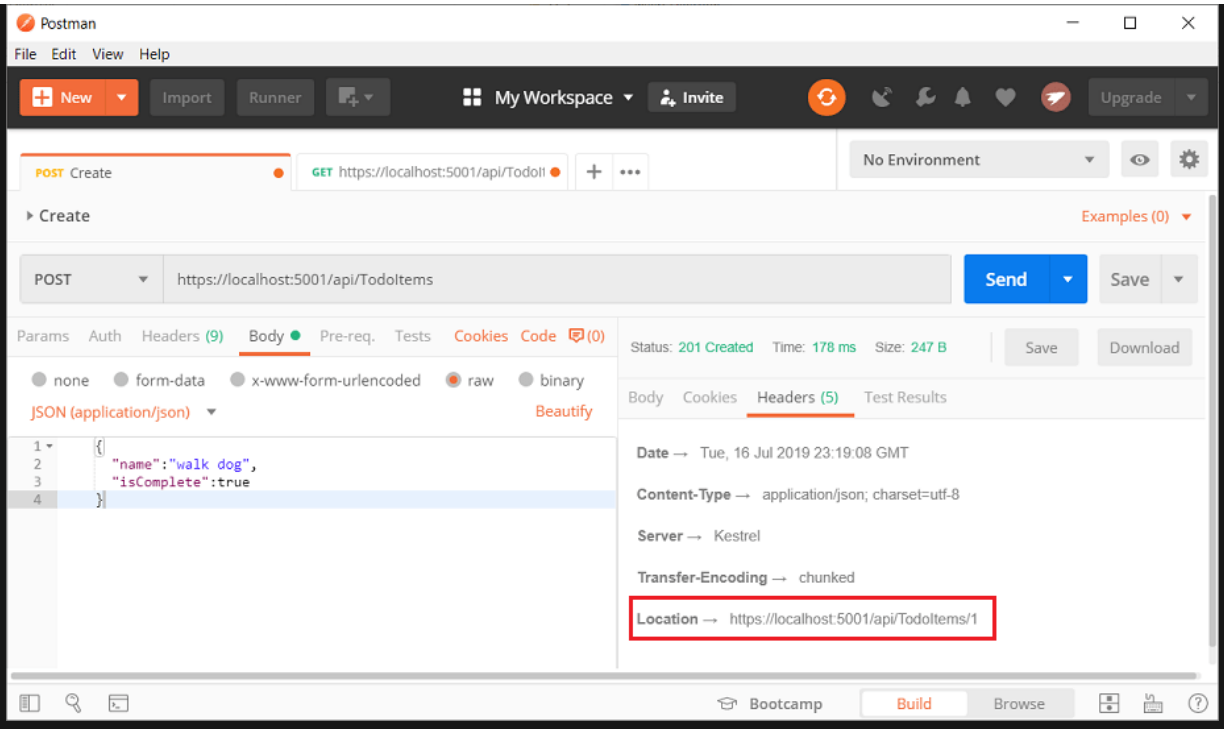
```
{
  "name":"walk dog",
  "isComplete":true
}
```

- Select **Send**.



Test the location header URI with Postman

- Select the **Headers** tab in the **Response** pane.
- Copy the **Location** header value:



- Set the HTTP method to `GET`.
- Set the URI to `https://localhost:<port>/api/TodoItems/1`. For example, `https://localhost:5001/api/TodoItems/1`.
- Select **Send**.

Examine the GET methods

These methods implement two GET endpoints:

- `GET /api/TodoItems`
- `GET /api/TodoItems/{id}`

Test the app by calling the two endpoints from a browser or Postman. For example:

- `https://localhost:5001/api/TodoItems`
- `https://localhost:5001/api/TodoItems/1`

A response similar to the following is produced by the call to `GetTodoItems`:

JSON Copy

```
[
  {
    "id": 1,
```

```
    "name": "Item1",
    "isComplete": false
  }
]
```

Test Get with Postman

- Create a new request.
- Set the HTTP method to **GET**.
- Set the request URI to `https://localhost:<port>/api/TodoItems`. For example, `https://localhost:5001/api/TodoItems`.
- Set **Two pane view** in Postman.
- Select **Send**.

This app uses an in-memory database. If the app is stopped and started, the preceding GET request will not return any data. If no data is returned, POST data to the app.

Routing and URL paths

The [HttpGet] attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Start with the template string in the controller's `Route` attribute:

C# Copy

```
[Route("api/[controller]")]
[ApiController]
public class TodoItemsController : ControllerBase
{
    private readonly TodoContext _context;

    public TodoItemsController(TodoContext context)
    {
        _context = context;
    }
```

- Replace `[controller]` with the name of the controller, which by convention is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoItems**Controller, so the controller name is "TodoItems". ASP.NET Core routing is case insensitive.

- If the `[HttpGet]` attribute has a route template (for example, `[HttpGet("products")]`), append that to the path. This sample doesn't use a template. For more information, see Attribute routing with Http[Verb] attributes.

In the following `GetTodoItem` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When `GetTodoItem` is invoked, the value of `"{id}"` in the URL is provided to the method in its `id` parameter.

C# Copy

```
// GET: api/TodoItems/5
[HttpGet("{id}")]
public async Task<ActionResult<TodoItem>> GetTodoItem(long id)
{
    var todoItem = await _context.TodoItems.FindAsync(id);

    if (todoItem == null)
    {
        return NotFound();
    }

    return todoItem;
}
```

Return values

The return type of the `GetTodoItems` and `GetTodoItem` methods is ActionResult<T> type. ASP.NET Core automatically serializes the object to JSON and writes the JSON into the body of the response message. The response code for this return type is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

`ActionResult` return types can represent a wide range of HTTP status codes. For example, `GetTodoItem` can return two different status values:

- If no item matches the requested ID, the method returns a 404 NotFound error code.
- Otherwise, the method returns 200 with a JSON response body. Returning `item` results in an HTTP 200 response.

The PutTodoItem method

Examine the `PutTodoItem` method:

C# Copy

```
// PUT: api/TodoItems/5
[HttpPut("{id}")]
public async Task<IActionResult> PutTodoItem(long id, TodoItem todoItem)
{
    if (id != todoItem.Id)
    {
        return BadRequest();
    }

    _context.Entry(todoItem).State = EntityState.Modified;

    try
    {
        await _context.SaveChangesAsync();
    }
    catch (DbUpdateConcurrencyException)
    {
        if (!TodoItemExists(id))
        {
            return NotFound();
        }
        else
        {
            throw;
        }
    }

    return NoContent();
}
```

`PutTodoItem` is similar to `PostTodoItem`, except it uses HTTP PUT. The response is 204 (No Content). According to the HTTP specification, a PUT request requires the client to send the entire updated entity, not just the changes. To support partial updates, use HTTP PATCH.

If you get an error calling `PutTodoItem`, call `GET` to ensure there's an item in the database.

Test the PutTodoItem method

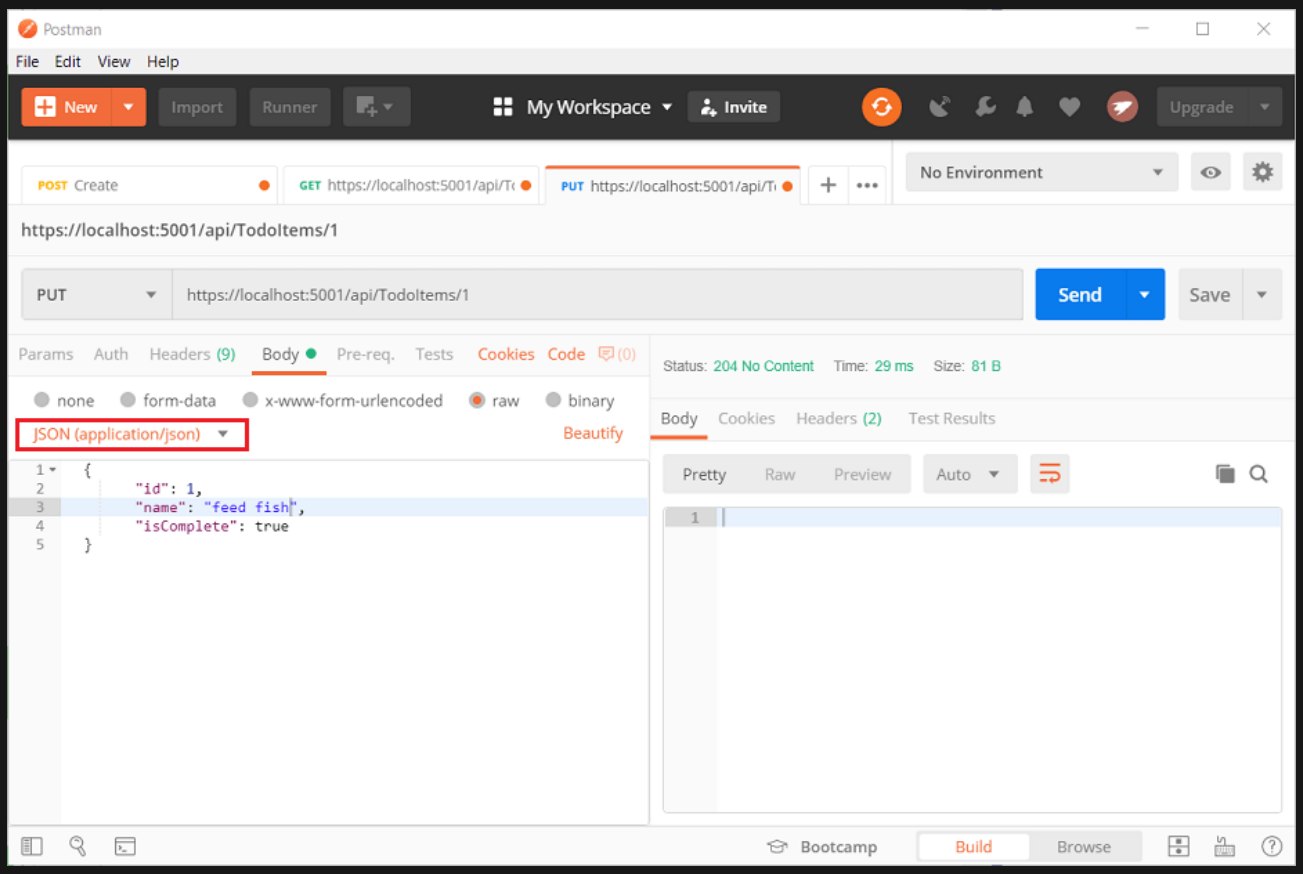
This sample uses an in-memory database that must be initialized each time the app is started. There must be an item in the database before you make a PUT call. Call GET to ensure there's an item in the database before making a PUT call.

Update the to-do item that has Id = 1 and set its name to "feed fish":

JSON Copy

```
{
  "id":1,
  "name":"feed fish",
  "isComplete":true
}
```

The following image shows the Postman update:



The DeleteTodoItem method

Examine the `DeleteTodoItem` method:

C# Copy

```
// DELETE: api/TodoItems/5
[HttpDelete("{id}")]
public async Task<ActionResult<TodoItem>> DeleteTodoItem(long id)
{
    var todoItem = await _context.TodoItems.FindAsync(id);
    if (todoItem == null)
    {
        return NotFound();
```

```
    }

    _context.TodoItems.Remove(todoItem);
    await _context.SaveChangesAsync();

    return todoItem;
}
```

Test the DeleteTodoItem method

Use Postman to delete a to-do item:

- Set the method to `DELETE`.
- Set the URI of the object to delete (for example `https://localhost:5001/api/TodoItems/1`).
- Select **Send**.

Prevent over-posting

Currently the sample app exposes the entire `TodoItem` object. Production apps typically limit the data that's input and returned using a subset of the model. There are multiple reasons behind this and security is a major one. The subset of a model is usually referred to as a Data Transfer Object (DTO), input model, or view model. **DTO** is used in this article.

A DTO may be used to:

- Prevent over-posting.
- Hide properties that clients are not supposed to view.
- Omit some properties in order to reduce payload size.
- Flatten object graphs that contain nested objects. Flattened object graphs can be more convenient for clients.

To demonstrate the DTO approach, update the `TodoItem` class to include a secret field:

C# Copy

```
public class TodoItem
{
    public long Id { get; set; }
    public string Name { get; set; }
    public bool IsComplete { get; set; }
```

```
    public string Secret { get; set; }
}
```

The secret field needs to be hidden from this app, but an administrative app could choose to expose it.

Verify you can post and get the secret field.

Create a DTO model:

C# Copy

```
public class TodoItemDTO
{
    public long Id { get; set; }
    public string Name { get; set; }
    public bool IsComplete { get; set; }
}
```

Update the `TodoItemsController` to use `TodoItemDTO`:

C# Copy

```
    [HttpGet]
    public async Task<ActionResult<IEnumerable<TodoItemDTO>>> GetTodoItems()
    {
        return await _context.TodoItems
            .Select(x => ItemToDTO(x))
            .ToListAsync();
    }

    [HttpGet("{id}")]
    public async Task<ActionResult<TodoItemDTO>> GetTodoItem(long id)
    {
        var todoItem = await _context.TodoItems.FindAsync(id);

        if (todoItem == null)
        {
            return NotFound();
        }

        return ItemToDTO(todoItem);
    }

    [HttpPut("{id}")]
    public async Task<IActionResult> UpdateTodoItem(long id, TodoItemDTO
todoItemDTO)
    {
```

```
        if (id != todoItemDTO.Id)
        {
            return BadRequest();
        }

        var todoItem = await _context.TodoItems.FindAsync(id);
        if (todoItem == null)
        {
            return NotFound();
        }

        todoItem.Name = todoItemDTO.Name;
        todoItem.IsComplete = todoItemDTO.IsComplete;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException) when (!TodoItemExists(id))
        {
            return NotFound();
        }

        return NoContent();
    }

    [HttpPost]
    public async Task<ActionResult<TodoItemDTO>> CreateTodoItem(TodoItemDTO
todoItemDTO)
    {
        var todoItem = new TodoItem
        {
            IsComplete = todoItemDTO.IsComplete,
            Name = todoItemDTO.Name
        };

        _context.TodoItems.Add(todoItem);
        await _context.SaveChangesAsync();

        return CreatedAtAction(
            nameof(GetTodoItem),
            new { id = todoItem.Id },
            ItemToDTO(todoItem));
    }

    [HttpDelete("{id}")]
    public async Task<IActionResult> DeleteTodoItem(long id)
    {
        var todoItem = await _context.TodoItems.FindAsync(id);

        if (todoItem == null)
```

```
        {
            return NotFound();
        }

        _context.TodoItems.Remove(todoItem);
        await _context.SaveChangesAsync();

        return NoContent();
    }

    private bool TodoItemExists(long id) =>
         _context.TodoItems.Any(e => e.Id == id);

    private static TodoItemDTO ItemToDTO(TodoItem todoItem) =>
        new TodoItemDTO
        {
            Id = todoItem.Id,
            Name = todoItem.Name,
            IsComplete = todoItem.IsComplete
        };
}
```

Verify you can't post or get the secret field.

Call the web API with JavaScript

See Tutorial: Call an ASP.NET Core web API with JavaScript.

Add authentication support to a web API 2.1

ASP.NET Core Identity adds user interface (UI) login functionality to ASP.NET Core web apps. To secure web APIs and SPAs, use one of the following:

- Azure Active Directory
- Azure Active Directory B2C (Azure AD B2C)
- IdentityServer4

IdentityServer4 is an OpenID Connect and OAuth 2.0 framework for ASP.NET Core. IdentityServer4 enables the following security features:

- Authentication as a Service (AaaS)
- Single sign-on/off (SSO) over multiple application types
- Access control for APIs
- Federation Gateway

For more information, see Welcome to IdentityServer4.

Additional resources 2.1

View or download sample code for this tutorial. See how to download.

For more information, see the following resources:

- Create web APIs with ASP.NET Core
- ASP.NET Core Web API help pages with Swagger / OpenAPI
- Razor Pages with Entity Framework Core in ASP.NET Core - Tutorial 1 of 8
- Routing to controller actions in ASP.NET Core
- Controller action return types in ASP.NET Core web API
- Deploy ASP.NET Core apps to Azure App Service
- Host and deploy ASP.NET Core
- YouTube version of this tutorial